A PROFESSIONAL GUIDE FOR PROJECT CONTROLLERS

Project Scheduling Professional

Planning, Control and
PMI-SP Examination Preparation



Professor Amgad Badewi

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First edition, 2026.

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Formal scheduling definitions quoted from Project Management Institute, Practice Standard for Scheduling, Third Edition (2019), retain the source wording and are identified by printed page references. Source inconsistencies are discussed separately from the quotations.

The examples and practice questions are educational. Original illustrative scenarios are distinguished from documented cases. Professional decisions should take account of the applicable contract, organisational procedures, evidence and specialist advice.

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Executive summary

A project schedule is a reasoned account of how an organisation intends to deliver a result. Its value lies in the decisions it enables: whether a commitment is credible, where scarce resources should be directed, which uncertainty deserves attention and what action is justified when circumstances change. A collection of dates becomes useful only when the work, relationships, assumptions and responsibilities behind those dates can be explained. This book develops that capability for project controllers, planners, schedulers and other professionals preparing for the PMI Scheduling Professional (PMI-SP) examination.

The central argument is that credible scheduling combines analytical discipline with professional judgement. Network calculations matter, but a mathematically correct network can omit essential acceptance work. A detailed resource plan matters, but a resource assignment cannot create capacity that does not exist. A probability distribution can inform a commitment, but it cannot guarantee a completion date. A baseline establishes an authorised reference, while a forecast explains the current expectation; confusing the two weakens both accountability and decision-making. The professional task is to connect these different forms of evidence into a coherent account of delivery.

The book follows the schedule through its life cycle, from the first planning decision to final closeout. Its fourteen chapters progressively develop the underlying concepts, methods and controls. The sequence supports readers meeting scheduling for the first time while retaining the depth needed for substantial project controls responsibilities. No previous study of risk management, programme management or another optional module is assumed. Statistical ideas, resource constraints and earned value measures are introduced in their scheduling context, with worked examples, comparisons and explicit discussion of their limitations.

Building a credible delivery argument

The opening chapters establish the purpose and architecture of a schedule. They distinguish the scheduling approach, the software tool, the project-specific model, a controlled model instance and the presentations used to communicate its results. They then establish the planning framework: what the schedule must represent, how much detail is useful, how responsibilities are allocated and which control rules make subsequent updates trustworthy. Scope is translated into activities, milestones and interfaces, with particular attention to the acceptance evidence that makes a milestone meaningful. Duration estimates and working calendars give time a defensible basis before network calculations begin.

Logic development makes the delivery argument testable. Dependencies, leads, lags, calendars and constraints determine what can proceed, what must wait and which sequence controls a stated completion. Critical path and float calculations are treated as explanations of the model under stated assumptions. The digital schedule and its basis of schedule then preserve those assumptions in a form that can be reproduced, challenged and maintained. This distinction is essential: the scheduling application performs calculations, while the organisation remains responsible for the plan that those calculations represent.

Feasibility and uncertainty require further tests. Resource analysis examines whether the people, equipment, access and working conditions implied by a schedule are actually available. Resource optimisation can change the controlling sequence and the forecast finish; it should therefore be explained alongside its consequences for cost, productivity and delivery risk. Schedule risk analysis examines the range of possible outcomes and the effects of common drivers, correlation, alternative scenarios and

responses. A credible milestone is supported by evidence about these conditions, together with a clear explanation of the confidence that the evidence can justify.

Different kinds of work also require different planning arrangements. Adaptive, lean and location-based approaches offer ways to organise learning, manage flow and coordinate repeated work. They are compared with network-based scheduling in relation to the decisions each method supports. Hybrid arrangements require explicit interfaces and compatible control rules. Method selection is therefore a design decision about the work and its uncertainty, rather than a contest in which one label must replace every other approach.

Maintaining control as delivery changes

An approved baseline begins a continuing control process. Progress evidence must distinguish actual events from estimates, measure completed work consistently and explain the basis of the remaining forecast. Data dates, calendars, relationships and status rules determine whether an update describes a coherent state of the project. Performance measures help identify variation, but their interpretation depends on their units, scope and assumptions. A favourable aggregate indicator cannot, on its own, demonstrate that a critical milestone is secure.

Change control and recovery planning connect analysis with authority. The controller must distinguish the effect of an approved change from the effect of poor performance, preserve the evidence behind successive forecasts and test recovery options for feasibility. Acceleration, resequencing and added capacity can have different consequences for cost, risk and quality. Delay analysis requires particular care about records, causation and the purpose of the analysis. The book develops these distinctions without treating a software output as a substitute for contractual or professional judgement.

Assurance examines whether the schedule is fit for its intended decisions. It includes structural checks, component conformance and substantive examination of the delivery argument. An apparently healthy metric can coexist with unrealistic assumptions; conversely, a flagged exception may be justified when its meaning and control are understood. Assurance findings should therefore lead to proportionate action and a clear account of any remaining limitations. Stakeholder communication completes the control cycle by placing reliable, relevant information before the people who have to act on it.

Closeout preserves the value of the scheduling record. Final status, approved changes, actual performance and the basis of key decisions should be reconciled before lessons are drawn. Historical information becomes useful for future estimates only when its context, units and limitations remain visible. The closing chapters therefore connect examination readiness with the ability to explain and defend a complete scheduling decision, from strategy and development through monitoring, communication and closeout.

Examination preparation and professional application

The examination strand follows the five domains of the published PMI-SP Examination Content Outline: Schedule Strategy; Schedule Planning and Development; Schedule Monitoring and Controlling; Schedule Closeout; and Stakeholder Communications Management. The chapters develop the concepts and judgement associated with those domains through original questions and explained answers. Appendix C provides a full-length, 170-question practice examination with answer explanations and a domain performance index. Practice results are diagnostic information for study; they do not reproduce PMI's scoring system or predict certification success.

The professional strand extends this preparation through documented cases, academic research and official publications from the United Kingdom and other national settings. These sources expose the

practical consequences of incomplete scope, optimistic assumptions, weak interfaces and poorly communicated uncertainty. Cases are used to test the reasoning behind a scheduling decision, rather than to imply that every project in a sector follows the same pattern. Independent illustrative examples allow readers to practise calculations without confusing invented learning assumptions with reported project evidence.

Two reference appendices support precise use of the terminology. Appendix A brings together scheduling definitions and acronyms, with the printed page references of the source standard. Appendix B explains the schedule component catalogue and its relationship with conformance assessment. Where the source contains inconsistencies, the quotation and the subsequent technical explanation remain distinct. This makes it possible to preserve a source definition while teaching the calculation or interpretation needed in practice.

The intended outcome is a reader who can build, interrogate and communicate a credible schedule, and explain what would make its conclusions change. That capability rests on several habits: make assumptions visible; connect milestones to acceptance evidence; test logic and resources together; distinguish measurement from inference; preserve the authorised reference; and give decision-makers a clear account of uncertainty and options. These habits support both disciplined examination preparation and the professional judgement expected of a project controls practitioner.

How to use this book

Read the chapters in sequence when developing scheduling knowledge from first principles. Readers with practical experience can use the chapter sequence below to locate a specific control problem, then return to the foundational chapters if a term or calculation needs clarification. Each chapter brings together explanatory teaching, a chapter framework, illustrations, comparison tables, documented cases, examination practice and references. The original frameworks organise the reasoning taught in this book; they are not additional PMI standards or validated certification instruments.

Table F.1 | Learning sequence

Stage of the scheduling work	Chapters	Principal question
Establish purpose and structure	1-3	What must the schedule represent, and which decisions must it support?
Build a reproducible model	4-6	How do estimates, calendars and relationships produce the calculated dates?
Test feasibility and uncertainty	7-9	Can the proposed work be delivered, and which approach and confidence are justified?
Maintain and assure control	10-12	What does current evidence imply, and what action or authorisation is needed?
Communicate and demonstrate judgement	13-14	How should the decision be explained, preserved and defended?

Attempt the chapter questions before reading their explanations. When an answer is wrong, reconstruct the reasoning rather than memorising the option letter. For a numerical question, record the unit, calendar, data date and assumptions before calculating. For a scenario question, identify the decision, the available evidence and the authority needed for the proposed action. These habits help distinguish a technically possible intervention from the most appropriate professional response.

Use Appendix A when terminology needs precision and Appendix B when a schedule field or conformance rule needs closer examination. Source page citations refer to the printed pagination of PMI's *Practice Standard for Scheduling*, Third Edition, rather than the page number displayed by a PDF reader. Formal quotations retain the source wording and spelling. The surrounding discussion uses British English. Examples, tables and figures distinguish original teaching material from findings attributed to published sources.

Use the practice examination in Appendix C after studying the main chapters. Set aside the stated time, keep the answer explanations out of view and record one response to each question. Examine performance by domain and by type of error, including terminology, calculation, omitted constraints and decision reasoning. Return to the relevant teaching before attempting a changed example. Consult PMI's official certification information for the examination arrangements that apply when booking.

The book supports independent study without another course module or a particular software package. Check software implementation against the application's documentation and approved organisational

procedures. Investigate any result that cannot be explained from its underlying assumptions, however polished its presentation may appear.

Working with calculations and evidence

Read each worked calculation as an explanation of a particular model. Establish whether its units are working days, elapsed days, labour hours, currency or completed items before using the numbers. Locate the time origin, the information cut-off and the stated calendar. Then follow the intermediate steps and explain the result in words. If an assumption changes, reconsider the calculation rather than carrying its original answer into a different situation. Reproducing the arithmetic and interpreting its meaning are related but distinct skills.

Keep an estimate, a calculated result and an authorised commitment separate in your notes. An estimate expresses a judgement about the work under stated conditions. A model calculates consequences from its inputs and rules. A commitment also involves a decision about acceptable exposure and the authority to accept it. The examples in this book often place these three ideas close together because a practical recommendation depends on their relationship. When studying, identify which idea a question addresses before choosing a formula or proposing an action.

Read documented cases with the same care. Identify what the cited publication actually establishes, the period it describes and the limitations of the available evidence. A reported delay does not, by itself, demonstrate that one scheduling method caused it. An association in a research study is not automatically a causal explanation, and a successful outcome does not prove that every earlier forecast was justified. Use each case to test a particular reasoning step, then consider which conditions would have to hold before transferring its lesson to another project.

Finally, distinguish the book's teaching frameworks from the source standard's formal terminology. A framework can organise an investigation or make a discussion more consistent without becoming a validated score. Use the illustrations to explain connections, the comparison tables to identify differences and the references to examine the underlying evidence. Your explanation should remain understandable to somebody who has not seen the diagram or used your scheduling software.

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CHAPTER 01

Understanding Scheduling and Credible Delivery

The decision behind a delivery date

A delivery date is useful when somebody can explain what must happen for it to be achieved. A sponsor may need to announce an opening, an operations manager may need to release a plant for maintenance, and a supplier may need to reserve a production slot. Each decision depends on more than the appearance of a date in a report. The underlying work must be understood, the sequence must be possible, the people and equipment must be available, and the remaining uncertainty must be recognised. Scheduling connects these conditions so that the organisation can decide what to do, when to commit and when to reconsider. For a project controls professional, the central question is therefore how much confidence the evidence justifies in the proposed delivery date.

This chapter develops that question from first principles. It explains why scheduling matters, distinguishes the principal terms used by PMI, compares delivery life cycles and introduces the main scheduling approaches. It then connects the schedule with wider project controls and develops a practical framework for testing milestone credibility. The final section considers professional judgement, the traceability of planning evidence and PMI-SP preparation. The mathematics of critical paths, resource optimisation and quantitative schedule risk will be developed in later chapters. Here, the objective is to understand what those techniques are intended to explain and which decisions they should support.

The terminology follows PMI's *Practice Standard for Scheduling*, Third Edition. Definitions quoted from that publication retain its wording, including American spelling within quotations; the chapter's own explanation uses British English. The standard concentrates on individual project schedules, principally using the critical path approach, while also discussing adaptive and other approaches. Its principles can inform the schedules of projects within programmes, but it is not itself a programme or portfolio scheduling standard (PMI, 2019, pp. 2-8). The PMI-SP examination content outline provides the examination reference. The additional models, cases and independent examples develop the judgement expected of a Level 6 project controls professional.

The illustrative examples in this chapter are independent teaching scenarios. Their durations and arrangements are stated where they are used; they are not industry benchmarks or reported project performance. They require no prior knowledge of another module or case study. Documented real projects are identified separately and supported by published sources. The distinction matters because a small invented network can make a calculation transparent, while a published case can show the organisational conditions within which scheduling decisions must be made.

The chapter framework

The **Credible Delivery Framework** brings together six questions that will recur throughout the book. First, is the required outcome and its acceptance evidence clear? Second, does the schedule include the necessary work and interfaces? Third, does the selected approach represent a feasible sequence and a sensible way of learning? Fourth, are resources, calendars and operating conditions realistic? Fifth, has uncertainty been examined, including alternative actions? Finally, has the reasoning been challenged by appropriate people who understand their responsibilities? These questions provide a structure for explanation and review; they are not an additional PMI standard or a numerical certification scheme.

The framework should be used as a connected argument. A strong resource plan cannot compensate for omitted commissioning work. A carefully calculated critical path cannot justify a date if its activity durations depend on an unavailable specialist. An independent reviewer cannot make an ambiguous acceptance condition measurable merely by signing a form. Equally, uncertainty does not mean that planning is pointless. It means the team must state which conditions support its forecast, what could change it and how it will respond. Figure 1.1 places the six questions around the delivery decision because every question contributes to the same judgement.

Figure 1.1 | The Credible Delivery Framework

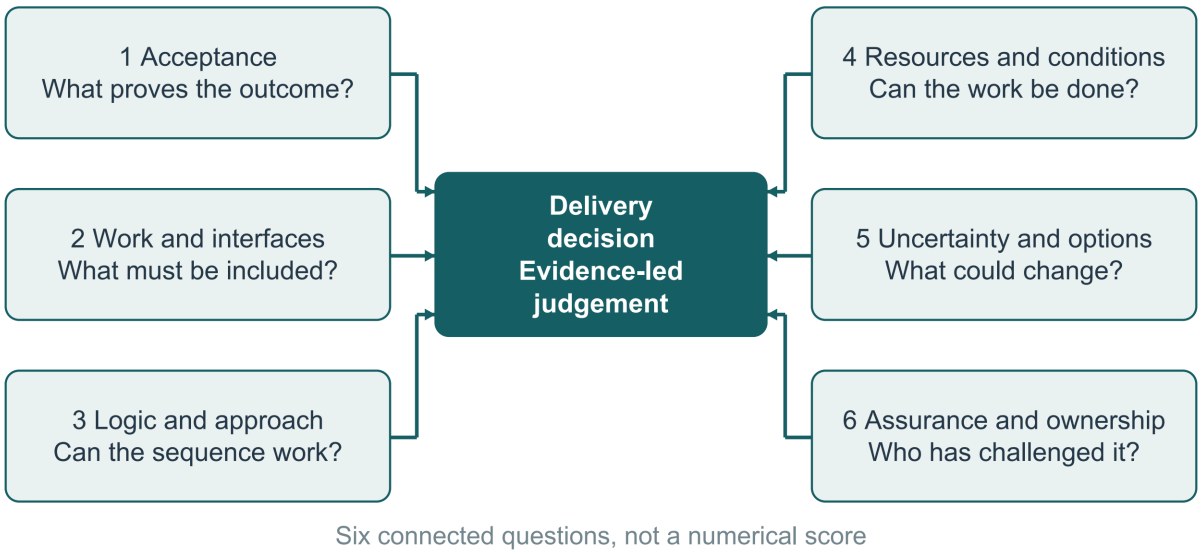


Figure 1.1. An original teaching framework for this book. The six tests organise professional reasoning; they are not a validated scoring model. Foundations: PMI (2019), with the evidence-led perspective of GAO (2015).

By the end of the chapter, you should be able to explain the value and limits of a schedule, distinguish a model from its published views, compare life cycles and methods, trace a delivery date to its supporting conditions, and identify an appropriate improvement to planning practice. You should also be able to recognise when a question concerns the examination's scheduling principles and when it asks for a broader professional recommendation. Both require clear reasoning, but only the published PMI-SP outline determines examination scope.

1.1 The purpose and value of scheduling

Coordinating work and enabling decisions

A project brings together activities that consume time and resources while depending on information, decisions and other work. Scheduling makes those relationships explicit enough to be examined. In an illustrative equipment-installation project, purchasing a control panel before the relevant design has been accepted could create rework. Waiting until every civil activity is finished before considering operator training could postpone useful preparation. The schedule helps the team distinguish genuine dependencies from habitual sequencing, identify opportunities for parallel work and see which decisions need attention now. Its value comes from improving coordination and decisions throughout delivery, rather than from the original production of a bar chart.

PMI explains scheduling as the application of knowledge, skills, tools and techniques to develop and maintain useful schedule models. It links those models with communication, collaboration, performance reporting and the reassessment of remaining work as circumstances change (PMI, 2019, pp. 2-5). A credible model therefore has two connected uses. Before execution, it helps the team examine how the work could be performed. During execution, it helps explain what the latest evidence means for the future. A model that records yesterday accurately but cannot respond logically to a change in remaining work is incomplete as a management aid.

Consider a sponsor asking whether an additional survey is worth commissioning this week. The survey has a direct cost, but it may reveal a foundation issue before panel installation dates are agreed. The schedule allows the team to locate the investigation in time, identify the decisions that depend on it and assess whether its results could still change the delivery approach. Information has timing value: an accurate finding arriving after an irreversible commitment may be less useful than an earlier finding that allows the team to choose a different sequence. Scheduling therefore supports the timing of knowledge as well as the timing of physical work.

Objectives, outputs and operational readiness

An installed pumping system is a project output; reliable service at the required capacity is an example of the operational outcome sought from its use. A schedule should represent the work needed to bridge the two. Installing equipment does not by itself demonstrate that it functions as an integrated system, that operators can use it safely, that records are complete or that the organisation has authorised its use. These conditions differ between sectors and contracts, but the general scheduling question is stable: what evidence makes the claimed milestone true?

In a water-infrastructure project, the milestone 'pumping station ready' would be too ambiguous to support a serious commitment. The electrical contractor might interpret it as installation complete; the commissioning engineer might require successful system testing; the operator might require training, maintenance information and an accepted operating procedure. A better milestone description identifies the readiness state and the authority that confirms it. That wording then helps the planner identify the activities, evidence and interfaces needed before the milestone. Clear acceptance language improves the schedule because it exposes work that vague wording can conceal.

England case study Crossrail and the work behind opening

The National Audit Office's 2021 update on Crossrail provides a useful example of the distinction between visible construction progress and a credible opening programme. It reported that the central section had not opened in December 2018 as intended. Its examination of subsequent planning described how an April 2019 plan containing approximately 300 activities developed into a much more detailed plan with over 10,000 activities by August. The report also found that both plans relied on overoptimistic information about the completeness of the railway, while testing revealed further work. The finding concerns the quality of the underlying understanding, not a claim that increasing the number of activities caused delay (NAO, 2021, pp. 29-32).

The Elizabeth line's central section subsequently opened to passenger service on 24 May 2022, as recorded by the Department for Transport. That opening is a dated outcome, not evidence that every earlier forecast was sound or that one planning technique explains the result (DfT, 2022). For our purposes, the case invites a more useful question than whether a schedule looked detailed: how had the team demonstrated that the remaining work, integration and testing were sufficiently understood to support the opening forecast? A schedule may contain thousands of activities and still depend on incomplete evidence about the state of the asset.

The practical lesson applies across sectors. Before treating 'installation 95 per cent complete' as reassurance about operational readiness, ask what remains in the five per cent, what testing could reveal, and which acceptance activities depend on the final interfaces. A percentage describes a chosen measure; it does not automatically describe the amount of time or uncertainty remaining. A small quantity of unfinished work can control a large milestone if everything else depends on its completion. The lesson is to connect progress statements with the delivery logic and acceptance evidence, rather than infer readiness from an attractive aggregate figure.

What scheduling can and cannot establish

A schedule can expose a contradiction between scope, resources and a desired date. It can quantify the consequences of assumptions, compare feasible alternatives and preserve an agreed reference for control. It cannot guarantee the future, remove the need for competent delivery management or make unreliable data trustworthy. The US Government Accountability Office's *Schedule Assessment Guide* treats a reliable schedule as an essential management tool and relates schedule quality to comprehensive scope, sound construction, credibility and control (GAO, 2015). These qualities should be interpreted through evidence: what has been included, how it is connected, what supports its assumptions and how it is maintained.

This matters when a deadline is fixed. A contractual or policy requirement can be a legitimate constraint, but entering that date into software does not demonstrate that the work can finish by then. The team still needs to examine the gap between the required date and the modelled result. It might reduce scope through an authorised decision, change the delivery method, secure additional capacity, alter an interface or accept a different level of exposure. Where no feasible solution is supported, the professional contribution is to explain the unresolved gap and the decision it creates. Concealing it deprives the organisation of time to respond.

1.2 Understanding the language and architecture of a schedule

Work, events, resources and relationships

PMI defines a **logical relationship** as 'A dependency between two activities or between an activity and a milestone.' It describes a **resource** as 'A skilled human resource (specific disciplines either individually or in crews or teams), equipment, services, supplies, commodities, materials, budgets, or funds required to accomplish the defined work.' These definitions show why a schedule is more than a collection of dates: work requires inputs and is connected through dependencies (PMI, 2019, p. 2).

An activity represents work that takes time; a milestone represents a significant point or event. The distinction affects both modelling and communication. 'Test the integrated system' needs an allowance for the work, appropriate resources and a clear completion condition. 'Integrated test accepted' can then identify the event reached when the evidence has been accepted. Giving the acceptance milestone a zero duration does not mean that inspection or approval takes no effort; any time-consuming preparation, review or testing must be represented in the preceding activities. Otherwise, the model hides work inside an apparently instantaneous event.

Activity. 'A distinct, scheduled portion of work performed during the course of a project.' (PMI, 2019, p. 2)

Milestone. 'A significant point or event in a project, program, or portfolio.' (PMI, 2019, p. 183)

In a planning workshop, these terms provide practical tests. If the team cannot explain what is being done, who or what is required, and what makes the activity complete, the entry may be a label rather than a usable planning unit. If a relationship cannot be justified, it may be unnecessarily restricting the sequence. If an important dependency exists only in somebody's memory, the model may produce a forecast that the delivery team knows is impossible. Clear language allows technical specialists to challenge the model without first becoming expert users of the scheduling software.

Method, tool, model, instance and presentation

Scheduling tool. 'A tool that provides schedule component names, definitions, structural relationships, formats, and algorithms for schedule calculation that support the application of a scheduling method.' (PMI, 2019, p. 3)

Schedule model. 'A representation of the plan for executing the project’s activities including durations, dependencies, and other planning information, which is used to produce a project schedule along with other scheduling artifacts.' (PMI, 2019, p. 3)

Schedule model instance. 'A version of the schedule model that has been processed by a scheduling tool based on inputs and adjustments made to the project-specific data within the scheduling tool.' (PMI, 2019, p. 3)

Schedule presentation. 'An output published from a schedule model instance used to communicate project-specific data for reporting, analysis, and decision making.' (PMI, 2019, p. 3)

The scheduling method supplies the analytical approach, while the tool provides the functions through which it is applied. The model combines the project's particular activities, dependencies, durations and other information. Processing and saving that model produces an identifiable instance. A presentation selects and displays information from that instance for a particular audience. These distinctions matter because a failure at one level cannot necessarily be repaired at another. A clearer dashboard does not correct missing relationships, and a more capable tool does not decide whether the selected delivery approach suits the work.

For an illustrative plant-installation project, the team might use a critical path approach in its approved scheduling software. The model contains the design, procurement, installation and testing activities, with their calendars and dependencies. The instance saved after the month-six update records the information accepted at that point. An operations meeting might use a four-week look-ahead view from the same instance, while the sponsor receives a milestone summary. These presentations differ because the decisions differ; they should not contain contradictory forecasts arising from uncontrolled copies of the underlying information.

Figure 1.2 | From delivery approach to decision view

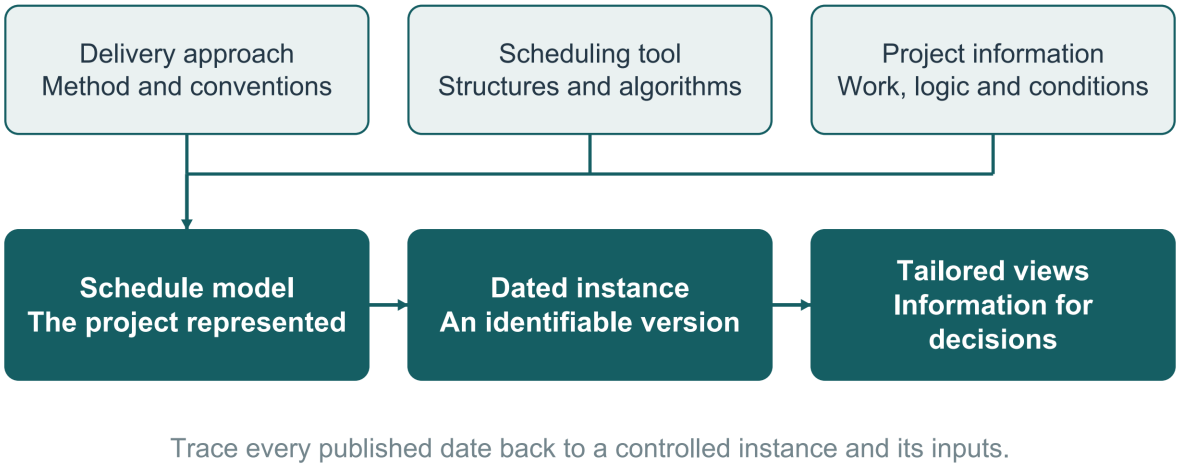


Figure 1.2. An original explanation of the layers of scheduling information. A published view should be traceable to an identifiable model instance and its inputs. Terminology follows PMI (2019, pp. 3-6).

The model remains selective. It represents the parts of reality needed to answer the planning and control questions, rather than every detail of human activity. Excessive detail can make updates difficult and conceal the relationships that matter; insufficient detail can hide work or prevent responsibility from being assigned. The appropriate level depends on purpose, risk, reporting frequency and the decisions that the audience needs to make. Chapter 2 examines schedule levels in depth. For now, the key test is whether the model is detailed enough to support its intended decisions and maintainable enough to remain current.

Table 1.1 | Method, tool, model, instance and presentation

Element	Its practical function	Illustrative example	A common misunderstanding
Approach or method	Determines how work and time are represented and analysed	Critical path analysis with rolling wave detail	Choosing software settles every methodological choice
Tool	Provides data structures and calculation functions	The employer's approved scheduling application	A calculation is reliable because software produced it
Model	Represents this project's delivery plan and assumptions	Linked design, supply, installation and test activities	A list of manually fixed dates is automatically a responsive model
Instance	Preserves an identifiable calculated version	The controlled month-six update	A saved file needs no status date or version context
Presentation	Shows information needed by a particular audience	Sponsor milestone report or team look-ahead	A bar chart contains all the reasoning behind its dates

Target, baseline, forecast and scenario

A target expresses an intended result. A baseline establishes the authorised reference against which performance and change can be assessed. A forecast expresses the expected future position using current information and stated assumptions. A scenario explores what might happen under a different set of conditions. These working distinctions prevent four different management questions from collapsing into one date. A team can reasonably retain an ambitious target while forecasting a later completion, provided the difference and the action needed to close it are visible. Changing a forecast is not, by itself, authority to replace the baseline.

> **Schedule baseline.** 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results.' (PMI, 2019, p. 189)

Suppose a sponsor wants an independently defined work package available at the end of week nine, while the currently approved plan finishes at the end of week ten. New supplier information suggests week eleven. A scenario with an additional installation crew produces a possible week-ten finish, subject to access and cost checks. Each date tells a different story: an aspiration, an authorised reference, a current expectation and a conditional alternative. Reporting only the most favourable number would conceal the decision. Reporting all four without explaining their status would create confusion. The professional task is to present a coherent recommendation with the evidence and authority associated with each position.

Figure 1.3 | Four dates with different meanings

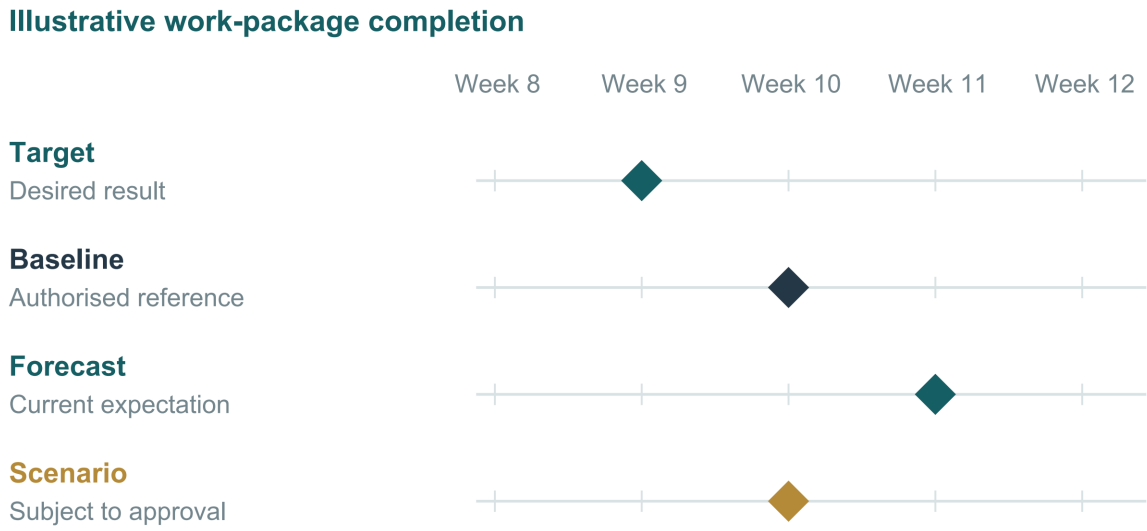


Figure 1.3. Illustrative teaching dates for a separate work-package scenario from the network in Figure 1.5. This is not a probability distribution. A scenario becomes an authorised plan only through the relevant review and decision process.

1.3 Selecting a life cycle that matches the work

Predictive planning and the stability of requirements

A predictive life cycle is useful when enough is understood about the required output and delivery method to plan much of the work before execution. It does not imply that change is impossible or that the original plan should never be challenged. A civil foundation package may use a predictive sequence because its design requirements, construction activities and inspections can be established in advance. The resulting model still needs to respond to actual progress, changed conditions and approved changes. Predictive planning is an approach to organising knowledge and commitments, not a claim that the future is certain (PMI, 2019, pp. 10-14).

The amount of useful advance planning depends on the quality of available information. Drawing a highly detailed sequence for a technical solution that has not yet been established can create an impression of certainty without increasing understanding. Conversely, describing mature, tightly constrained work as uncertain can become an excuse for avoiding necessary coordination. The planner should investigate what is genuinely known, what can be resolved before commitment and what must be learned through delivery. The question is not whether detailed planning is desirable in the abstract, but where detail has a defensible basis and a useful purpose.

Iterative and incremental delivery

An iterative approach develops understanding through repeated refinement. A design team may build and test a prototype, obtain feedback and improve the design before committing to the final version. An incremental approach delivers usable portions progressively. A digital monitoring system might release an initial operating dashboard and then add additional functions. These characteristics can coexist, but they answer different questions. Iteration concerns how the work is improved; increments concern how value is delivered in usable portions. Repeating an internal design review does not automatically create an increment that a customer can use.

In an illustrative industrial upgrade, the civil works may be largely predictive while the operator interface benefits from iterative demonstrations. The team could test a mock-up with operators, discover that alarm messages are confusing and revise the display before the final configuration. If the monitoring capability can be safely released in usable stages, incremental delivery may also be possible. The schedule must show where these learning cycles interact with fixed physical interfaces and acceptance requirements. Labelling one workstream 'agile' does not remove the need to coordinate it with procurement, commissioning and operational changeover.

Adaptive and hybrid delivery

Adaptive approaches organise work to accommodate continuing discovery and changing priorities. PMI explains adaptive life cycles through combinations of iterative and incremental characteristics and discusses both iteration-based and flow-based ways of working. Hybrid delivery combines characteristics where different parts of the project need different arrangements (PMI, 2019, pp. 12-13, 21-23). A hybrid design should therefore explain the boundaries, handovers and decision rules between approaches. Simply combining meetings and documents from several methods is not enough to show that the resulting system is coherent.

Research supports taking the choice seriously rather than treating hybrid delivery as a compromise of lesser quality. Gemino, Reich and Serrador (2021) examined 477 projects across industries and countries. Their observational analysis associated hybrid and agile approaches with stronger stakeholder outcomes than the study's traditional category, while time, budget, scope and quality outcomes were similar. This does not establish that adopting a hybrid label causes success. Mirzaei, Mabin and Zwikael (2025), drawing on ten qualitative case studies, examined how organisations combined practices in relation to team type, project goals and coordination needs. Together, the studies support an evidence-based selection conversation; neither supplies a universally best arrangement for every project.

The planner should ask whether requirements are sufficiently stable, how quickly useful feedback can be obtained, whether partial outputs can be used safely, and how strongly the work depends on external approvals or physical interfaces. Some activities can be reprioritised at short notice; others require an agreed outage or a long manufacturing lead time. A project may therefore use a predictive master schedule to coordinate major commitments while planning the detail of a software or design workstream adaptively. The master schedule must represent the workstream's deliverables and interfaces without pretending that every future task is already known.

Figure 1.4 | Comparing ways of learning and delivering

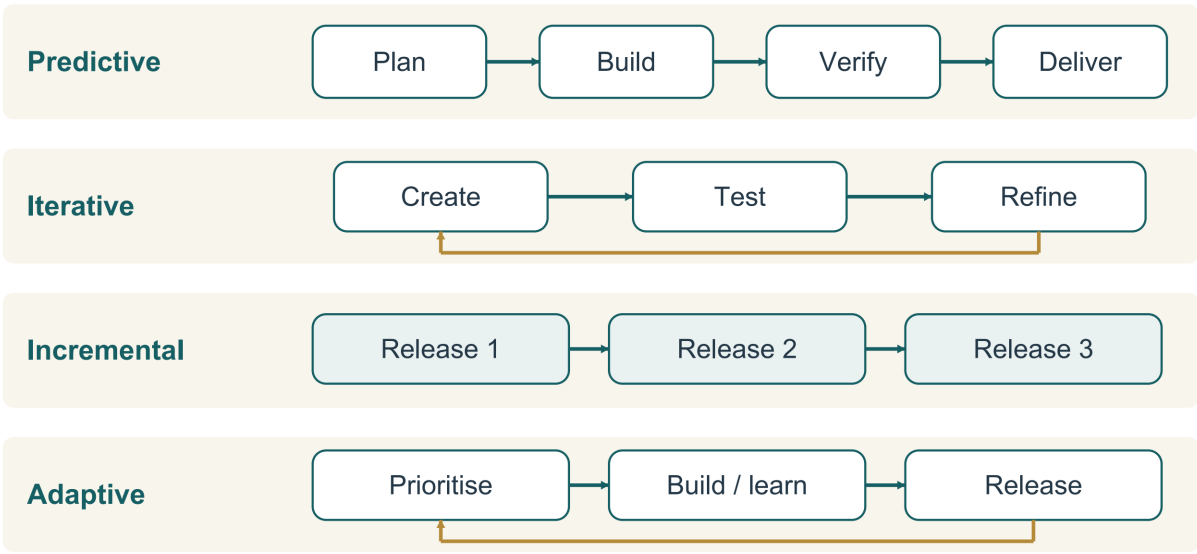


Figure 1.4. Original conceptual illustrations. Predictive work uses an established sequence; iterative work refines a solution; incremental work releases usable portions; adaptive work combines learning and delivery. Real projects may combine these patterns.

Table 1.2 | Comparing project life cycles

Life cycle	When it can be useful	What the schedule must make visible	Limitation to examine
Predictive	Requirements and delivery methods are sufficiently understood	Planned sequence, dependencies, commitments and update rules	Early assumptions may be treated as settled facts
Iterative	Feedback is needed to refine a solution	Learning cycles, reviews and criteria for proceeding	Repeated refinement may continue without clear decision points
Incremental	Usable portions can be delivered progressively	Release content, interfaces and acceptance for each increment	Partial delivery may create integration or operational burdens
Adaptive	Discovery and prioritisation continue during delivery	Short planning horizons, flow or iteration controls and forecasts	Flexibility can be overstated where external commitments are fixed
Hybrid	Different workstreams need different arrangements	Boundaries, integration milestones and compatible control rules	Unclear handovers can leave dependencies unmanaged

A practical selection conversation

Before selecting a life cycle, bring the people who understand the work into the conversation. Ask what can be specified now, what evidence could change the solution, which decisions are expensive to reverse, and what the receiving organisation could actually use at intermediate stages. Then test the proposed approach against contractual, operational and safety conditions. For a project combining physical works and a digital control interface, this discussion might support predictive planning for civil works, iterative development of the operator interface and a controlled integrated commissioning sequence. The resulting choice should be recorded as a reasoned design decision, with conditions for review if the project changes.

For PMI-SP preparation, retain the principle that all these approaches require planning. Their differences concern the timing, detail and form of planning and the way new information is incorporated. A question presenting adaptive work as having no schedule, no dependencies or no control is likely to be hiding a conceptual error. At Level 6, extend the reasoning by explaining how the selected approach fits the actual workplace context and what evidence would justify choosing differently. That explanation is more useful than claiming that one method is universally modern, efficient or superior.

1.4 Introducing the principal scheduling approaches

Critical path and the consequences of dependence

Critical path. 'The sequence of activities that represents the longest path through a project, which determines the shortest possible duration.' (PMI, 2019, p. 178)

Critical path method. 'A method used to estimate the minimum project duration and determine the amount of scheduling flexibility on the network paths within the schedule model.' (PMI, 2019, p. 178)

The apparent contradiction between the longest path and the shortest possible project duration is resolved by considering dependence. Several streams of work may proceed in parallel, but a common successor must wait for every required predecessor. The longest connected stream therefore sets the earliest completion under the model's stated assumptions. Shortening a different stream may create more spare time without moving the finish. This is a statement about the model and its conditions, not a promise that the real project will finish at that point. Resource limits, calendars, constraints and uncertainty can affect the result and require further analysis.

The independent work-package example in Figure 1.5 makes this reasoning visible. Design and its acceptance review take two weeks. Panel manufacture then takes four weeks, while site preparation takes three weeks and can proceed in parallel. Installation takes one week after both are complete, followed by two weeks of integrated testing. Assume a common working calendar, finish-to-start relationships, no lags, adequate separate resources, no rework and no additional date constraints. The manufacturing route takes $2 + 4 + 1 + 2 = 9$ weeks. The site route takes $2 + 3 + 1 + 2 = 8$ weeks. The earliest finish under these assumptions is therefore the end of week nine, not the sum of every activity duration.

Figure 1.5 | A small network with two converging routes

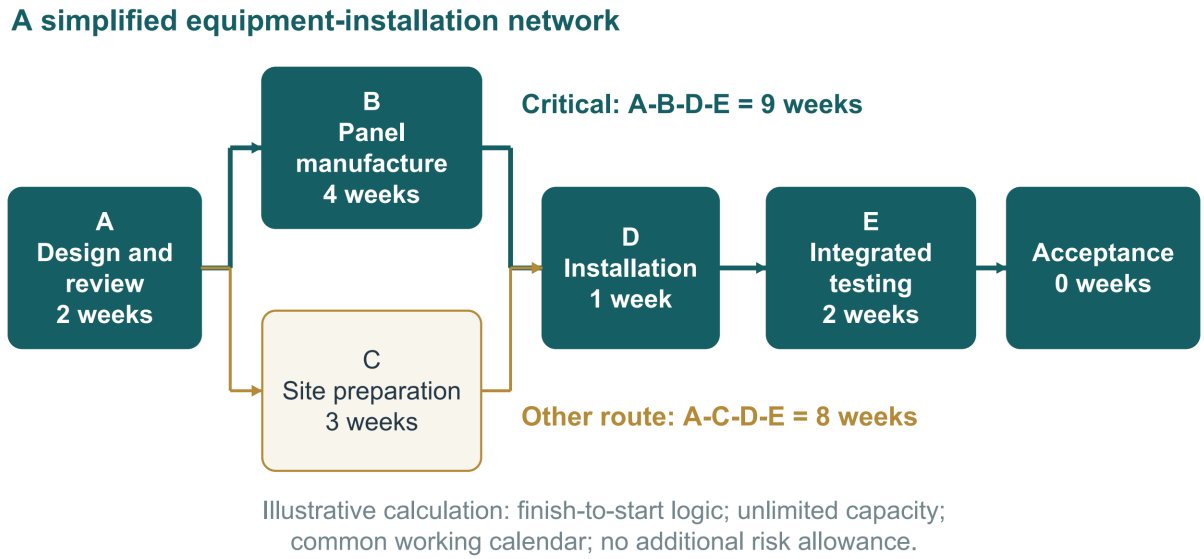


Figure 1.5. Independent illustrative work-package example. The manufacturing route controls the finish under the stated assumptions. The model is deliberately small so that the reasoning can be checked without software.

If panel manufacture takes one week longer, the earliest finish moves to the end of week ten, because installation must wait. If site preparation takes one additional week, both branches finish together and the earliest overall finish remains week nine. That difference illustrates the value of logic: equally sized delays can have different consequences depending on where they occur. It also explains why average activity progress can be misleading. A team could complete considerable work on the shorter branch while making no improvement to the date controlled by the longer branch. Chapter 5 develops these calculations and their complications in detail.

Now change a resource assumption. If the same specialist crew must perform both panel manufacture and site preparation, the parallel model is no longer feasible as drawn. If the crew must finish the four-week manufacturing activity before undertaking the three-week preparation activity, the simple sequence becomes 2 + 4 + 3 + 1 + 2 = 12 weeks. This is a deliberately artificial teaching constraint, not a typical staffing arrangement for such work. Its purpose is to show that a logical network can calculate correctly while representing impossible resource use. The planner must validate both the dependency structure and the capacity required to execute it.

Critical chain and protecting the delivery system

Critical chain approach. 'A schedule method that allows the project team to place buffers on any project schedule path to account for limited resources and project uncertainties.' (PMI, 2019, p. 178)

Critical chain brings resource dependence and protective buffers into the planning and control conversation. At an introductory level, the important distinction is that a resource can connect activities even where no technical dependency requires one to follow the other. If two packages both require the same scarce test team, they cannot necessarily proceed simultaneously. Protection also needs to be managed coherently: adding unexplained allowances to every activity can obscure the true sources of uncertainty and the decisions available to the team. Later chapters examine buffer placement and monitoring. Here, learners should recognise why limited capacity and uncertainty can make a purely logical, resource-unconstrained result insufficient.

Float and a buffer should not be treated as interchangeable words. Float arises from the relationships between network dates and paths, under the relevant calculation assumptions. A buffer is a deliberate element of the selected planning approach intended to accommodate uncertainty or protect a commitment. Both can influence decisions, but they arise differently and should have clear management rules. A team that spends an allowance without understanding what it protects may improve a local appearance while weakening the overall delivery position. The professional question is which commitment the allowance supports and how evidence about its consumption will influence action.

Rolling wave and deliberate progressive detail

> **Rolling wave planning.** 'An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.' (PMI, 2019, p. 189)

Rolling wave planning is useful where distant work cannot yet be decomposed responsibly, even though its overall scope and interfaces must be recognised. For example, the next design and procurement activities of an equipment project may be planned in detail while later commissioning work remains in larger planning packages until supplier information is available. The absence of detailed tasks does not remove the need to allow for that work, its resources, its dependencies or the time required to develop the detail. A mature rolling wave approach identifies when the next package must be elaborated and who is responsible for supplying the necessary information.

It is possible to misuse this approach by leaving difficult work vague until there is too little time to prepare it. If a commissioning package is due to begin in six weeks but depends on an operating procedure that takes eight weeks to approve, the team has already missed an important planning decision. Progressive detail should therefore be governed by the lead time needed to make reliable commitments. The framework's questions about completeness and resources still apply at a higher level. Uncertainty about detail should be visible as a condition to resolve, rather than concealed by an empty section of the schedule.

Repetitive work, flow and location

Location-based and linear approaches can make the movement of work through space easier to understand. A pipeline, road or series of repeated fit-outs may require several crews to move through locations in a coordinated sequence. A conventional activity list can represent the work, but a time-location view may make crew interference, production rates and interruptions more visible. Line of balance similarly supports reasoning about repetitive output over time. These approaches are not automatically superior to critical path analysis; they reveal particular characteristics of the work and may be combined with other views (PMI, 2019, pp. 25-27).

Flow-based and lean approaches direct attention to the conditions under which work is released and the amount of work in progress. Starting more activities is not always the same as completing useful outputs sooner. If downstream capacity is limited, releasing additional work may increase queues, competing priorities and unfinished inventory. In a configuration workstream, starting work on several incomplete design packages could overload the same reviewer and delay final acceptance of all of them. A useful planning discussion asks which work is ready, what capacity can genuinely receive it and how the team will identify and remove constraints. Chapter 9 develops the corresponding tools and representations.

Table 1.3 | Comparing scheduling approaches

Approach	Main question it helps answer	Useful setting	What it cannot establish alone
Critical path	Which connected sequence controls the calculated finish?	Work with identifiable activities and dependencies	Feasibility of unlimited parallel resource use or certainty of duration
Critical chain	How do scarce resources and protective buffers affect delivery?	Work with material resource dependence	A reliable result without sound assumptions and buffer governance
Rolling wave	How much detail is useful now and when is more needed?	Work with progressively available information	That unidentified future work can be ignored
Location or line of balance	How do crews and production move through repeated locations?	Linear or repetitive delivery	Every approval, external dependency or non-repetitive interface
Adaptive or flow-based planning	How will learning, priorities and available capacity shape the next work?	Evolving requirements or repeated service flow	Freedom from external milestones, acceptance or resource limits

The comparison should end in a justified choice rather than a contest between labels. Compare two plausible approaches by explaining what each would make visible, what each might hide and what information is still needed. A defensible early judgement can remain provisional. It is more useful to record the conditions under which a method would fit than to promise a complete scheduling strategy before examining the work.

1.5 Connecting the schedule with integrated project controls

Scope, resources, cost and risk

A schedule belongs within a wider controls system because decisions rarely affect time alone. A proposed acceleration might require extra expenditure, introduce congestion, change procurement terms or reduce the time available for testing. A cost saving might increase manufacturing duration or transfer work into a more constrained period. The model helps the team examine these relationships, but the decision requires information from the relevant disciplines. A planner should be able to explain where an assumption came from and whose judgement is needed to validate it, rather than regard the schedule as a separate technical product owned entirely by the planning function.

Consider an independent procurement example in which a team proposes bringing a panel delivery forward by two weeks. The supplier might be able to reserve an earlier production slot, but only if the design is accepted sooner. That decision could require additional design-review capacity and earlier expenditure. It might also reduce time for operator input, increasing the chance of later configuration changes. The delivery-date improvement is therefore conditional on a chain of technical, resource and commercial decisions. The appropriate recommendation sets out those conditions and compares the overall consequences. An unexplained date change in the schedule would hide the work needed to make it credible.

Figure 1.6 | Scheduling within integrated project controls

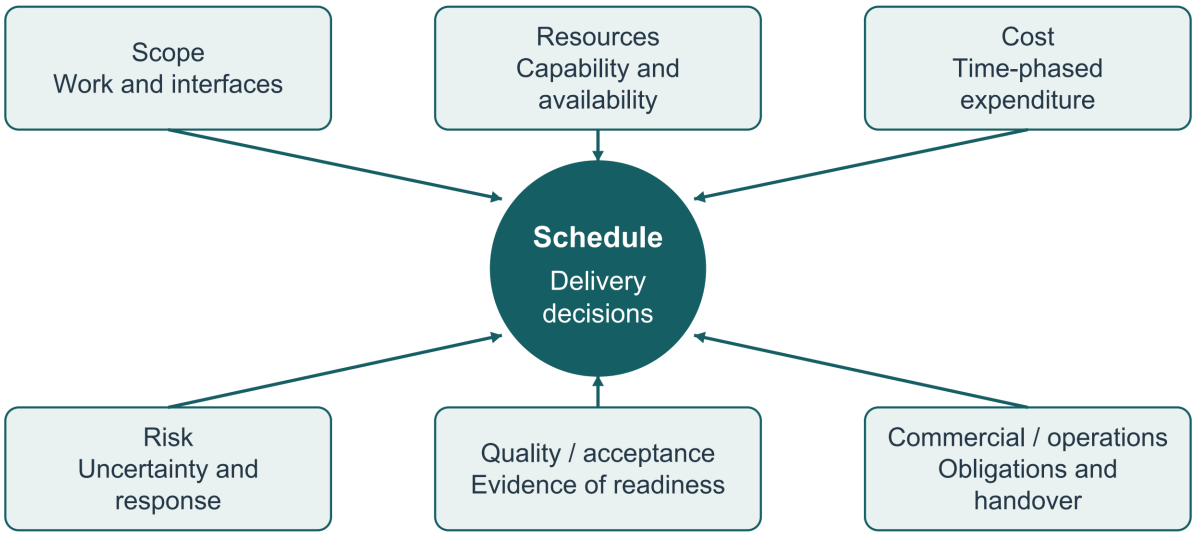


Figure 1.6. An original interface model. Each connection represents information and decisions that may change the schedule; the diagram does not imply that the scheduler holds every approval authority.

Decisions and information are scheduled work

Design reviews, client decisions, permits and acceptance activities can control delivery as strongly as physical production. They require inputs, competent reviewers and sufficient time. If an activity is labelled 'client approval' without an agreed submission standard or accountable decision-maker, the planner has recorded a hope rather than established a workable interface. The team should identify the information required, the review period, the process for comments and the condition that releases the successor work. This is especially important when a decision-maker supports several projects and their availability is a shared constraint.

The UK Infrastructure and Projects Authority's *Project Routemap: Systems Integration* provides an instructive positive case from the Francis Crick Institute. Its account describes planning sponsors' requirements and inputs through the life cycle, using board reporting to highlight forthcoming decisions and employing full-scale mock-ups to resolve user and interface questions. The guidance places systems integration within the client's responsibilities and encourages early visibility of problems (IPA, 2021, pp. 8, 22, 25). The transferable scheduling lesson is to plan the decisions and evidence that enable delivery, not simply the subsequent construction activities.

Germany case study planning the operational transition

The German Federal Government's account of Berlin Brandenburg Airport describes a staged transition: the airport opening on 31 October 2020, introduction of the south runway on 4 November and the closure of Tegel on 8 November. These events form a useful reminder that introducing a new asset and withdrawing an existing service can involve different dependencies and authorities (Federal Government of Germany, 2020). The government's account does not provide the complete underlying schedule, so the sequence should not be used to reconstruct a critical path or attribute a precise quantity of delay to a particular defect.

Germany's Federal Ministry of Transport also presents established major-project reform principles concerning early planning, transparent treatment of time and risk, clear responsibilities and collaboration. Its webpage was updated in 2026, but the recommendations it describes originated in

2015; they should not be mistaken for a newly issued 2026 standard (BMV, 2026). For a water-infrastructure replacement, the corresponding lesson is to schedule the transition between old and new pumping arrangements explicitly. The existing service may need to remain available until the replacement has passed agreed tests, operators are prepared and a controlled changeover has been authorised.

USA case study James Webb and the milestone beyond launch

In May 2021, GAO reported substantial technical progress on the James Webb Space Telescope alongside faster-than-expected consumption of schedule reserve. Its account identified remaining technical work, dependencies on launch partners and risks that would continue after launch. NASA had established arrangements for commissioning and contingency response (GAO, 2021, 'What GAO Found'). NASA's mission timeline records the actual launch on 25 December 2021 (NASA, n.d.). These sources describe different points in time: the audit's position before launch and the subsequent recorded event. The earlier report should not be treated as a current forecast.

For scheduling education, the case distinguishes a prominent public milestone from the whole sequence required to achieve the intended capability. Launch, deployment, commissioning and scientific use are related events with different evidence. A commercial or infrastructure project has its own technical conditions, but the same planning question is useful: what remains after the headline milestone, and who controls that work? In an equipment-installation project, delivery of a control panel is significant, yet installation, integrated testing and operational acceptance remain. The scheduler should make those successors visible instead of allowing the arrival of a major component to stand for completion of the work package.

Interfaces need owners as well as arrows

A logical link establishes an analytical relationship; it does not necessarily establish an effective working agreement. If a supplier must provide a test certificate before commissioning, someone must know the required content, delivery date, review route and escalation process. A predecessor labelled 'certificate received' can conceal several activities: preparation, checking, submission, review and correction. The appropriate detail depends on risk and importance, but the responsibilities should be clear even where the schedule uses a summary representation. Interface ownership connects the model with the people who can make its assumptions true.

This is where the PMI-SP foundation develops into Level 6 practice. A learner should be able to explain why a particular interface deserves attention, evaluate the adequacy of the evidence and recommend a proportionate improvement. That might mean agreeing a common calendar, clarifying acceptance criteria, establishing a review lead time or reconciling two contractors' different definitions of completion. The improvement need not involve sophisticated software. Its value should be visible in the quality of coordination, the credibility of the forecast or the speed with which an important decision can be made.

1.6 Testing the credibility of milestones

Applying the six evidence tests

Begin with the acceptance test: describe what will be true at the milestone and how the receiving party will know. Then examine completeness: identify the work, documentation, decisions and interfaces needed to reach that state. Test the sequence by asking whether the dependencies represent the delivery method and whether any assumed parallel working is possible. Test resources and conditions by examining capacity, calendars, access, supply and operating constraints. Test uncertainty by considering the reliability of durations, the possibility of rework and the effects of unresolved assumptions. Finally, test assurance and ownership by identifying who has challenged the evidence and who can authorise the commitment.

These tests should produce an intelligible argument rather than a decorative score. A statement such as 'the milestone passed five out of six checks' could be dangerously reassuring if the failed check concerns a legal access restriction or an unavailable commissioning team. The significance of a gap depends on what it controls. A useful review distinguishes evidence that is available, assumptions awaiting confirmation, gaps that prevent a commitment and actions that could resolve them. It also records the date of the evidence, because a resource commitment or supplier forecast may change after the review.

Figure 1.7 | From physical completion to accepted capability

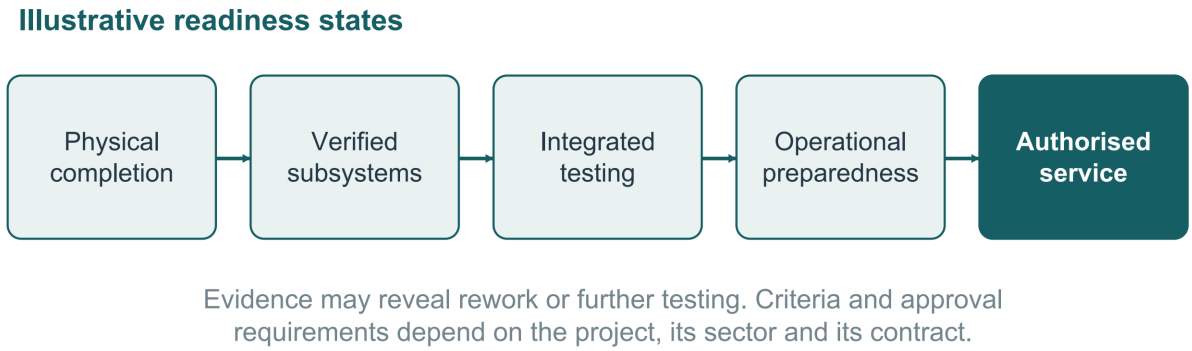


Figure 1.7. Illustrative readiness conditions for teaching. Actual projects may overlap or repeat these activities and must use their own contractual, technical and regulatory acceptance requirements.

UAE case study Barakah and staged readiness

Barakah Unit 4 supplied its first electricity to the UAE grid on 23 March 2024. The plant owner explained that progressive power testing would follow grid connection. Commercial operation was announced on 5 September 2024 by the Abu Dhabi Media Office (ENEC, 2024; Abu Dhabi Media Office, 2024). These are distinct milestones, each with a different meaning. Their separation is not evidence of a delay between two versions of the same commitment. The announcements support the dated events and the presence of testing between stages; they do not independently demonstrate performance against the original contractual baseline.

The practical application is to replace broad expressions such as 'plant complete' with identifiable acceptance states. A first successful output may demonstrate one capability while further testing, operating evidence or authorisation remains necessary. The schedule should identify the work that supports each state and the external interfaces that can control it. This is a conceptual transfer, not an assertion that a pumping station and a nuclear power plant share the same regulatory process. Sector-specific requirements must come from the relevant project authorities and technical specialists.

Egypt case study the Grand Egyptian Museum

Egypt's State Information Service announced in October 2024 that a partial trial run of the Grand Egyptian Museum would begin on 16 October. A later official account records the inauguration ceremony on 1 November 2025 (SIS, 2024; SIS, 2025). The first source is an advance announcement of a trial; the second records an inauguration. They do not establish an original completion baseline or support a delay calculation merely by subtracting the dates. Their value for scheduling is the distinction between testing selected operations and reaching a separately defined public milestone.

For an industrial installation, a trial run could reveal how the system behaves under controlled conditions and whether operating arrangements need refinement. Acceptance for routine service would require the agreed evidence to be complete. A ceremonial opening, if one exists, would be another event with its own dependencies. Keeping these milestones separate helps the organisation make decisions about what can safely proceed and what remains conditional. It also prevents a report from appearing to improve performance simply by changing the meaning of 'open'. The same discipline applies when comparing projects internationally: apparently similar milestone names may refer to different operational states.

France case study comparing the same milestone

The French Cour des comptes' 2025 report on the EPR programme presents successive Flamanville 3 targets, including entries referring to grid connection and others referring to fuel loading. Those labels must be preserved when comparing dates (Cour des comptes, 2025, p. 27, Table 1). EDF recorded first grid connection on 21 December 2024. The nuclear regulator's account explains that commissioning authorisation governed successive power-increase stages and the performance of start-up tests (EDF, 2024; ASN, 2025, p. 14). Fuel loading, first criticality, grid connection and full operating capability should therefore not be silently treated as the same event.

The professional lesson is about data identity as much as dates. A baseline milestone should have a stable description, an agreed acceptance condition and a traceable identifier. If its meaning changes, the change must be visible before a variance is calculated. Otherwise, a report may compare unlike events and produce an apparently precise result that answers the wrong question. This does not require elaborate technology: even a short milestone register can record the reference, definition, owner, evidence and version. The essential discipline is to preserve what the date represents.

What uncertainty changes about the argument

A calculated finish is conditional on the model's assumptions. It is not automatically a confidence statement. Two alternative schedules can have the same deterministic finish while exposing the project to different combinations of uncertain durations, resource conflicts or converging paths. Acebes and colleagues (2021) examined this distinction through methods tested on scheduling benchmark problems. Their work illustrates why planned duration alone is insufficient to characterise execution risk. It does not establish a universal improvement percentage for real projects, and the quality of any risk result still depends on its input assumptions.

At this stage, learners do not need to calculate a probability distribution. They should be able to identify which uncertainties could alter the result and what evidence would improve understanding. If a specialist supplier gives a delivery estimate without confirming material availability, record that condition. If several workstreams must finish together before testing can start, ask what happens if one is late. If the sponsor requests a commitment with high confidence, explain why a single deterministic calculation may not answer the question. Chapter 8 will develop quantitative schedule risk analysis, including the interpretation of confidence dates.

Historical comparison can also challenge an internal forecast. Baerenbold's (2023) review of 41 papers on reference class forecasting identifies both its potential and the importance of relevant, reliable comparison data. Much of the reviewed literature concerns large infrastructure and cost forecasting, with less attention to schedules. It does not demonstrate that the technique always outperforms alternatives. For a planner, the useful introductory practice is to ask how comparable completed work performed, whether its scope and conditions genuinely resemble the proposed work and which differences must be explained before transferring an estimate.

Australia case study an executable plan across organisations

The Australian National Audit Office's 2025 OneSKY audit recorded that a February 2023 integrated baseline review could not provide assurance over the schedule. Remediation required a credible, resourced contractor delivery schedule and an integrated master schedule covering programme delivery. The report later recorded completion of relevant remediation actions, but this was not equivalent to system acceptance (ANAO, 2025, Table 2.4 note a and paragraphs 2.53-2.58). The distinction matters: producing or improving a planning product is a management action, while delivery of the intended capability remains a separate result.

For project controls practice, this case encourages examination of the boundary between an organisation's work and its suppliers or partners. A contractor may have an internally coherent plan that does not contain all the customer's training, transition or acceptance activities. The customer's milestone may therefore require a wider integrated view. The scheduler should identify the missing interfaces, agree who owns them and explain how the schedules will be reconciled. The audit does not prove that schedule quality alone caused every programme difficulty; it provides concrete evidence of the need to assure connected plans rather than inspect each file in isolation.

Table 1.4 | Milestone lessons from international cases

Official case	Distinction that matters	Question to transfer into practice
Crossrail in England	Reported construction progress and complete readiness evidence	What essential work or assurance could be missing from the progress measure?
James Webb in the USA and international partnership	A headline milestone and the work that follows it	Which external dependencies and remaining stages still control capability?
Barakah in the UAE	First grid connection and commercial operation	Which tests and acceptance conditions separate the milestones?
OneSKY in Australia	Individual contract plans and integrated delivery	Who owns the interfaces between organisational schedules?
Flamanville in France	Different milestone meanings within a history of target dates	Are baseline, forecast and actual dates describing the same event?
BER in Germany	New-facility opening and operational transfer	How are introduction, transition and withdrawal of the old service connected?
Grand Egyptian Museum in Egypt	Trial operation and official inauguration	What precisely does each readiness claim permit the organisation to do?

The comparison identifies planning questions, not a ranking of national performance. Sources and evidence boundaries are explained in the accompanying case discussions.

1.7 Professional judgement and accountable scheduling

Making an honest recommendation

The scheduling professional works with people who may have different incentives, incomplete information and strong preferences about dates. Professional judgement involves listening carefully, testing the evidence and explaining what follows from it without overstating confidence. A sponsor's desired date deserves to be understood because it may protect a contractual opportunity or an operational need. It should then be tested against the work and available choices. Equally, a pessimistic forecast should not be accepted merely because it appears cautious. It requires the same scrutiny of scope, logic, productivity and assumptions as an optimistic one.

An honest recommendation connects the current evidence with a decision. It might support the proposed milestone, recommend a conditional commitment, request a specific investigation or explain why the date is not presently justified. The recommendation should identify who can act, when the decision is needed and what consequence follows from waiting. Where the scheduler lacks approval authority, the appropriate action is to provide a clear analysis and escalation route. Demonstrating competence does not mean making commitments on behalf of other people; it means making the decision easier to assess and the remaining uncertainty harder to overlook.

A workflow for keeping the plan credible

The working cycle in Figure 1.8 begins by establishing the objective and evidence, then develops a model that represents the proposed delivery approach. Challenge follows before commitment: delivery specialists, resource owners and receiving parties test whether the assumptions are defensible. An authorised baseline or other agreed reference then supports execution and observation. Actual progress, new information and approved changes feed back into the model. The cycle preserves both accountability and learning. It allows the organisation to understand why its expectation has changed without erasing the history of earlier decisions.

Figure 1.8 | Maintaining credibility through the control cycle

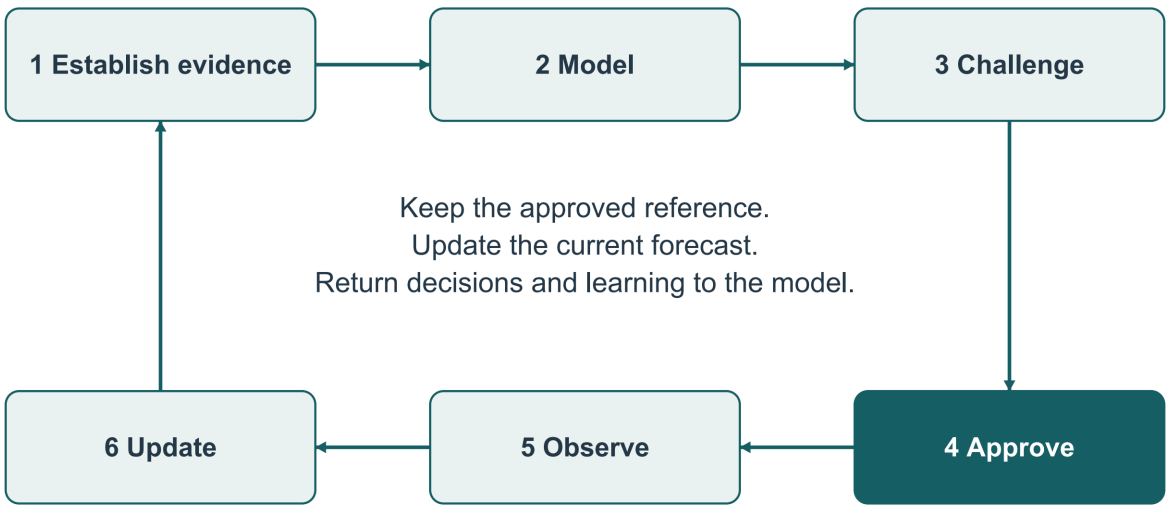


Figure 1.8. Original teaching workflow. Formal approval and change authority remain those of the employer; updating information does not itself authorise a baseline change.

A practical control cycle needs proportionate evidence. A short work package may be managed with a modest model and a concise narrative, while a major integrated project may require several levels of planning and specialist analysis. In both cases, a report should identify the date of the information, explain meaningful variances and make required decisions visible. Regular reporting should not become a ritual in which people repeat numbers whose origin nobody checks. If an update does not change a decision, confirm an assumption, expose a problem or preserve a useful record, the team should reconsider what purpose it serves.

Evidence, technology and personal responsibility

Digital tools can help calculate dates, identify logic problems, compare versions and prepare presentations. AI may help organise information or suggest questions, but it does not establish that the underlying activities, resource commitments or acceptance conditions are correct. A professional who uses an automated suggestion should be able to explain how it was checked and why it was accepted or rejected. Sensitive workplace information must remain within the employer's authorised arrangements. The professional responsibility for the analysis and its use cannot be transferred to a tool that does not understand or own the delivery commitment.

Figure 1.9 shows a simple evidence chain. Begin with the claim, identify its source and date, make assumptions visible, explain the analysis, record the challenge and show the decision or change that followed. The chain need not produce a large document. A clear annotated schedule extract, a relevant source record and a short explanation of the analysis may provide stronger evidence than many pages of unconnected screenshots. What matters is whether another competent person can follow the argument, recognise its limitations and understand the basis of the recommendation.

Figure 1.9 | Turning a planning claim into traceable evidence

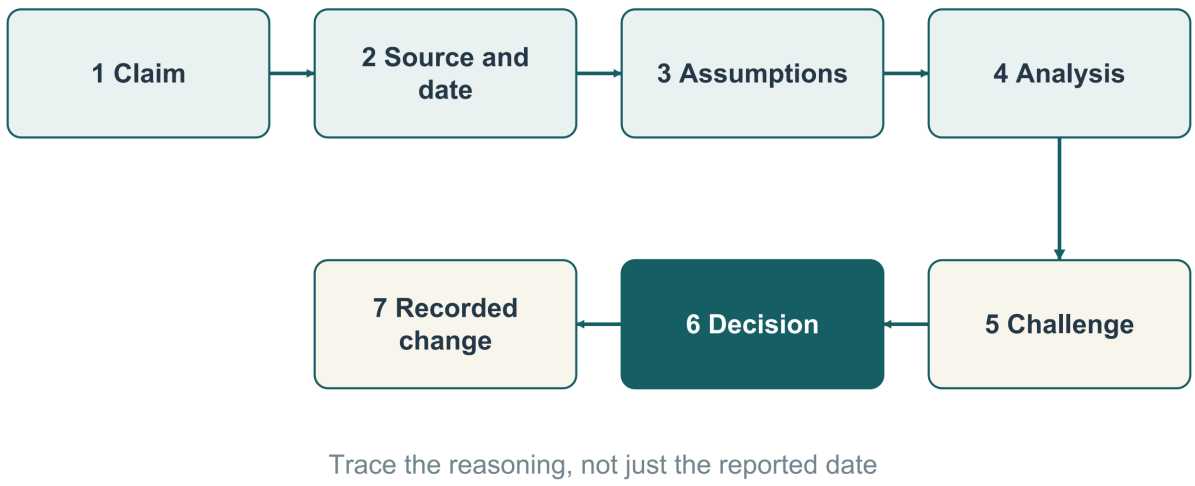


Figure 1.9. Original model of evidence traceability. The sequence connects a planning claim with its sources, assumptions, analysis and resulting decision.

Keeping PMI-SP preparation in view

The current PMI-SP examination outline has five domains: schedule strategy, planning and development, monitoring and controlling, closeout, and stakeholder communications management. Chapter 1 establishes concepts used across those domains, with particular emphasis on strategy and the reasoning behind model development. Later chapters deepen the techniques and control tasks. The published domain weights are 14, 31, 35, 6 and 14 per cent respectively, so monitoring and control require sustained practice rather than a single final revision session (PMI, n.d.a). The examination outline remains the scope reference; the chapter's original frameworks organise learning without replacing it.

The current examination information lists 170 questions over 210 minutes. Eligibility also depends on the applicant's education and relevant scheduling experience, so reading this book does not itself establish eligibility (PMI, n.d.b). For learning purposes, begin with accurate distinctions and situational judgement before trying to memorise every software field. Ask what the scenario establishes, what evidence is missing, which action is within the scheduler's role and which option improves the reliability of the plan. Numerical confidence is valuable only when the underlying model and assumptions justify it.

Knowledge check and examination practice

These questions are original learning questions aligned with the chapter's concepts. They are not recalled or endorsed PMI examination items. Attempt them before reading the explanations. For each answer, identify the evidence in the question that makes your choice preferable and the assumption that makes a tempting alternative unsound.

Question 1 The sponsor view

A planner calculates and saves the month-four schedule, then exports a milestone chart for the sponsor. What is the chart in PMI's terminology?

A The scheduling method.
B The scheduling tool.
C A schedule presentation.
D The complete schedule model.

Question 2 An accepted milestone

A team has a zero-duration milestone called 'system accepted'. The acceptance review takes three working days. What is the most appropriate treatment?

A Remove the review time because the milestone has zero duration.
B Represent the review work and its dependencies before the acceptance milestone.
C Add the three days to every preceding activity.
D Assume acceptance occurs when installation finishes.

Question 3 The two route network

Using Figure 1.5's stated assumptions, design takes two weeks, panel manufacture four, site preparation three, installation one and integrated testing two. Manufacture and site preparation run in parallel after design. What is the earliest finish?

A Twelve weeks.
B Eight weeks.
C Ten weeks.
D Nine weeks.

Question 4 A resource assumption changes

The two parallel branches in Figure 1.5 now require the same specialist crew, which can work on only one branch at a time. What should the planner do first?

A Re-examine resource feasibility and model an achievable sequence.
B Keep the original date because the logical links have not changed.
C Shorten both durations without new evidence.
D Change the baseline immediately to remove the problem.

Question 5 Choosing an approach

A project has stable civil works but an operator interface that needs repeated user feedback. Which response is most defensible?

A Avoid planning the interface until the civil works finish.
B Use one approach everywhere regardless of the work.
C Consider a hybrid arrangement and define the interfaces between planning approaches.
D Remove the interface work from the master schedule because its detail may change.

Question 6 An uncomfortable forecast

The latest evidence supports a later finish than the approved baseline. The sponsor still wants the original date. What should the scheduler do?

A Replace the baseline with the forecast without approval.
B Explain the variance, assumptions and feasible response options while preserving change control.
C Report the requested date as the forecast.
D Stop updating until the sponsor changes the target.

Question 7 A detailed schedule

A contractor submits a schedule with thousands of activities. Which fact would most strengthen confidence in its delivery milestone?

A Every activity has a different colour.
B The file is larger than the previous version.
C All dates match the client's desired finish.
D Scope, logic, resources and acceptance assumptions have been checked using relevant evidence.

Question 8 Comparing milestone history

A report compares a baseline fuel-loading date with an actual grid-connection date and calls the difference schedule variance for one milestone. What should be checked first?

A Whether both dates describe the same defined event.
B Whether the actual date can be renamed to match the baseline.
C Whether the earlier event can be removed from the record.
D Whether the difference looks large enough to report.

Answer explanations

1 C. The chart is a presentation drawn from a saved instance. A is the analytical approach; B is the application supporting calculation; D is the underlying representation containing more information than the exported view. The distinction supports traceability from what the sponsor sees to the model and data that produced it.

2 B. The milestone represents the acceptance event, while the review activity represents time-consuming work. A omits real work. C adds unsubstantiated time and may count the review repeatedly. D substitutes installation for acceptance without evidence. Zero-duration modelling of the milestone does not remove the work necessary to achieve it.

3 D. The controlling route is 2 + 4 + 1 + 2 = 9 weeks. A adds both parallel branches as though sequential. B follows the shorter branch and ignores the required panel. C adds a week not justified by the stated model. Later resource, calendar or risk information could change the result, but must not be invented in answering this question.

4 A. The previous parallel arrangement no longer has a supported capacity assumption. B ignores that change, C invents a productivity improvement, and D confuses investigating a forecast with authorising a baseline revision. The planner should first understand the resource constraint and analyse feasible alternatives.

5 C. The choice responds to different learning and coordination needs while keeping interfaces visible. A postpones necessary learning; B ignores context; D hides a real dependency. A hybrid label is not sufficient by itself: roles, cadence, deliverables and acceptance conditions must still be established.

6 B. Forecasting should reflect current evidence and explain the decision required. A removes the approved reference without authority, C conceals the discrepancy between desire and expectation, and D prevents useful control. A target may remain while the team investigates credible ways to achieve it.

7 D. Credibility comes from the supporting evidence and model quality. A may improve presentation but not feasibility; B measures file size; C establishes agreement with a requested date without explaining how it can be achieved. Activity count is useful only where the detail represents necessary, maintainable planning information.

8 A. A meaningful comparison requires stable milestone identity and acceptance meaning. B changes a label without resolving the difference, C destroys relevant history, and D considers materiality before establishing validity. Dates for different events may both be correct while their subtraction answers no useful variance question.

From scheduling principles to a planning framework

Chapter 2 turns these principles into a coherent planning framework. The questions become more specific: who owns the model, which levels are needed, how information moves between organisations, what constitutes an acceptable update and who can approve a change. The six credibility tests remain relevant because the framework must support delivery decisions that people can understand, challenge and act upon. Its purpose is to establish dependable planning arrangements before greater technical detail is added to the schedule.

References and further reading

Page references for the PMI book refer to printed page numbers. Dates in historical reports describe the position at publication; later achieved milestones are supported by separately identified sources. The bibliography distinguishes research, independent audit, government guidance and project-owner announcements through the named publishing organisations.

Abu Dhabi Media Office (2024) *Unit 4 of Abu Dhabi's Barakah Nuclear Energy Plant begins commercial operations*. 5 September. Official announcement.

Acebes, F., Poza, D., González-Varona, J.M., Pajares, J. and López-Paredes, A. (2021) 'On the project risk baseline: Integrating aleatory uncertainty into project scheduling', *Computers & Industrial Engineering*, 160, 107537. doi:10.1016/j.cie.2021.107537.

ASN (2025) *Abstracts of the ASN Report on the state of nuclear safety and radiation protection in France in 2024*. Autorité de sûreté nucléaire, p. 14. Regulator publication.

Australian National Audit Office (ANAO) (2025) *Management of the OneSKY Contract*. Auditor-General Report No. 46 of 2024-25, 20 June. Table 2.4 note a and paragraphs 2.53-2.58. Audit report.

Baerenbold, R. (2023) 'Reducing risks in megaprojects: The potential of reference class forecasting', *Project Leadership and Society*, 4, 100103. doi:10.1016/j.plas.2023.100103.

Bundesministerium für Verkehr (BMV) (2026) *Reformkommission Bau von Großprojekten*. Webpage updated 29 July, describing recommendations and actions dating from 2015. Federal ministry guidance.

Cour des comptes (2025) *La filière EPR une dynamique nouvelle des risques persistants*. January, p. 27, Table 1. Supreme audit institution report.

Department for Transport (DfT) (2022) *Cheaper tickets and quicker journeys as part government funded Elizabeth line officially opens*. 24 May. Government announcement.

EDF (2024) *Update on the Flamanville EPR the reactor produces its first electrons on the national electricity grid*. 21 December. Operator announcement.

Emirates Nuclear Energy Corporation (ENEC) (2024) *Unit 4 of Barakah Nuclear Energy Plant successfully connected to UAE grid*. 23 March. Project-owner announcement.

Federal Government of Germany (2020) *BER takes off*. 30 October. Government account.

Gemino, A., Reich, B.H. and Serrador, P.M. (2021) 'Agile, Traditional, and Hybrid Approaches to Project Success: Is Hybrid a Poor Second Choice?', *Project Management Journal*, 52(2), pp. 161-175. doi:10.1177/8756972820973082.

Infrastructure and Projects Authority (IPA) (2021) *Project Routemap Systems Integration*. November, pp. 8, 22 and 25. UK government guidance.

Mirzaei, M., Mabin, V.J. and Zwikael, O. (2025) 'Customising Hybrid project management methodologies', *Production Planning & Control*, 36(9), pp. 1188-1205. First published online in 2024. doi:10.1080/09537287.2024.2349231.

NASA (n.d.) *Webb Mission Timeline*. Official mission chronology.

National Audit Office (NAO) (2021) *Crossrail a progress update*. HC 299, 9 July, pp. 29-32. Audit report.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: Project Management Institute. ISBN 978-1-62825-561-4. Referenced sections include pp. 2-14, 18-28, 178, 183 and 189. Definitions in this chapter are quoted from the cited pages; the explanations and teaching illustrations are original.

Project Management Institute (PMI) (n.d.a) *PMI Scheduling Professional Examination Content Outline*. Official examination outline.

Project Management Institute (PMI) (n.d.b) *PMI Scheduling Professional PMI-SP*. Examination and eligibility information. Official certification page.

State Information Service Egypt (SIS) (2024) *Grand Egyptian Museum to start partial trial run on 16 October PM Madbouly*. 11 October. Government announcement.

State Information Service Egypt (SIS) (2025) *President El-Sisi Attends the Historic Opening Ceremony of the Grand Egyptian Museum GEM*. 1 November, updated 3 November. Official event account.

US Government Accountability Office (GAO) (2015) *Schedule Assessment Guide Best Practices for Project Schedules*. GAO-16-89G, 22 December, pp. 148-150. Official guide.

US Government Accountability Office (GAO) (2021) *James Webb Space Telescope Project Nearing Completion but Work to Resolve Challenges Continues*. GAO-21-406, 13 May, 'What GAO Found'. Audit findings.

CHAPTER 02

Designing the Planning Framework and Schedule Strategy

Designing the system behind the dates

A project can contain thousands of logically connected activities and still struggle to answer a simple question: which forecast should management use today? The engineering team may report against one information cut-off, a contractor against another and the programme office against a spreadsheet prepared for last month's board meeting. Each document can look professional while representing a different state of knowledge. The problem begins before the calculation of dates. It concerns the arrangements through which people create, interpret, approve and maintain scheduling information. A dependable planning framework makes those arrangements explicit, so that technical scheduling work supports decisions across the project rather than producing competing versions of its future.

This chapter examines how to design that framework. It moves from the purpose of scheduling to the practical rules that make a model usable: levels of detail, responsibilities, identifiers, calendars, information exchanges, approval routes and reporting cycles. The discussion is self-contained. Familiarity with a separate risk management course is unnecessary; whenever uncertainty matters, the relevant idea is explained in the scheduling context. The emphasis is on professional judgement: selecting arrangements proportionate to the work, explaining their consequences and recognising when apparently convenient shortcuts weaken the reliability of the resulting forecast.

By the end of the chapter, the reader should be able to distinguish a scheduling strategy from the plans that implement it; explain the six schedule levels described in the PMI source; allocate the responsibilities needed to maintain reliable information; specify the main rules for configuring a schedule model; connect contractor and programme schedules through controlled interfaces; protect current, historical and baseline records; and design reporting that leads to timely action. These capabilities directly support the Schedule Strategy domain of the PMI-SP examination, while also preparing the reader for later work on planning, monitoring and stakeholder communication.

The chapter uses real publications and project evidence from England and other countries to test its ideas. These examples have different purposes. An audit can establish weaknesses found in a particular project; a government standard can describe required practice within its stated jurisdiction; a research study can investigate an association or propose a method. None should be treated as proof that one arrangement works everywhere. The scheduling professional needs to understand both the evidence and the boundary within which it is useful.

The chapter framework

The original framework in Figure 2.1 organises planning design around seven connected decisions. Purpose identifies what decisions the schedule must support. Levels determine the detail needed by different users. People establishes who supplies evidence, who maintains the model and who may authorise changes. Model rules make calculations and classifications consistent. Interfaces connect work across organisational boundaries. Data controls preserve the identity and history of information. Reporting closes the loop by turning analysis into decisions, actions and further updates. This is a teaching framework built around the chapter's content, rather than a named PMI method or a numerical maturity assessment.

Seven connected planning decisions

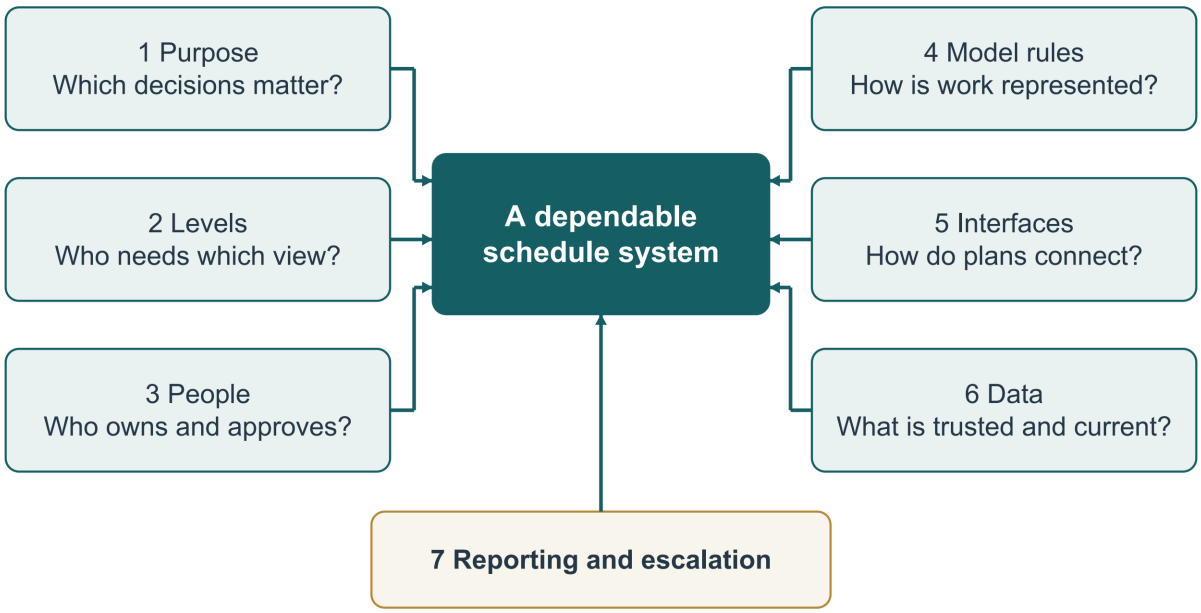


Figure 2.1. An original framework for designing a dependable scheduling system. Each decision affects the others: a reporting commitment, for example, changes the data, responsibilities and update cycle needed to support it.

The framework should be read as a set of design questions, not as seven documents that every project must produce separately. A small project may capture the essential decisions in a short, controlled plan. A complex programme may need several coordinated procedures and data specifications. The test is whether the arrangements are clear enough to use and substantial enough to control the work. A long document with ambiguous ownership is less useful than a concise agreement that identifies the required information, its source, its timing and the decision it enables.

2.1 Establishing the scheduling strategy and management plans

Begin with the decisions the schedule must support

A scheduling strategy explains the intended use of scheduling within the particular delivery environment. It should address the project's life cycle, the nature of its commitments, the maturity of its scope, the organisations involved and the decisions that need to be made. A project replacing equipment during a short operational shutdown needs particularly close control over access, resource availability and the sequence of reinstatement. A research programme needs an approach that distinguishes agreed commitments from work whose technical content will emerge through investigation. Both need disciplined scheduling, but identical update frequencies, activity durations and approval arrangements would serve them poorly.

The first conversation should therefore concern decisions and evidence. The team might need to know whether a design release can support procurement, whether several packages can reach a common integration milestone, or whether the available workforce can deliver the proposed sequence. These questions reveal the information the model must contain and the people who must contribute to it. Only then can the team make a reasoned choice about techniques and tools. Selecting software first can conceal the underlying design question: whether the proposed scheduling system can represent the work and support the decisions that matter.

PMI places schedule management within the wider planning of the project and treats the model as something that itself requires design. Its source discussion includes training, data management, performance thresholds, reporting, compatibility with other plans, contractual obligations and resource considerations (PMI, 2019, pp. 45-46). The practical implication is that the scheduling strategy cannot be developed by the scheduler in isolation. Commercial staff understand submission obligations; delivery teams understand the work; operational representatives understand access and acceptance; and the project manager understands how schedule decisions interact with scope, cost and commitments. Their contributions need to shape the rules before the model is populated in detail.

Establish the authority and the boundary of the plan

The project charter gives the scheduler an initial route to the project's purpose, authorised leadership, high-level objectives and constraints. Read it alongside the business case, requirements and commercial documents, then distinguish an aspiration from a binding commitment and a planning assumption. A statement of work may identify the deliverables and acceptance conditions; a contract may specify submissions, notices and dates; a memorandum of understanding may record an interface commitment between organisations. Record the source, owner and decision status of each relevant requirement. An unresolved conflict between a sponsor's target and an agreed interface date needs a decision, rather than an unexplained constraint entered into the software. A charter establishes context and authority; it does not replace a developed, approved schedule baseline.

PMI's Practice Standard for Scheduling applies to individual project schedule models, including individual projects situated within programmes or portfolios. It is not, by itself, a complete standard for managing a programme or portfolio (PMI, 2019, p. 8). This distinction matters when the team integrates schedules: each project's model needs sound logic, evidence and controls, while programme-level benefit dependencies, priorities and governance require the wider arrangements described in the programme plan. The source assumes sufficient prior planning and a suitable work breakdown structure. This book develops those foundations explicitly, so readers can study scheduling without prior formal study of another project controls discipline.

Separate the purpose of the different planning documents

> **Schedule management plan.** 'The schedule management plan is a collection of processes, approaches, templates, and tools that comprise the project's execution strategy and objectives as reflected in the project's schedule model.' (PMI, 2019, p. 47)

The schedule management plan translates the strategy into operating arrangements. It explains how the model will be created, updated, analysed and communicated. It should make the selected approach practical: who participates in planning, which calendars and codes are used, when progress is collected, which indicators are reported, and which decisions require approval. A statement that the project will use critical path analysis is insufficient. The team also needs rules about model boundaries, interdependencies, review, maintenance and the treatment of changes that affect the plan.

The schedule data management plan concentrates on the information infrastructure and its controls. PMI's discussion covers users and access rights, backup frequency, retrieval of previous instances, retention and risks to availability, including distributed working (PMI, 2019, pp. 46-47). These subjects overlap with wider information management and business continuity arrangements, so the schedule plan should connect to those arrangements instead of creating contradictory local rules. The two plans may be separate documents or clearly identified parts of a combined plan. What matters is preserving the distinction between managing the scheduling process and managing the information on which that process depends.

The basis of schedule has a related but different purpose. It explains the reasoning behind a particular model: its scope, assumptions, methods, exclusions, calendar choices, resource assumptions and other conditions that help a reviewer interpret the dates. The management plan establishes how the project will work; the basis explains why a particular schedule has been constructed as it has. A model creation plan adds the practical route for producing the initial model, including information gathering, workshops, integration and review. Confusing these purposes can leave a project with extensive narrative about assumptions but no agreed update process, or with a detailed procedure but no explanation of the assumptions behind its dates.

Document and model architecture

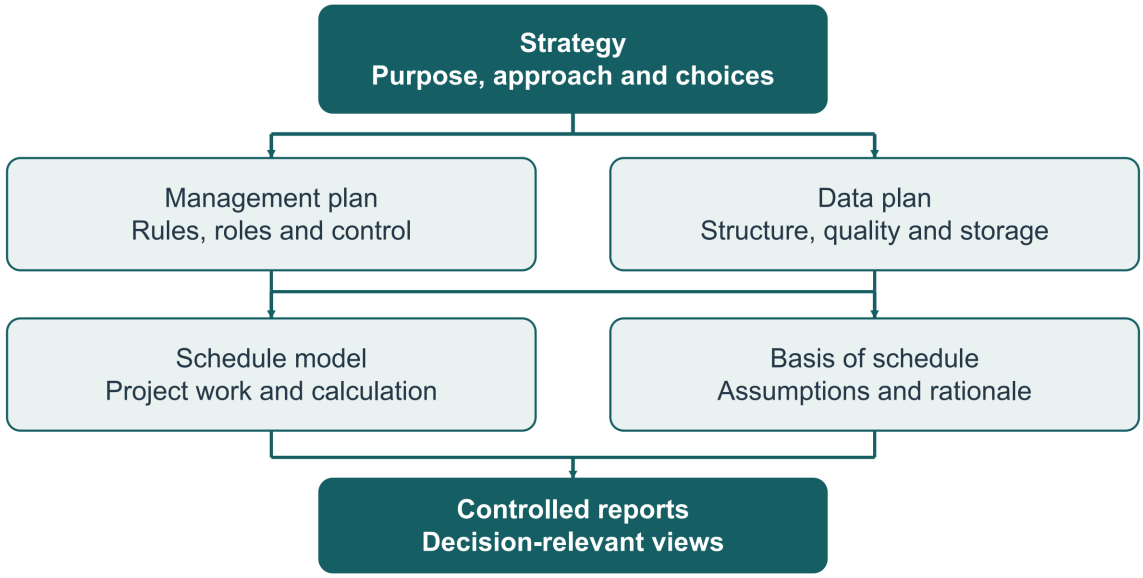


Figure 2.2. An original explanation of the relationships between strategy, operating plans, model creation, the basis of schedule and controlled outputs. A project may combine documents while retaining these distinct purposes.

Table 2.1 | The purposes of planning documents

Planning element	The main question it answers	What a useful answer contains
Scheduling strategy	Why is this approach suitable here?	Delivery characteristics, decision needs, integration requirements and proportionate controls
Schedule management plan	How will scheduling be performed?	Methods, responsibilities, modelling rules, review cycles, measures and approval arrangements
Schedule data management plan	How will information remain usable and protected?	Access, exchange, validation, identifiers, versions, retention, backup and tested recovery
Model creation plan	How will the first usable model be produced?	Inputs, planning sessions, contributors, integration steps, review and completion criteria
Basis of schedule	Why does this model contain these assumptions and dates?	Scope boundaries, sources, calendars, logic rationale, constraints, resources and limitations

Tailor the plan without removing its essential controls

Tailoring begins with proportionality, rather than with reducing the page count. A small installation project may need only one principal calendar and a short list of activity codes, but it still needs to identify the approved baseline and the person entitled to change it. A major programme may need extensive coding and several linked models, but those additions should serve identifiable decisions. Every proposed control has both a benefit and a maintenance cost. The professional task is to justify that balance and to remove arrangements that add effort without improving understanding, coordination or accountability.

The scheduling strategy should also acknowledge the maturity of the available information. Scope boundaries, a preliminary work breakdown structure and resource definitions are needed to design useful data arrangements; they do not all have to be complete in their final detail. Unresolved matters should be recorded with owners and dates for resolution. Otherwise, the team risks presenting provisional conventions as settled standards and discovering later that contractor data cannot be combined. An explicit interim decision is more manageable than an invisible assumption because people can see when it must be revisited and which parts of the model depend on it.

USA guidance: the plan that governs the schedule

The US Department of Energy's 2026 capital-project order connects the performance baseline, integrated master schedule and project execution plan. Within its scope, projects must maintain an integrated master schedule, while the execution plan establishes management arrangements and is revised through configuration control (DOE, 2026, Appendix C, p. C-16). The lesson for this chapter is the relationship between the model and the authority governing it. The schedule file cannot explain every responsibility or approval condition by itself. These are DOE-specific requirements, rather than universal obligations for PMI-SP candidates, but they provide a current official example of controlling the scheduling system as well as its outputs.

France's revised public-client BIM guidance offers a complementary distinction between organisational policy, project information requirements and the convention that governs delivery and collaboration. It

addresses roles, data management, exchange processes and the adjustment of arrangements as participants and needs change (MIQCP and Plan BIM, 2024a, pp. 34-37). This is guidance for building information management, not a scheduling standard. Its useful transfer is to document architecture: an organisational rule, a project's particular requirements and the agreed procedure for meeting them should each have a clear purpose. Repeating the same general policy in several documents does not establish an executable process.

2.2 Designing schedule levels and the information hierarchy

Detail should follow purpose

> **Schedule Level.** 'A project team-specified rule for the relative granularity of schedule activities in the overall schedule model.' (PMI, 2019, p. 190)

Schedule levels help different audiences use information at an appropriate degree of detail. An executive deciding whether to release funding needs the principal commitments, their forecast condition and the consequences of a decision. A supervisor coordinating tomorrow's work needs the tasks, access conditions and resources that make that work executable. These views can be consistent while displaying different information. The aim is to preserve the connection between strategic commitments and the work that supports them, so that detail can be examined when needed without overwhelming every audience with the same activity list.

The source book describes levels 0 to 5 and explicitly recognises that conventions vary with the approach, organisation and practitioner (PMI, 2019, pp. 65-66). Its names should be learned for the examination, while workplace practice should be checked against the applicable organisational and contractual requirements. A schedule labelled Level 3 by one organisation may be called Level 2 or a control schedule by another. Agreement on the number alone does not establish agreement on content. A useful hierarchy specification describes purpose, scope, level of decomposition, interfaces, update requirements and the information exchanged with adjacent levels.

Schedule hierarchy and traceability

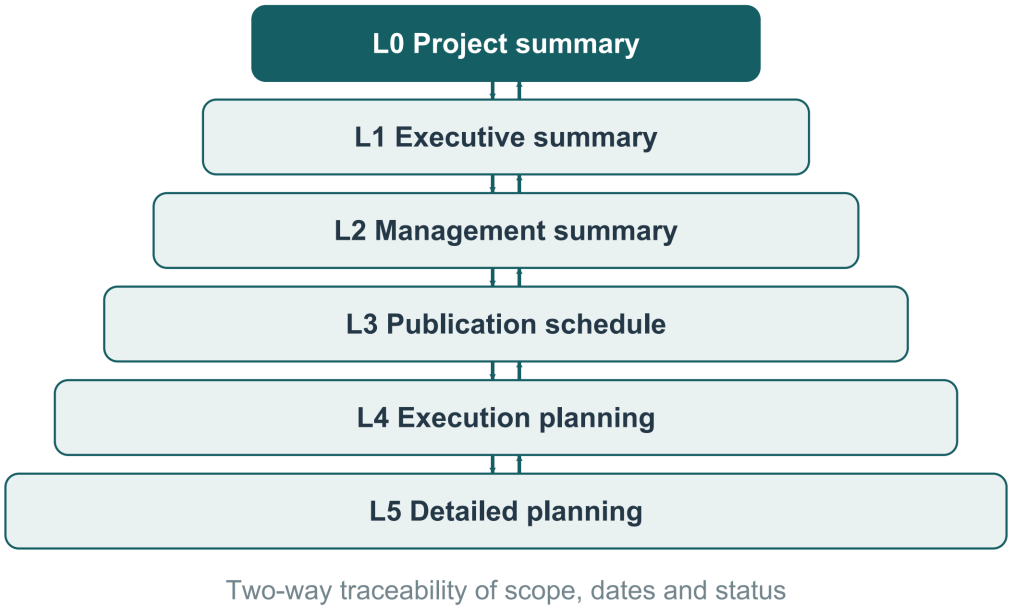


Figure 2.3. The six schedule levels described by PMI (2019, pp. 65-66), presented in an original diagram. The arrows represent traceability between commitments and supporting work; they do not require six separate software files.

Table 2.2 | Schedule levels and the decisions they support

Source-book level	Purpose and typical content	The control question to retain
0: Project summary	A single representation of the project, useful when comparing projects within a programme or portfolio	Which project dates and boundaries does the line represent?
1: Executive summary	Principal phases, summary activities and key milestones supporting executive decisions	Can each reported commitment be traced to the current supporting plan?
2: Management summary	Integration of major deliverables and participants across the project life cycle	Are significant interfaces and their consequences visible?
3: Publication schedule	Execution of deliverables and interfaces between parties, disciplines or workgroups	Does the information support analysis of critical work and corrective action?
4: Execution planning	More detailed coordination of work and interfaces, commonly presented over a short horizon	Are the work packages and prerequisites sufficiently detailed to coordinate delivery?
5: Detailed planning	Near-term task and resource requirements for those performing the work	Are tasks ready, resourced and consistent with the higher-level commitments?

Connect the levels through meaning, not appearance

A hierarchy is credible when its levels describe the same work and preserve its important relationships. Suppose an executive report shows that a laboratory will be ready for operational use in December. The supporting schedule needs to explain what that statement includes: construction completion, equipment qualification, records, training and the relevant acceptance decision. A lower-level team may legitimately describe the physical installation as complete in November, but that date must not be substituted for operational readiness. The problem would be semantic, even if both dates were copied accurately. The hierarchy must preserve the meaning of milestones as well as their numerical values.

Vertical traceability connects a summary statement to the work and milestones that support it. Horizontal integration connects related work across teams or packages at a comparable level. Both are necessary. A programme can contain perfectly aligned summaries while omitting the dependency between one contractor's information release and another contractor's manufacture. Conversely, detailed interfaces can be well connected while the executive report displays an obsolete milestone. The first weakness conceals a delivery dependency; the second conceals its management consequence. Review should therefore test both the path down through the hierarchy and the links across its boundaries.

Rolling up information requires care. A summary finish often reflects the latest finish among its relevant children, but it cannot establish operational readiness unless all necessary work has been included. Percentage complete is even more sensitive: averaging ten activity percentages gives equal importance to activities that may differ greatly in size, value or contribution to the output. The aggregation method must be appropriate to the purpose and stated clearly. A summary is a controlled interpretation of supporting information, not merely a convenient grouping of bars. If a metric cannot be explained in terms of its underlying data, its apparent precision is unhelpful.

Choose a maintainable degree of granularity

Granularity concerns how finely the work is represented. The necessary detail depends on uncertainty, interfaces, resource needs, the update cycle and the consequences of missing a change. A twelve-week activity called 'Complete design' may conceal several approvals that different teams need at different times. Breaking it into useful deliverables can expose those dependencies. Breaking it into hundreds of administrative actions may add substantial maintenance effort while contributing little to forecast quality. The best decomposition is therefore the smallest level needed to assign responsibility, collect meaningful evidence and represent a decision-relevant dependency; it is not the greatest level that the software can display.

Near-term work often needs more detail than distant work. PMI describes Level 4 presentations commonly covering a week to a month and Level 5 planning commonly covering a day to a week, while recognising variation in use (PMI, 2019, p. 66). These are descriptive conventions rather than universal maximum durations or mandatory horizons. A shutdown can require control by shift; a long procurement programme may need a different rhythm. Whatever the convention, the detailed plan must remain connected to the current integrated schedule. A team should not quietly move a handover commitment in its weekly plan while leaving the programme interface unchanged.

A hierarchy also needs rules for decomposition over time. When a future planning package is replaced by detailed activities, the team should reconcile the scope, inherited interfaces, resources and milestones. The new detail may reveal a longer duration or an omitted approval. That finding should improve the forecast and be explained through the update process. It should not be suppressed to preserve the appearance of agreement with the former summary. Progressive elaboration is valuable precisely because it replaces assumptions with better information; the framework must make that transition visible and controlled.

The US Government Accountability Office gives explicit attention to both horizontal and vertical traceability. Its guide also calls for controlled current versions, explanatory narratives and a basis document; native schedule data and a dictionary of custom fields support meaningful examination (GAO, 2015, pp. 71-74, 130-138, 197). Although this is an established 2015 publication, it remains useful here because it distinguishes integration from the appearance of integration. Its hierarchy principles do not make the source book's Level 0-5 labels universal, nor does a management summary provide all the information needed for technical assurance.

2.3 Establishing ownership, participation and decision authority

A schedule is a shared plan with distinct responsibilities

The scheduler maintains the technical integrity of the model, but cannot personally verify every delivery fact or authorise every project commitment. Work owners supply evidence about what has happened and what remains. Functional managers confirm the availability and suitability of resources. Interface owners reconcile dependencies between organisations. The project manager integrates the implications and acts within delegated authority. The sponsor or other designated authority decides matters outside that delegation. These responsibilities may sit with fewer people on a small project, but the functions still need to be understood. Combining roles does not remove the distinction between providing information, analysing it and approving a change.

The most useful responsibility arrangements specify decisions and handovers. A generic instruction that a contractor is 'responsible for its schedule' leaves several questions unanswered: who checks its progress evidence, who accepts its interface dates, who reconciles its calendar with the programme, and who

challenges an infeasible resource assumption? A responsibility matrix can help, provided that each row describes a meaningful task or decision and that the parties agree what responsibility and accountability mean in their organisation. It should expose gaps and competing authority rather than decorate a governance document with initials.

Responsibilities from evidence to authority

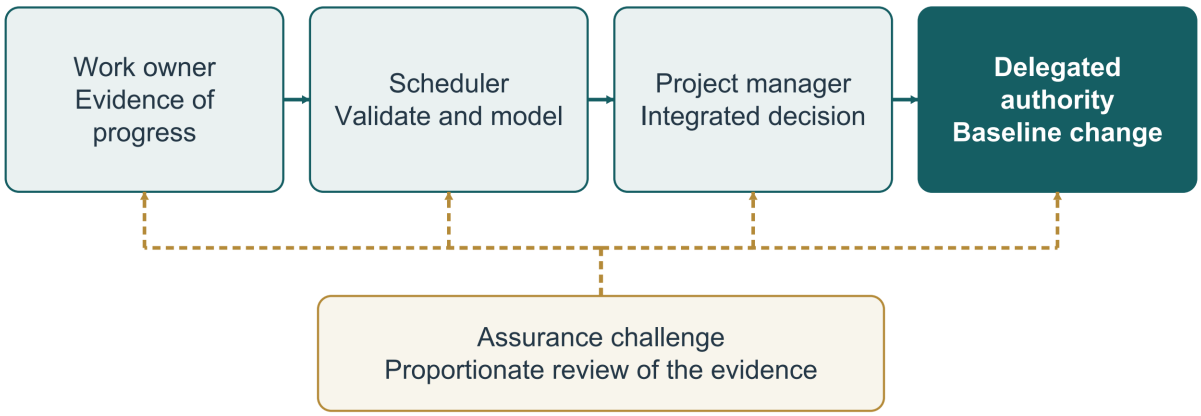


Figure 2.4. An original responsibility model. Information ownership, model maintenance, integrated management and approval authority are related functions; independent assurance can challenge the evidence and process without taking ownership of the delivery decision.

Table 2.3 | Scheduling responsibilities and boundaries

Function	Principal contribution	Boundary that should remain clear
Work owner	Verifies progress, explains remaining work and identifies delivery constraints	Reporting an expected finish does not authorise a new baseline
Scheduler or planning lead	Maintains the model, checks data and analyses consequences	Technical access to a file does not confer commercial or sponsor authority
Interface owner	Agrees handover meaning, evidence and coordinated dates with both parties	A copied date is insufficient without mutual understanding of the handover
Project manager	Integrates scope, schedule, resources, cost and delivery decisions	Decisions must remain within the agreed delegation
Delegated change authority	Authorises relevant changes after considering impacts and evidence	Approval should identify the specific change and controlled record
Assurance reviewer	Challenges completeness, consistency, assumptions and process compliance	Review findings inform decisions; they do not automatically approve the plan

Use planning workshops to resolve dependencies

A planning workshop should produce more than a collection of individually preferred dates. Its purpose is to develop a shared understanding of the work, test dependencies and resolve differences that affect delivery. Participants need sufficient preparation to contribute: scope boundaries, existing commitments, draft milestones, information requirements and known constraints. The facilitator should distinguish facts from assumptions and record unresolved matters with owners and required decision dates. Agreement that everyone has attended is not equivalent to agreement that the resulting sequence is feasible. The workshop output needs to show what was resolved, what remains uncertain and how the open matters will be closed.

For example, a designer may describe an information release as complete when it has passed an internal review, while a manufacturer requires a formally accepted package before production. The workshop should establish the state that the handover actually requires and schedule the work needed to reach it. If the parties cannot agree immediately, the uncertainty should remain explicit. An optimistic date entered simply to complete the planning session can propagate into procurement and resource commitments. The cost of that ambiguity increases as more decisions depend on it, which is why early planning should concentrate on meaning and ownership as well as sequence.

Research reinforces the need to consider collaboration beyond software access. Sheikhkhoshkar et al. (2025) analysed ten collaborative planning methods and 75 associated functions, examining their relationships through literature-based analysis. They distinguish the emphasis on people and commitments in process-oriented approaches from the emphasis on visualisation and information exchange in technology-oriented approaches. Their findings support attention to people, processes and technology together, while the study's literature-based design limits claims about measured delivery improvement. For the planner, the useful inference is to establish how commitments are formed and disagreements resolved, rather than assuming that a common dashboard creates collaboration.

Make challenge usable and proportionate

Good governance allows concerns to move to someone who can resolve them. A supervisor should be able to report that the proposed shift pattern is unavailable without being expected to redesign the whole programme. The planning lead should be able to identify incomplete data without becoming the owner of the contractor's missing work. The project manager should be able to distinguish a technical modelling correction from a proposal that changes the agreed delivery commitment. Escalation arrangements work when they specify the issue, the required decision, the authority needed and the latest useful decision date. A hierarchy of meeting invitations is not an adequate substitute.

Competence is part of this design. People who submit progress need to understand the evidence required and the meaning of the fields they complete. Reviewers need to understand the limits of the reported indicators. Software training alone cannot establish either capability. PMI explicitly includes common understanding of scheduling policies, procedures and technology within schedule management (PMI, 2019, p. 46). A proportionate induction should therefore use practical examples: the difference between physical completion and accepted completion, how to report remaining duration, and how to identify an assumption that has ceased to be valid.

Son et al. (2024) examined schedule-quality concerns from the perspective of Texas Department of Transportation reviewers. Their literature review identified 44 problems, adapted into 34 survey items, with 30 usable practitioner responses. Respondents regarded contractual compliance problems as particularly consequential and incomplete submissions as relatively frequent. The study supports clearer requirements, guidance and structured review, but its non-probability sample represents one authority's practitioners rather than universal defect rates. Its relevance is the breadth of competence required: a

review should distinguish the quality of the work plan, the integrity of the model and compliance with submission requirements.

The UK Government Functional Standard GovS 002 links strategy, planning, responsibility, authority and control. It expects plans at appropriate levels, controlled baselines, traceable changes and reporting that distinguishes the reporting period from publication. It also addresses validation, provenance and escalation when issues exceed an owner's ability to resolve them (Government Project Delivery, 2025a, clauses 4.1.3 and 7.2-7.9). These provisions apply within the standard's stated UK government scope. For other organisations, they provide a useful comparison: does the scheduling framework connect the information people receive with the authority and responsibility to act on it?

2.4 Specifying the model, tools and operating rules

Select capability against the scheduling requirement

> **Schedule Model.** 'A representation of the plan for executing the project's activities, including durations, dependencies, and other planning information, used to produce a project schedule along with other scheduling artifacts.' (PMI, 2019, p. 190)

The scheduling tool provides the environment in which the model is assembled and processed. The model contains the project's particular work and planning information. This distinction matters when specifying requirements: buying a tool with resource levelling does not establish that the project has reliable resource availability data, and buying a reporting platform does not establish that milestone definitions are consistent. The required capabilities should follow the scheduling approach and the decisions to be supported. PMI discusses dependency types, resources, constraints, baselines, progress, scenarios and comparison between instances as capabilities that a scheduling tool may provide (PMI, 2019, pp. 28-30).

A practical selection process tests representative information rather than relying entirely on feature lists. A team can check whether the proposed environment preserves the required calendars, activity identifiers, relationships, codes and baseline fields during an exchange. It can also test whether reviewers can inspect a native model, reproduce a report and retrieve a previous instance. The choice may be constrained by the employer's approved systems or by a contract. Within those boundaries, the planner should still identify limitations and compensating controls. A tool limitation becomes manageable when it is understood; it becomes hazardous when users assume that an exported or imported file behaves exactly like the original.

Preserve stable identities and distinguish saved instances

> **Activity Identifier.** 'An alphanumeric value assigned to an activity and used to differentiate that activity from other activities.' (PMI, 2019, p. 173)

PMI distinguishes the stable identity of a schedule model from the unique identity of each saved instance (PMI, 2019, p. 49). The stable identifier allows records across time to be associated with the same model. An instance identifier identifies a particular saved state. In the illustrative convention in Figure 2.5, the model retains the identity PRJ-042 while successive records receive a status date and revision. The convention is an example, not a required PMI naming pattern. A project can use another scheme if it reliably distinguishes models, reporting periods, revisions, purpose and approval status.

> **Schedule Model Instance.** 'A version of the schedule model that has been processed by a schedule tool and has reacted to inputs and adjustments made to the project-specific data within the scheduling tool (completed update cycle), which is saved for record and reference, such as data date version, target schedule models, and the baseline schedule model.' (PMI, 2019, p. 190)

Stable model identity and controlled instances

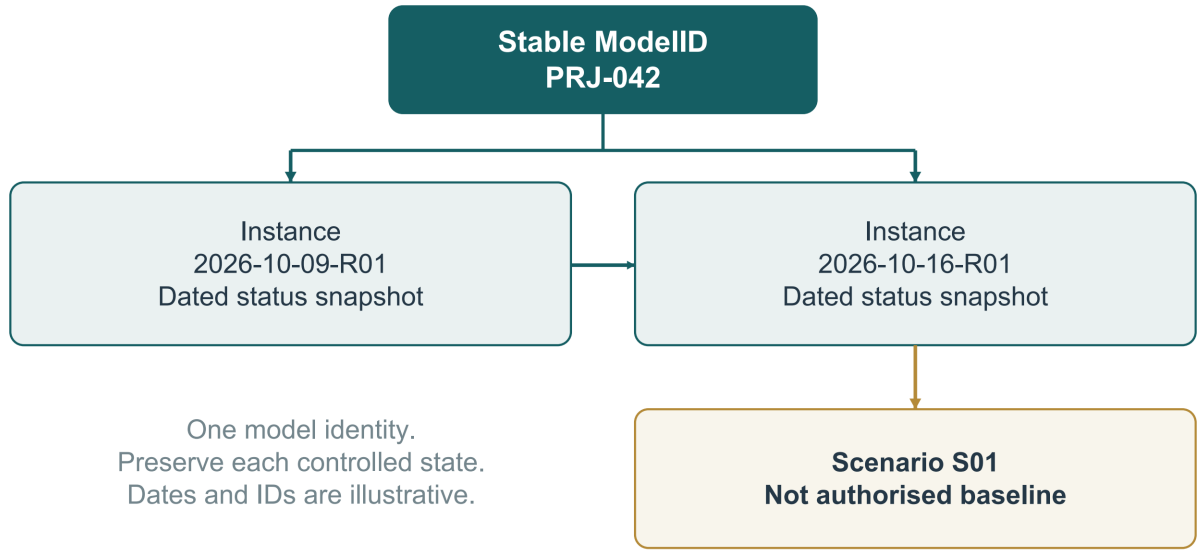


Figure 2.5. An original naming example using illustrative dates. Model identity, saved-instance identity and approval status answer different questions. A scenario branch does not become the authorised baseline simply because it is newer.

Activity identifiers also need to remain dependable. If ACT-010 is reused for a different activity after the original is deleted, a report comparison can mistake different work for the same work. If identifiers change on every import, meaningful change analysis becomes difficult. A useful convention therefore controls creation, retirement, mapping and reuse. Descriptive codes should generally remain separate from identity: an activity may retain its identifier when its responsible team changes, while its ownership code is updated. Embedding every characteristic into the identifier can make the scheme brittle because ordinary organisational changes then appear to create new activities.

Design codes and calendars as analytical controls

Activity coding determines how information can be selected, grouped and compared. Useful dimensions can include work package, phase, location, discipline, responsible organisation and interface classification. Each code should serve a reporting or analytical purpose and have a controlled set of meanings. A field that sometimes means the team performing the work and sometimes means the team approving it cannot support reliable accountability reporting. The data dictionary should explain each field, its valid values, who maintains it and how it maps to other project systems. PMI emphasises the flexibility gained by maintaining coding structures separately from activity identifiers (PMI, 2019, p. 51).

England case study: Heathrow's information arrangements

The Infrastructure and Projects Authority's Heathrow case describes an integrated data management environment bringing together data, tools, systems and processes from 1,500 projects. It reports an agreed data model, standardised entry and comparisons between reporting periods to identify inconsistencies. Users contributed to requirements and performance measures, with specialist involvement and progressive assurance (IPA, 2022, p. 38). The case illustrates why integration requires common meanings and controlled processes alongside technology. Its reported reductions in repeated manipulation and potential reporting errors should not be read as experimental proof that software integration alone improved completion dates. For scheduling, the relevant test is whether exchanged information retains its meaning and can be checked.

Establish calendar and resource assumptions

Calendars are calculation rules, not cosmetic labels. The framework must establish working days, shifts, hours, planned non-working periods and the treatment of geographically distributed teams. It should also specify when an activity or resource needs a different calendar from the project default. A nominal five-day duration does not mean the same elapsed period on a five-day working calendar and a seven-day working calendar. Similarly, forty working hours converts to five eight-hour days or four ten-hour days before any consideration of productivity, availability or interruptions. These simple distinctions explain why units and calendar settings must be agreed before information is combined.

The planner should distinguish recording a working pattern from assuming that the pattern can be sustained. An extended shift calendar does not prove that the required people are available, suitably skilled or able to maintain the assumed output. Resource planning therefore belongs in the framework even when the initial model is not fully loaded with named resources. The plan should identify the important resource types, the source of availability information, the treatment of shared capacity and the responsibility for confirming changes. PMI includes availability, calendars, skills and changing demand within its resource-planning discussion (PMI, 2019, p. 52). Later chapters develop the calculations; the design decision here is how reliable inputs will be obtained and maintained.

Table 2.4 | Rules that make a planning framework usable

Rule area	What the framework should establish	What becomes unreliable if it is unclear
Identity and coding	Stable identifiers, valid code values, ownership and mapping rules	Comparisons across periods and reports grouped by responsibility
Calendars and units	Working periods, hours per day, exceptions, time zones and conversions	Durations, interface dates and interpretation of available time
Calculation settings	Approved settings, treatment of constraints and out-of-sequence progress, change records	Reproducibility of dates and explanation of forecast movements
Resources	Required resource detail, availability sources and shared-capacity checks	The claim that a logically valid sequence is executable
Progress and evidence	Status cut-off, acceptable evidence, remaining-work rules and review responsibility	Actual dates, completion claims and forecasts of unfinished work
Performance and triggers	Metric definitions, comparison reference, tolerances and response authority	Consistent interpretation and timely corrective decisions

Align granularity, update frequency and calculation behaviour

The appropriate update interval depends on the rate of change and the time available to respond. A monthly cycle may be adequate for some stable long-term work but inadequate for a short outage in which a missed shift changes the whole sequence. More frequent reporting is not automatically better. If the organisation cannot validate, analyse and act on the information before the next cycle begins, it can accumulate reports without increasing control. The framework should therefore connect the information cut-off, submission deadline, model update, review, decision and publication. PMI explicitly links the update cycle to activity granularity and management use (PMI, 2019, pp. 50-51).

Calculation settings must also be controlled because they influence what the model predicts. The treatment of constraints, progress that occurs out of sequence, remaining work and resource levelling can affect dates. Two people can use the same activity data and obtain different results if they apply different settings. The plan should record the relevant settings and explain how changes are reviewed and disclosed. This does not require the chapter to prescribe one setting for every situation. It requires the project to make its choice deliberate, technically defensible and reproducible, with changes visible to those interpreting the forecast.

Define indicators before using them to judge performance

An indicator needs a clear numerator, denominator, observation period and interpretation. If a report states that 90 per cent of planned starts occurred, readers need to know which activities were included, whether the plan was fixed before the period and whether starting an activity without its essential prerequisites counts. The same apparent result could describe meaningful delivery or a collection of token starts. Measures of activity starts and finishes, backlog, duration growth and additions or deletions can reveal different aspects of performance, but none is a complete measure of project health (PMI, 2019, pp. 52-53).

The framework should distinguish performance indicators from data-quality indicators. A late milestone is a delivery concern; missing ownership or an invalid actual date is an information concern that can weaken the delivery assessment. Both deserve attention, but combining them into one unexplained score conceals the cause. Thresholds should identify a response, not merely a colour. For example, an illustrative local rule might require same-day escalation when an unresolved handover threatens an imminent outage, while a small movement in a non-driving activity is reviewed through the normal cycle. The threshold, its rationale and the person authorised to act should be agreed in advance, with room for professional judgement where the circumstances warrant it.

2.5 Integrating project, contractor and programme schedules

Distinguish a summary from an integrated model

> **Master Schedule.** 'A summary-level project schedule that identifies major deliverables, work breakdown structure components, and key schedule milestones.' (PMI, 2019, p. 183)

The word 'master' is used differently in organisations and software products. The glossary definition above concerns a summary-level schedule. PMI's discussion of a master schedule model also considers a master project containing linked subprojects (PMI, 2019, p. 53). A professional should therefore establish what the local term means before assuming what the file can do. A summary of major dates can support senior management communication; a logic-linked integrated model can support analysis of how a delay crosses package boundaries. One does not automatically provide the capabilities of the other.

The integrated planning framework should identify the model boundaries and the relationships across them. A programme may contain separate projects, each with its own approval and reporting arrangements. A project may contain contractor schedules, internal work and third-party commitments. These structures need not all be forced into one physical file. They do need a controlled means of connecting the information required to assess the overall delivery sequence. Where an organisation uses an integrated master plan, its agreed outcomes, events and completion criteria should be consistent with the time-based schedule that represents their delivery. The terminology and contractual meaning should be agreed explicitly.

Integration also requires a scope check. A contractor may correctly exclude client decisions or another contractor's work from its own obligations, while still depending on them. The programme model must

represent these dependencies even when the work sits outside that contractor's scope. Otherwise, each individual submission may appear complete within its boundary while the combined plan has gaps. The scheduling strategy should therefore specify who provides external information, who maintains the interface records and who owns unresolved dependencies that fall between contracts. An empty ownership boundary is a delivery risk even when every organisation has submitted a schedule.

Establish an agreement at each important interface

An interface should identify a deliverable or condition, the party producing it, the party receiving it, the evidence of acceptance and the activities that depend on it. It should also distinguish required dates from forecast dates. A manufacturer may need accepted design information by a particular date to preserve its planned production slot. The designer's forecast may be later. Copying the required date into the designer's schedule hides the conflict; maintaining both dates makes the decision visible. The team can then investigate resequencing, partial releases, additional review capacity or a revised commitment, with the implications assessed openly.

Controlled supplier interface

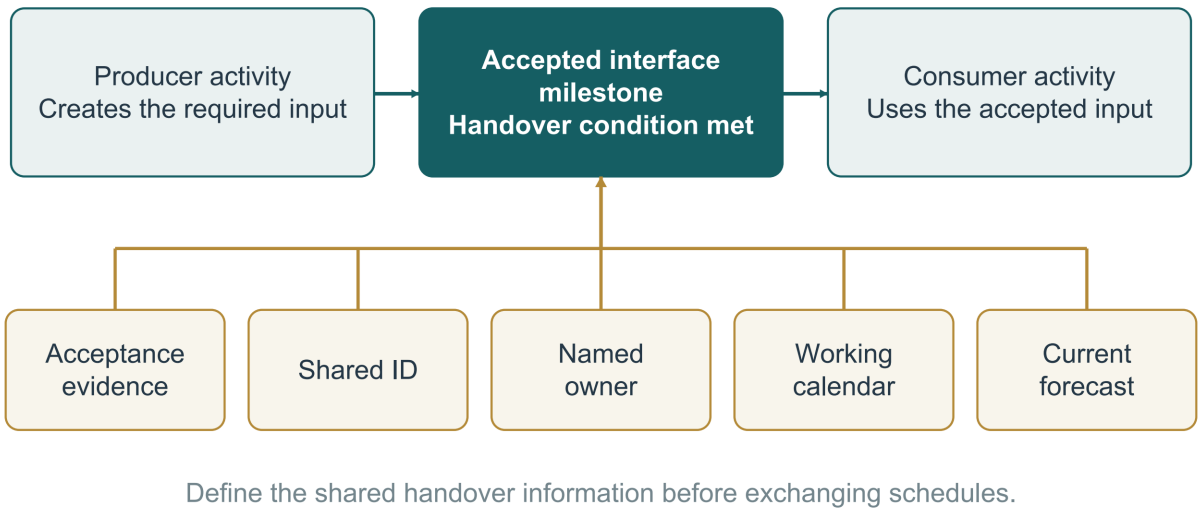


Figure 2.6. An original interface model. The handover connects producing and consuming work through an agreed condition and evidence. Shared identity, ownership, calendars and forecast rules allow different schedules to describe the same interface consistently.

Table 2.5 | Information needed at a delivery interface

Interface field	Why it is needed	Example of an ambiguity to resolve
Shared identifier and description	Makes the same handover recognisable in both schedules	Two similarly named releases contain different drawings
Producer and receiver	Identifies who provides and who needs the output	A central team receives a file but cannot accept it for the user
Acceptance condition and evidence	Establishes when the handover is usable	'Issued' means sent for review in one plan and approved in another
Required date and current forecast	Preserves the distinction between need and expected delivery	A required-by date is copied as though it were a supplier commitment
Calendars and timing convention	Makes the dates operationally interpretable	Friday evening in one location is outside the receiving team's working week
Linked activities and change route	Connects consequences and assigns responsibility for revisions	The milestone moves but the receiving package continues to use the old date

The interface agreement should be maintained at the level needed for control. A single handover milestone may be sufficient when one accepted package genuinely enables all downstream work. Several milestones may be necessary when different information releases support different activities. Over-combining them can hide opportunities for partial delivery; over-fragmenting them can create an unmanageable register. The right design follows the actual dependency and the decision it supports. An interface review should ask what can start when the condition is met, what remains blocked and who confirms that the condition is satisfied.

Germany guidance: information deliveries are part of the programme

Germany's federal-highway BIM execution-plan framework links digital deliverables and their dates to project phases and milestones. It combines content, timing, format and responsibility, including named roles and agreed exchanges between client and contractor (BMVI, 2021, pp. 20-23). The scheduling lesson is that information needed to release work should itself be planned and owned. A design file due at an integration milestone is a dependency whose review and release take time. The framework concerns information delivery in federal-highway projects; it neither prescribes PMI schedule levels nor makes an information model equivalent to a logic-linked control schedule.

Lindholm, Johansson and Yitmen (2025) investigate the same connection from a research perspective. Two Swedish cases and a workshop involving 14 participants from seven companies examined information delivery and planning. The study identified disconnections between information deliveries and production plans and proposed an information-delivery framework. Its sector and national context, and the distinction between a proposed framework and demonstrated performance improvement, limit generalisation. Nevertheless, the study supports a useful planning question: which information must reach which recipient, in which accepted state, before the dependent work can proceed?

Control the information exchange as well as the dependency

A common status date is useful for integration, but it is only one element of compatibility. Calendars, units, progress rules, coding, identifiers, baseline references and calculation settings must also be reconciled. A submission protocol should specify the native data required, any readable presentations, the narrative explaining changes and the validation checks before incorporation. If a contractor submits late, the integrated report should disclose the age and limitations of its information. Silently treating an older forecast as current can create an apparently consistent programme view that combines different reporting periods.

Where models are exchanged between systems, the planner should test what survives the transfer. An imported activity may retain its name and date while losing a relationship, calendar exception or custom code. A transfer that produces no error message is not necessarily a faithful transfer. Checks should compare agreed control totals and selected critical information, including key interfaces, activity identities, calendars and material changes in calculated dates. The framework should also define whether the integrated model holds a controlled copy of supplier information or reads from a maintained external source, since those designs create different responsibilities for timing, access and auditability.

Keep integration responsive to change

A changed interface is a coordination event, not simply a revised cell. If a supplier's accepted-information milestone moves, the receiving team should assess the effect on its own sequence, resources and commitments. The integrated model can then show whether the movement is absorbed, transfers to another milestone or creates a need for action. The change record should connect the cause, affected activities, decision and resulting controlled instance. That traceability allows a later reviewer to understand why a date moved without reconstructing the story from disconnected emails and presentation files.

An integrated schedule should preserve disagreement long enough for it to be resolved honestly. If two parties hold different forecasts for the same handover, choosing the more convenient date creates superficial consistency. The framework should instead identify the disputed assumptions, seek evidence from both sides and assign the decision to the appropriate authority. Once agreed, the resolution should be reflected in the affected models and reports. Integration is therefore both technical and organisational: links transmit the consequences of the dates, while governance establishes which dates and assumptions the parties are entitled to rely on.

France case study: Grand Paris Express and consistent records

The Grand Paris Express BIM charter, revised in March 2021 and reproduced in the French government's 2024 guidance volume, identifies intended uses including assessing the time and cost effects of modifications, visualising progress and checking consistency between technical information, costs and schedules. It also records its own revision history (Société du Grand Paris, 2021, reproduced in MIQCP and Plan BIM, 2024b, pp. 40-41, 56-61). These are documented requirements and aims, rather than evidence that BIM eliminated delay. They illustrate the need for a change to remain recognisable across several control records instead of being updated independently in each discipline's preferred system.

2.6 Controlling schedule data, versions and the baseline

Establish a controlled path from evidence to publication

Schedule data pass through several states before they should inform a decision. A work owner may submit an actual finish with supporting evidence; a reviewer may find that acceptance is still incomplete; the scheduler may need to distinguish physical completion from a remaining approval. The framework should provide a visible route for resolving the discrepancy before the milestone is reported as achieved. Validation should check both format and meaning. A date can be technically valid while referring to the wrong event, and a percentage can lie within the permitted range while lacking a defensible measurement basis.

The process in Figure 2.7 separates capture, validation, calculation, review, publication and archive. These steps can be performed within a single application or across several controlled systems. Their separation is conceptual: it makes clear that receiving information does not establish its validity, and calculating a schedule does not establish its authority for publication. Failed checks should return information to the appropriate owner with a specific reason, while material unresolved limitations should accompany the forecast. A deadline for reporting should not become an incentive to conceal uncertainty about the data.

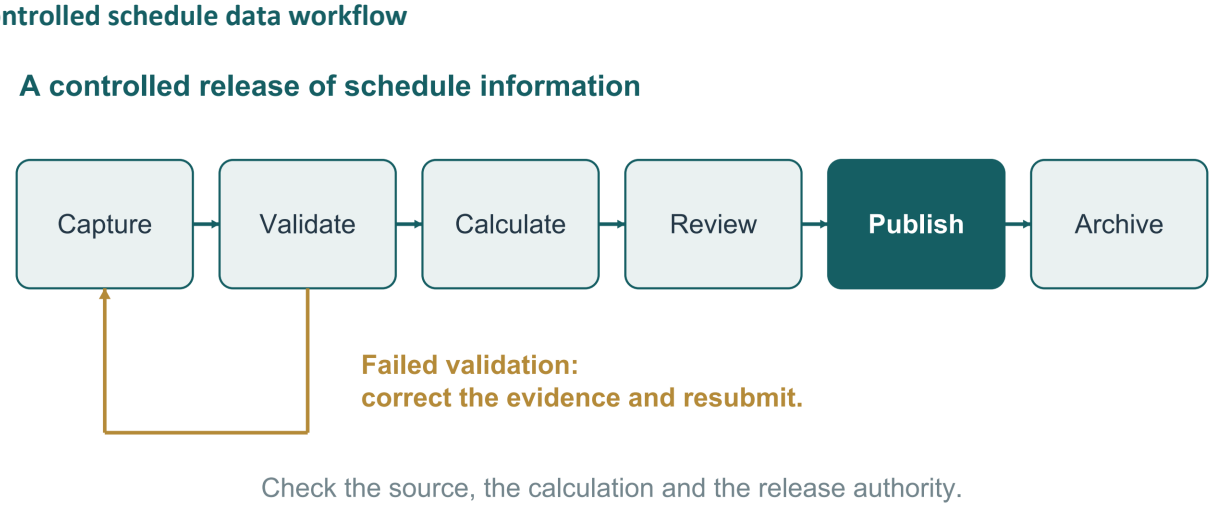


Figure 2.7. An original information-control workflow. Validation and review are decision points, with correction routes where evidence or interpretation is inadequate. The archive retains the issued record and its context.

The status date, sometimes called the data date in scheduling practice, marks the point at which progress is assessed for the update. It should be distinguished from the date on which a file is saved, approved or published. A report issued on Friday may legitimately describe the position at the preceding Monday cut-off. It should say so. The project also needs a policy for late evidence, corrections to earlier actuals and events occurring after the cut-off. These matters can change the interpretation of the forecast even when the report format remains identical. For a geographically distributed project, the cut-off should include an agreed time zone where the timing is material.

Define the data dictionary and validation rules

A useful data dictionary explains the purpose and meaning of a field, its type, permitted values, source, owner and update rules. It should distinguish calculated fields from entered fields and identify transformations applied during exchange. For example, a receiving system may store dates in a different format or use a different code for a discipline. The mapping should preserve meaning and be tested against representative records. If a conversion cannot preserve a field faithfully, the limitation should be documented and addressed before the resulting information is used to make a commitment.

The UK's Programme and Project Data Standard separates original planned milestone dates, current forecasts and actual dates, alongside identifiers, metadata and validation rules. It does not prescribe a single software product, and its scope excludes dependencies, assumptions and change-control entities (Government Project Delivery, 2025b, sections 1.2, 3.1, 3.5, 4-5). It therefore provides an example of deliberate data design rather than a complete scheduling schema. A local scheduling system still needs its dependency and change records. It should also preserve the original planned date separately from any later authorised baseline, so that different comparison questions remain answerable.

Validation should be layered. Basic checks identify duplicate identifiers, missing required fields, invalid codes and actual dates outside the permitted reporting period. Logical checks examine the relationship between values, such as a finish preceding its start or a claimed completion that lacks the agreed evidence. Schedule checks then examine whether the information behaves coherently in the model. Finally, review considers whether the resulting forecast is credible in the delivery context. Passing the first layer does not establish that the later layers will pass. A file can be perfectly formatted and still describe an infeasible plan.

Separate current forecasts from authorised reference points

> **Schedule Baseline.** 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results.' (PMI, 2019, p. 189)

The current forecast should respond to verified progress and the latest defensible assumptions. The baseline provides an authorised reference against which performance is assessed. These functions must remain distinct. Updating the forecast does not itself authorise a baseline change, and protecting the baseline does not justify keeping the forecast artificially fixed. A project can honestly report that the current completion forecast is later than the approved baseline while explaining the cause, consequences and proposed response. That difference is management information. Removing it by overwriting the baseline destroys the comparison that control is intended to provide.

Forecast update and baseline change paths

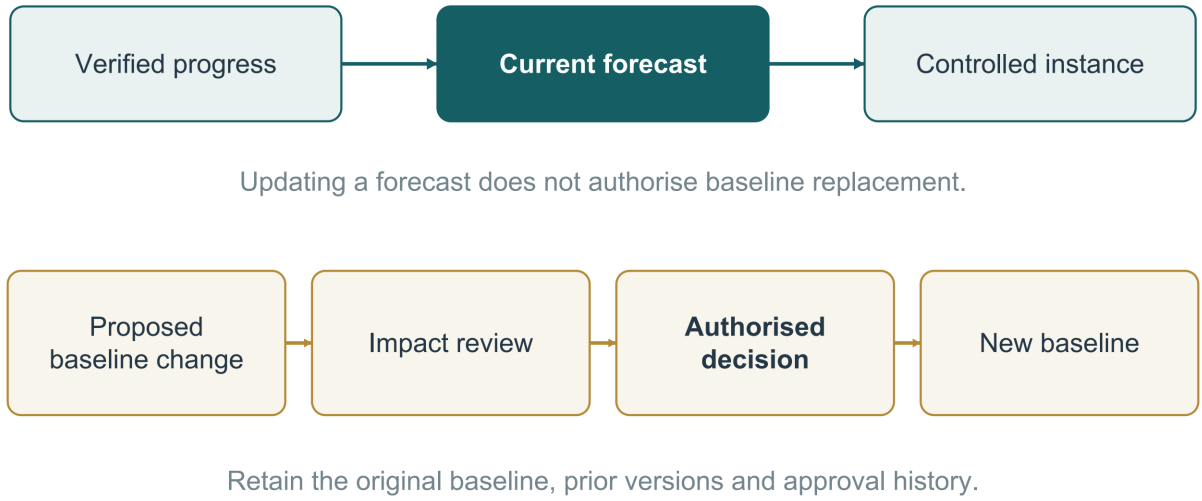


Figure 2.8. An original distinction between updating a current forecast and authorising a baseline change. Both require controlled records, but they answer different questions and may involve different decision authorities.

The framework should distinguish routine progress updates, corrections to erroneous data, maintenance of modelling detail, scenario analysis and changes to the authorised plan. These categories require different treatment, but none should be invisible. Correcting an actual date may improve factual accuracy while changing the interpretation of an earlier report. Decomposing a planning package may expose a previously hidden dependency. A recovery scenario may use additional resources that have not been approved. Clear classification enables the team to apply the right review and authority while retaining a traceable explanation of what happened.

Australia case study: keeping control records aligned

The ANAO's 2026 audit of the Collins submarine Life of Type Extension project records that an approved contract master schedule was expected by July 2022, but its baseline was not approved until June 2023. The integrated project management plan followed in June 2024. The audit also found that, as at February 2026, statement-of-work milestones did not reflect a revised design-review approach agreed in August 2025 (ANAO, 2026, paragraphs 4.2 and 4.9-4.11; Table 4.5 note). The lesson is the need to keep scope, schedule and contractual records aligned as decisions change. The audit covers wider strategic and technical issues; these control weaknesses should not be presented as the sole cause of project delay.

Table 2.6 | Distinguishing controlled schedule records

Record or change	Its purpose	Required control distinction
Current forecast	Shows the expected outcome using accepted current information	Update through the agreed cycle; disclose the status date and material assumptions
Approved baseline	Provides the authorised comparison reference	Change only through the relevant formal authority and retain its history
Original reference	Preserves the initial agreed position where needed for reporting and analysis	Do not silently replace it when a later baseline is authorised
Scenario	Tests an alternative set of assumptions or actions	Label its purpose and assumptions; prevent accidental issue as the committed plan
Correction or model maintenance	Improves factual accuracy or the representation of the work	Record the reason, affected information, reviewer and consequences
Published instance	Preserves what was issued for a particular reporting period	Retain the model, report, narrative and approval context needed to reproduce it

Preserve access, history and recoverability

Access rights should follow responsibilities. Some users need to submit progress, some to edit model data, some to administer the environment and others only to inspect information. Giving everyone unrestricted editing access can weaken accountability; giving delivery owners no practical means to correct information can weaken accuracy. The aim is a workable balance, supported by a record of who changed what and when. Approval status should be visible independently of file location. A document in a shared folder is accessible, but accessibility does not establish that it has been checked or authorised for the intended use.

UAE guidance: control the status of shared information

Abu Dhabi municipality's infrastructure BIM documentation guidance requires a live execution plan, task and master information delivery plans, and a responsibility matrix. Revisions are agreed, recorded and redistributed, while its shared information environment distinguishes work in progress, shared, published and archived states (DMT and Municipality of Abu Dhabi City, 2020, pp. 24-25, 35). This published municipal approach is not a UAE-wide scheduling law. Its relevant principle is that access, revision and permitted use need deliberate control. A file can be available for coordination without being authorised for execution, and an information delivery plan supports rather than replaces the project schedule.

Jaskula et al. (2025) reviewed 46 documents and interviewed 15 BIM experts about common data environments. Fragmented platforms, inconsistent workflows, skills and traceability emerged as practical implementation concerns. The authors caution that the interview sample does not represent the whole industry. Their findings support treating a common data environment as a combination of tools, roles and agreed processes, rather than assuming that a product purchase establishes reliable information. For scheduling, this directs attention to authoritative versions, access, review status and exchange routines across the systems people actually use.

Retain the information needed to explain and recover the model

An archive should retain sufficient context to explain the published position. That may include the native schedule, the issued views, its status date and instance identifier, the basis of schedule, material assumptions, change records and the approval or review record. The exact retention period should follow the applicable organisational, contractual and legal requirements; it should not be invented as a universal number for all projects. Historical records are useful for trend analysis, assurance, lessons and later reconstruction of decisions. Their value depends on being identifiable and retrievable, rather than merely existing somewhere in storage.

Backup and archive serve different purposes. Backup supports recovery after loss or corruption; archive preserves selected records with the context needed for future use. A backup that has never been restored successfully provides uncertain protection. The data management arrangements should specify frequency, responsibility, storage protection, recovery expectations and periodic retrieval tests. PMI specifically warns that projects can perform backups without establishing reliable retrieval procedures (PMI, 2019, p. 47). Recovery planning should include the information needed to resume scheduling, not only the latest presentation, since a picture of a schedule cannot recreate its logic, calendars and calculation settings.

Technology changes also need control. A software upgrade, revised interface or altered code dictionary can affect the ability to reproduce earlier results. The project should test representative models and preserve the information needed to interpret historical records. Distributed teams may require agreed maintenance windows so that essential access is not unexpectedly interrupted during an update cycle. These arrangements are often managed centrally, but the scheduling team must identify its own requirements and dependencies. Assuming that someone else has addressed recovery and compatibility is weaker than confirming how those controls support the actual reporting process.

2.7 Communicating decisions and keeping the framework live

Design the reporting cycle around action

> **Project Schedule.** 'An output of a schedule model that presents linked activities with planned dates, durations, milestones, and resources.' (PMI, 2019, p. 187)

Reporting should connect the current position to a decision. A useful schedule report identifies its status date and reference baseline, explains significant movements, distinguishes achieved work from forecast work, and states the action or decision required. Different audiences need different detail, but their views should remain traceable to consistent information. PMI links communication needs to the selection of schedule presentations, including critical paths, resources, dependencies, assumptions, progress and quantities (PMI, 2019, pp. 88-90). The question is not how many charts can be produced; it is which information allows the recipient to act responsibly.

The weekly example in Figure 2.9 allows time between collection and publication for validation, integration and decisions. It is an illustration, not a prescribed timetable. A project should place these steps around its operational and contractual needs, including the time required for contributors in different locations. Urgent exceptions need a separate route. If a newly discovered interface problem requires a decision tomorrow, waiting for Friday's report is a failure of control even when every normal reporting deadline is met. The framework should explain how the urgent decision and its consequences are subsequently recorded in the controlled information.

Egypt case study: connecting reporting with escalation

Egypt's Ministry of International Cooperation announced the launch of AIMS in July 2023 to connect information on development agreements, programmes and projects. Its account describes detailed monitoring reports prepared every three months with implementing entities and development partners, then submitted to relevant bodies and the Cabinet to identify and address challenges. It also records training for 120 staff in beneficiary entities (Ministry of International Cooperation, 2023). This is an official account of the system and its intended use, rather than an independent performance evaluation. Its portfolio oversight cycle illustrates coordinated reporting and escalation; it does not imply that operational schedules should be updated only quarterly.

Illustrative reporting and decision cycle

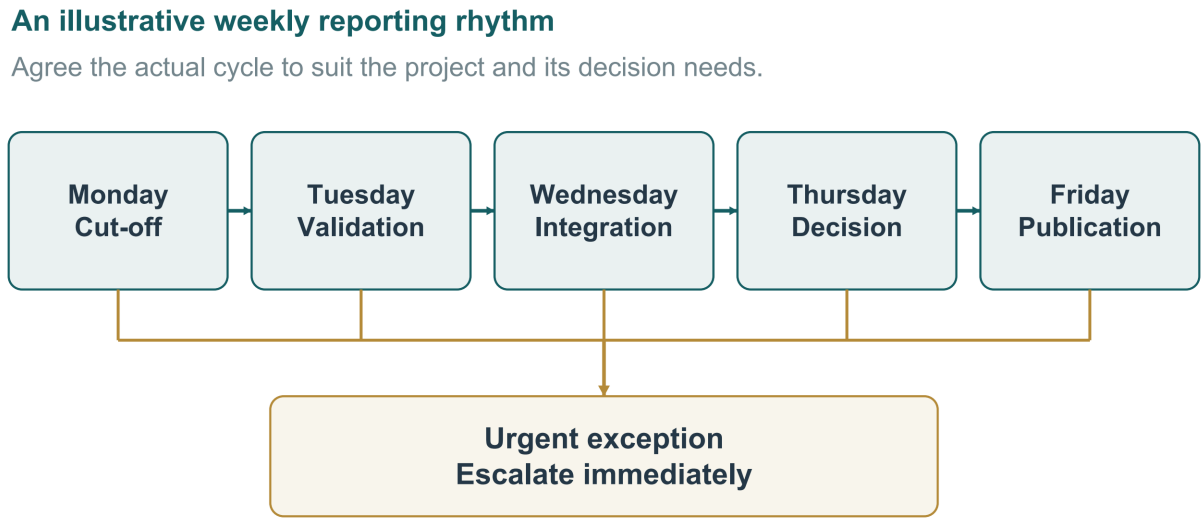


Figure 2.9. An original example of a weekly control cycle. Routine reporting provides a predictable rhythm; urgent exceptions require timely escalation within delegated authority. The sequence and frequency should be tailored to the project.

Table 2.7 | Reporting for different decision-makers

Audience and decision	Useful information	Control that preserves confidence
Supervisor coordinating near-term work	Ready tasks, access, resources, prerequisites and unresolved blockers	Current local evidence linked to the agreed package commitments
Project manager choosing a response	Driving work, interfaces, forecast changes, options and consequences	An identified model instance and a clear comparison reference
Sponsor authorising a material decision	Commitment outlook, uncertainty, choices and the latest useful decision date	Transparent assumptions and the relevant delegated authority
Contractor or commercial representative reviewing obligations	Required submissions, interface commitments, accepted changes and notices	Alignment with the applicable contract and retained issue records
Assurance reviewer examining reliability	Native model, basis, data definitions, history and unresolved findings	Access to reproducible evidence and a traceable response to findings

Align contractual reporting and professional interpretation

Contracts can require particular submissions, formats, review periods and notifications. The planning framework should identify these requirements and obtain appropriate commercial interpretation where their meaning is uncertain. A technical check by a scheduler, acceptance of a submission under a contract and approval of a new project baseline may be different acts. Their relationship depends on the relevant arrangements. The schedule should therefore retain the status of the submission and the decision that has actually been made. Neither a successful file import nor silence after circulation should be assumed to confer an authority that the project has not established.

The framework should also state whether earned value management (EVM) and earned schedule will be used. EVM compares the budgeted value of completed work with planned value and actual cost; earned schedule adds a time-based interpretation of progress. Their use requires agreed measurement rules and consistent scope, schedule and cost information (PMI, 2019, pp. 52-53). These indicators complement the analysis of driving activities and milestone forecasts. A favourable aggregate measure does not establish that a particular critical handover will occur on time. Later chapters develop the calculations; the decision here is which measures the project needs and how their inputs will be controlled.

Review the framework when delivery conditions change

A live framework has an owner, a review mechanism and a controlled means of revision. A move from design into commissioning may require closer update intervals, different evidence of progress and new acceptance authorities. A change in contracting strategy may require different model boundaries and interface ownership. Lessons from rejected submissions may reveal that a field definition or instruction is unclear. These findings should improve the management and data plans, with affected users informed and historical records kept interpretable. The aim is stable control that can adapt to changing work, rather than either an unchanging procedure or an undocumented series of local exceptions.

Keeping PMI-SP preparation in view

The official PMI-SP Examination Content Outline assigns 14 per cent to Schedule Strategy and 14 per cent to Stakeholder Communications Management. The strategy tasks address configuration management, selection of an appropriate approach, scheduling policies and procedures, integration with other project plans, and the team's understanding of scheduling responsibilities. Domain 2 also requires alignment with the programme plan or integrated master plan. These requirements explain why this chapter treats governance, data and communication as scheduling competence rather than administration around it (PMI, 2012, pp. 3-4, 9). The original questions that follow test these distinctions; they are teaching questions, not reproduced PMI examination items. At Level 6, the additional expectation is to justify the choice, examine its limitations and explain the consequences for others.

Knowledge check and examination practice

Question 1 Recovering the planning information

A project already has an agreed critical path approach, reporting hierarchy and update cycle. An assurance review finds that nobody knows who can retrieve an earlier native model after a system failure. Which part of the planning arrangements most directly needs attention?

A The choice between predictive and adaptive delivery.
B The schedule data management arrangements for access, recovery and tested retrieval.
C The number of executive milestones displayed.
D The replacement of the current forecast with the original baseline.

Question 2 Agreeing a schedule hierarchy

A client and contractor both agree to provide a 'Level 3 schedule', but their drafts contain different levels of detail and different interfaces. What should the planner do first?

A Require the contractor to use the client's number without further discussion.
B Add more activities until the files contain equal numbers of rows.
C Remove the interfaces from both schedules to make their formats consistent.
D Agree the required purpose, content, granularity, interfaces and links between levels.

Question 3 Preserving identity through organisational change

Responsibility for an existing activity moves from one delivery team to another. The activity's scope remains unchanged. Which approach best supports reliable comparison between reporting periods?

A Retain its stable activity identifier, update the responsibility code and record the change.
B Assign a new identifier and delete the history so that the new owner starts cleanly.
C Reuse the identifier of another completed activity.
D Keep the former ownership code because identifiers and codes must never change.

Question 4 Reporting an unwelcome forecast

Verified progress indicates that completion is now expected three weeks after the approved baseline. No baseline change has been authorised. What is the most appropriate treatment?

A Move the baseline to the forecast date to avoid reporting an obsolete plan.
B Keep the forecast at the baseline date until a recovery option is approved.
C Update and explain the current forecast, preserve the baseline and follow the agreed decision process.
D Publish only the percentage complete because reporting the variance could alarm stakeholders.

Question 5 Resolving a handover mismatch

A supplier reports a design package as 'issued', while the receiving team requires accepted information before manufacture. Both schedules show the same handover date. What is the main unresolved issue?

A The handover is reliable because the dates match.
B The parties have not established a common acceptance condition and usable evidence for the interface.
C The milestone must be converted into a summary activity.
D The receiver must use the supplier's reporting software before any review can occur.

Question 6 Responding before the normal report

The normal schedule report is issued on Friday. On Tuesday, a validated interface problem is found that requires an authorised decision by Wednesday to preserve an access window. What should the planning framework enable?

A Defer the matter to Friday to protect reporting consistency.
B Allow the scheduler to approve any additional expenditure required.
C Remove the affected activity until the next reporting period.
D Escalate the decision promptly to the appropriate authority and retain a controlled record of the outcome.

Question 7 Tailoring resource detail

A project has not assigned named people to every activity, but its proposed sequence relies on a scarce specialist team. Which response best reflects the chapter's guidance?

A Establish how specialist capacity and availability will be confirmed and represented; tailor resource detail to the control need.
B Declare the model automatically non-compliant because PMI requires every activity to contain named resources.
C Ignore availability until the specialist activities start.
D Change the calendar to seven working days so that availability is no longer relevant.

Question 8 Testing integration

An executive milestone agrees with the summary in a contractor's schedule, but a required handover from another contractor is absent from both models. Which conclusion is most appropriate?

A Matching summary dates establish complete schedule integration.
B The problem can be solved solely by changing the executive chart format.
C The apparent vertical consistency does not establish horizontal integration across the missing dependency.
D The missing handover is irrelevant because it belongs to a different contract.

Answer explanations

Question 1: B. Access, recovery and tested retrieval belong directly to the schedule data management arrangements. A concerns the delivery approach and does not resolve the missing recovery process. C changes a presentation without restoring underlying information. D confuses the forecast and baseline and would not establish recoverability.

Question 2: D. The parties need a shared description of the required information and how it connects to other levels. A assumes that the label resolves meaning. B treats activity count as a proxy for suitability, although equally long schedules can describe different work. C removes necessary integration information to achieve superficial similarity.

Question 3: A. Stable identity supports comparison while the responsibility code records the changed organisational fact. B unnecessarily breaks continuity for unchanged work. C creates ambiguity between different activities. D wrongly treats a descriptive classification as an immutable identity and leaves the ownership information inaccurate.

Question 4: C. The forecast should reflect accepted current evidence, while the baseline remains the authorised comparison reference until formally changed. A overwrites that reference without authority. B conceals the expected outcome. D removes information needed for management decisions and does not resolve the delay.

Question 5: B. Equal dates are insufficient if the parties mean different states of the deliverable. A mistakes numerical agreement for semantic agreement. C changes the representation without resolving acceptance. D makes an unnecessary software assumption: different tools can support a controlled interface when meaning, evidence and exchanges are agreed.

Question 6: D. An urgent decision needs to reach the person with authority while action remains useful, and the result must enter the controlled record. A allows the reporting routine to defeat its purpose. B assigns financial authority without evidence of delegation. C conceals relevant work and weakens the model.

Question 7: A. The framework should make the significant resource assumption testable and maintainable. B overstates PMI's requirements; the source describes resource loading as good practice rather than a universal requirement. C postpones a feasibility check until it is less useful. D changes a calendar without establishing actual capacity or a sustainable working pattern.

Question 8: C. Agreement between a summary and supporting detail does not establish the missing relationship across organisational boundaries. A confuses two different integration tests. B changes appearance without adding the dependency. D ignores work that can affect delivery even when responsibility sits elsewhere.

Preparing for the next chapter

The planning framework establishes how scheduling will be undertaken and how its information will be trusted. Chapter 3 develops the content that operates within that framework: scope, work breakdown, activities, milestones and interfaces. The link is practical. A stable identifier cannot compensate for an undefined activity, and a clear approval route cannot compensate for omitted work. Equally, well-defined work needs the ownership, conventions and controls established here if its dates are to remain useful throughout delivery.

References and further reading

PMI page references identify the printed pages of the third edition. Official guidance is cited within its stated organisational or national scope; diagrams in this chapter are original teaching illustrations. Final journal issue years are used where articles appeared online earlier.

Australian National Audit Office (ANAO) (2026) *Defence's Collins Class Submarines Life of Type Extension - Planning and Implementation*. Auditor-General Report No. 33 of 2025-26, 22 May. See paragraphs 4.2 and 4.9-4.11 and Table 4.5. Official audit report.

Bundesministerium für Verkehr und digitale Infrastruktur (BMVI) (2021) *Masterplan BIM Bundesfernstraßen: Rahmendokument BIM-Abwicklungsplan (BAP)*. Version 1.0, October, pp. 20-23. Official federal-highway framework.

Department of Municipalities and Transport (DMT) and Municipality of Abu Dhabi City (2020) *BIM Documentation Guidelines for Infrastructure*. Version 1.0, October, pp. 24-25, 35. Official municipal guidance.

Government Project Delivery (2025a) *Government Functional Standard GovS 002: Project Delivery*. Version 2.1, September. See clauses 4.1.3 and 7.2-7.9. Official standard.

Government Project Delivery (2025b) *Programme and Project Data Standard*. 11 December. See sections 1.2, 3.1, 3.5, 4 and 5. Official data standard.

Infrastructure and Projects Authority (IPA) (2022) *Project Routemap: Delivery Planning*. See p. 38, Heathrow Airport Limited case study. Official module.

Jaskula, K., Kifokeris, D., Papadonikolaki, E. and Rovas, D. (2025) 'Common data environments in construction: state-of-the-art and challenges for practical implementation', *Construction Innovation*, 25(5), pp. 1522-1541. DOI: 10.1108/CI-04-2023-0088.

Lindholm, J., Johansson, P. and Yitmen, I. (2025) 'Toward a BIM information delivery framework based on common data environment', *Construction Innovation*, 25(7), pp. 139-157. DOI: 10.1108/CI-06-2024-0185.

Ministry of International Cooperation, Egypt (2023) *Launch of the electronic system for managing data and monitoring concessional development-finance projects (AIMS)*. 20 July. English description of the Arabic publication. Official ministry announcement.

Mission interministérielle pour la qualité des constructions publiques (MIQCP) and Plan BIM (2024a) *BIM et maquette numérique: Guide de recommandations à la maîtrise d'ouvrage dans le domaine du bâtiment - Construction neuve et réhabilitation*. Tome 1, revised April, pp. 34-37. Official guidance, volume 1.

MIQCP and Plan BIM (2024b) *BIM et maquette numérique: Guide de recommandations à la maîtrise d'ouvrage dans le domaine du bâtiment*. Tome 2, revised April, Annexe V. Reproduces Société du Grand Paris (2021), *Charte BIM de la Société du Grand Paris*, index 2, 24 March, pp. 40-41, 56-61. Official guidance, volume 2 and reproduced charter.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. See pp. 3-4 and 9. Official examination outline.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: Project Management Institute. Principal chapter coverage: sections 2.3-2.5, 3.1 in full, 3.2.1.9 and relevant communication/reporting material in 3.5; definitions from the cited printed pages of the supplied book.

Sheikhkhoshkar, M., Bril El-Haouzi, H., Aubry, A., Hamzeh, F. and Rahimian, F. (2025) 'From process-based to technology-driven: a study on functionalities as key elements of collaborative planning methods for construction projects', *Production Planning & Control*, 36(10), pp. 1330-1351. DOI: 10.1080/09537287.2024.2360581.

Son, J., Han, B.G., Khwaja, N. and O'Brien, W.J. (2024) 'Assessment of Schedule Quality Problems from the DOT Schedule Reviewers' Perspective: Case of TxDOT', *Transportation Research Record*, 2678(10), pp. 622-633. DOI: 10.1177/03611981241234903.

US Department of Energy (DOE) (2026) *Program and Project Management for the Acquisition of Capital Assets*. DOE O 413.3C, approved 5 August. See Appendix C, p. C-16, sections 15-18. Official order.

US Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, 22 December, pp. 71-74, 130-138, 197. Official guide.

CHAPTER 03

Turning Scope into Activities, Milestones and Interfaces

Before a date can be credible

A schedule can contain carefully calculated dates and still describe the wrong work. A project may include manufacture and installation but omit the information needed to begin them, the inspections needed to accept them or the preparation needed to use the result. The calculation can be internally consistent while the delivery plan remains incomplete. The difficulty is not solved by adding more activities indiscriminately. It is solved by establishing a defensible connection between the project's purpose, its requirements, the deliverables that satisfy them and the work needed to create and accept those deliverables. This chapter develops that connection before duration estimation and detailed network analysis begin.

The central question is what the schedule must represent. A requirement describes a condition that must be satisfied. A deliverable provides an identifiable result. A work package establishes a manageable scope boundary. An activity describes work performed within the delivery plan. A milestone marks a significant event or condition in that plan. These concepts are related, but they are not interchangeable. Treating them as equivalent can obscure ownership, inflate apparent progress and hide dependencies between organisations. A building component can be installed while its system remains untested; an information package can be issued while it remains unsuitable for the work that depends on it.

The chapter is self-contained and uses the PMI scheduling standard alongside official publications, research and documented project evidence. Its examples require no knowledge of a continuing fictional project or another module. By the end, the reader should be able to translate requirements into a coherent work breakdown structure, connect scope with responsibility and cost control, define measurable activities, distinguish the main activity forms, establish meaningful milestones, identify delivery interfaces and use progressive detail without losing control of the total scope. The emphasis is on explaining why a representation is suitable and where it could mislead a decision-maker.

These capabilities are central to PMI-SP preparation. The examination's Schedule Planning and Development domain includes creating breakdown structures and work packages, defining activities and milestones, and examining major milestones against contractual and scope requirements. At Level 6, the professional task extends beyond recalling terms: it requires detecting omissions, resolving conflicting interpretations and defending how the proposed schedule represents the work. A useful activity list is therefore the result of structured enquiry with people who understand delivery, rather than an administrative transcription of a document into software.

The chapter framework

The original framework in Figure 3.1 follows a chain of traceability from purpose to acceptance. The chain asks why the work is needed, what conditions must be met, what will be produced, how the scope is divided, what actions are necessary and which events demonstrate achievement. Three tests run across it. Coverage asks whether the agreed scope and enabling work are represented. Ownership asks who is accountable for each meaningful element and interface. Acceptance asks what evidence makes a completion claim defensible. Interfaces cross the chain because an output can satisfy one team's task while still failing to meet another team's input requirement.

Scope-to-schedule traceability framework

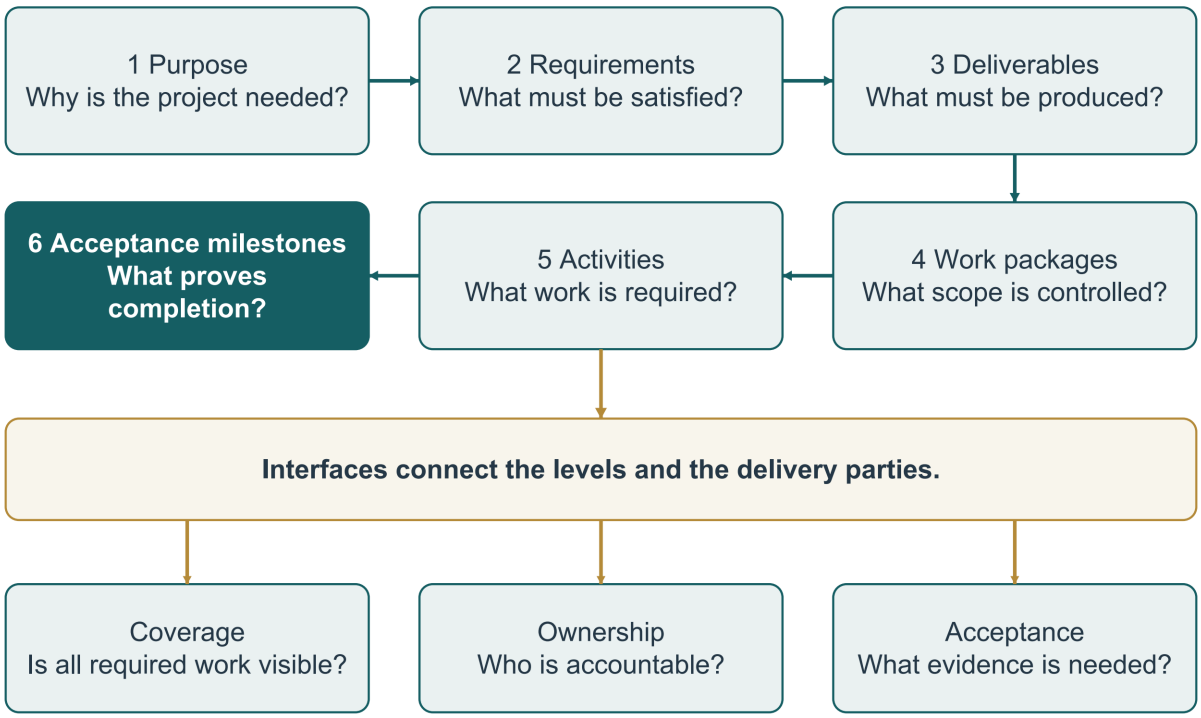


Figure 3.1. An original teaching framework for tracing purpose through scope to scheduled work and acceptance. Coverage, ownership and acceptance are review questions, not a numerical score or a separately prescribed PMI methodology.

Traceability should work in both directions. Starting with a requirement, the reviewer should be able to locate the deliverable, supporting work and acceptance evidence. Starting with an activity, the reviewer should be able to explain which authorised scope or necessary management function justifies it. The relationships are not always one to one: several activities can support one deliverable, and one test can provide evidence for several requirements. Those connections should be explicit enough to review without counting the same work or evidence more than once. The framework provides a way to challenge the model while preserving the professional judgement needed for different delivery environments.

3.1 Translating requirements and deliverables into a work breakdown structure

Distinguish the reason for the project from the work it contains

> **Requirement.** 'A condition or capability that is required to be met or possessed by a system, product, service, result, or component to satisfy a contract, standard, specification, or other formally imposed documents.' (PMI, 2019, p. 188)

The project's intended benefit helps explain why it exists, but it does not by itself define a schedulable scope. A public building may seek lower energy consumption, for example, while the project delivers specified equipment, controls, testing and operational information intended to support that result. The planner needs to understand the connection without treating the benefit as a substitute for the delivery work. Some benefits depend on later operating behaviour or external conditions. The schedule should represent the work and transition conditions within the project's responsibility, with explicit interfaces to later activities where those interfaces affect delivery or acceptance.

Requirements may come from several sources: the approved business case, a contract, technical specifications, operational needs, stakeholder agreements or applicable approval conditions. They should be reconciled before they are converted into activities. Two documents can use the same term with different meanings, or specify outcomes that compete for the same resources or access window. The planner should make such conflicts visible and obtain resolution through the agreed authority. Entering both statements into a schedule does not resolve their incompatibility. Likewise, silently choosing the most convenient interpretation may produce a tidy model that lacks an authorised basis.

> **Deliverable.** 'Any unique and verifiable product, result, or capability to perform a service that is produced to complete a process, phase, or project.' (PMI, 2019, p. 179)

A useful deliverable description identifies something that can be checked. 'Improved service' is an aspiration unless the relevant capability and acceptance conditions are specified. 'An accepted operating procedure for the new service' identifies a result that can be reviewed and authorised. The deliverable need not be a physical object: a verified design, trained operational capability or approved decision can be essential to delivery. The planner should therefore look beyond construction or manufacture and ask what information, assurance, authorisation and transition outputs are needed to make the principal product usable.

The UK Government's Project Routemap connects requirements with intended outcomes, stakeholder needs and arrangements for requirements governance. For the scheduler, the implication is practical: a requirement needs an identifiable source, interpretation and route to verification before it becomes an apparently firm delivery commitment. The Routemap also addresses change throughout delivery. Requirements traceability therefore needs to remain usable as scope evolves, rather than being completed once and filed away (IPA, 2021a, pp. 8, 10, 21–23).

Decompose the total scope without turning the WBS into a timetable

> **Work Breakdown Structure (WBS).** 'A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables.' (PMI, 2019, p. 193)

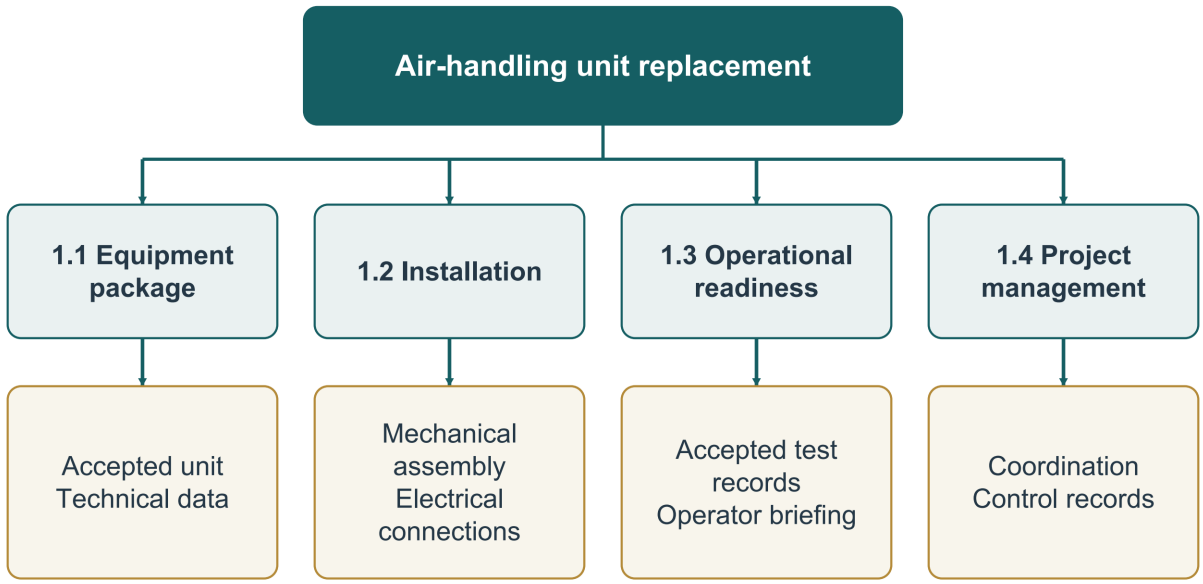
The WBS organises the scope into progressively more manageable elements. It helps the team establish what belongs within the project and where each part will be managed. It does not, by itself, establish the order of execution. Two neighbouring work packages may proceed in parallel, while work in different branches may have a strong dependency. Reading a WBS from top to bottom as though it were a

sequence can therefore create false logic. The work breakdown answers a scope question; the network developed later answers a dependency question. A reliable schedule needs both and a clear relationship between them.

Decomposition should preserve the total agreed scope at each level. The children of an element should collectively explain the work of their parent without leaving gaps or duplicating responsibility for the same work. This is often expressed through the 100 per cent rule. It does not mean that every future activity must already be known in detail. It means that the scope boundary remains represented, including work that will be elaborated later. Nor does it mean including every possible improvement that stakeholders might eventually request. Completeness is judged against the authorised scope, while unresolved assumptions and possible changes remain visible through their appropriate records.

Deliverable-oriented descriptions are useful because they focus the discussion on results rather than departmental habits. A branch called 'Electrical department' says who may contribute, but does not explain the output for which the project is responsible. A branch called 'Accepted power distribution system' directs attention to the scope and evidence of achievement. In practice, organisations may structure their WBS by product, geography, phase or a combination suited to their work. The choice should still preserve clear boundaries and enable scope to be traced. It should not create several competing places in which the same installation, test or handover could be counted.

Illustrative work breakdown structure



Illustrative boundaries: confirm inclusions and exclusions.

Figure 3.2. An original, simplified WBS illustration for replacing a small air-handling unit. It demonstrates decomposition rather than claiming to be a complete design or installation specification. Actual boundaries, enabling work and acceptance requirements must be established for the particular project.

The illustration includes project management alongside equipment, installation and operational readiness. Management and enabling work consume time and resources even when they do not become part of the physical asset. Their treatment should be deliberate. Coordination, required approvals, temporary arrangements and records should not disappear because the team has organised the main branches around hardware. At the same time, a supporting function should not become a convenient

place to hide identifiable delivery work. An inspection with a specific result belongs in the plan as measurable work, even if the inspector works in a department that also provides general project support.

NASA's WBS Handbook explains why short hierarchical titles need supporting descriptions of content and boundaries. It warns about reusing a previous structure without examining its suitability and about weaknesses in non-product-oriented decomposition. A familiar template can accelerate discussion, but each branch still needs to be justified against the current deliverables. NASA also connects the WBS with schedule and budget integration, reinforcing its role as an organising basis for control rather than a decorative chart (NASA, 2021, pp. 33–35, 38–43).

Make work-package boundaries usable

> **Work Package.** 'The work defined at the lowest level of the work breakdown structure for which cost and duration are estimated and managed.' (PMI, 2019, p. 193)

A work package should be sufficiently bounded for someone to estimate, manage and explain it. The level of decomposition needed will vary: a specialist equipment package may remain relatively compact, while complex installation work may require several packages because different access conditions or responsibilities matter. A universal number of WBS levels would not solve this design problem. The test is whether the chosen boundary supports ownership, estimation, coordination and measurement without concealing important interfaces. A package that combines unrelated work merely because the same contractor performs it may be commercially convenient but weak as a control unit.

The WBS dictionary gives substance to labels and codes. It can record the scope included, exclusions, required deliverables, acceptance conditions, responsible owner, important assumptions and interfaces. A short title alone rarely resolves all of these matters. For example, 'Equipment installation' might include positioning and connection but exclude removal of the existing unit, access preparation or testing. The dictionary should make these boundaries explicit so that another package can be identified for the excluded but necessary work. Exclusion from one package does not establish exclusion from the project as a whole.

Table 3.1 | Clarifying scope and work-package boundaries

Scope element	Question to resolve	Example of a useful clarification
Requirement	What condition must be satisfied?	The operational performance and evidence expected, rather than a vague improvement claim
Deliverable	What identifiable result will be produced?	An accepted equipment package, verified design or usable operating capability
WBS element	Where does this part of scope belong?	A single traceable home within the agreed decomposition
Work package	What bounded work will be estimated and managed?	Included work, exclusions, owner and connection to other packages
Dictionary entry	What does the label actually mean?	Boundaries, acceptance conditions, assumptions and interfaces that avoid conflicting interpretations

France: an opening event does not close every scope package

The French National Assembly's 2025 report on heritage expenditure describes Notre-Dame's reopening on 7–8 December 2024 alongside restoration work continuing in 2025. Public reopening and completion of every restoration package were different states. A scheduler learning from this case would distinguish the scope needed for authorised public use from the remaining restoration scope, preserving both within the relevant plans. The publication does not establish the project's detailed WBS or prove that a particular scheduling technique was used. It demonstrates why a prominent opening date cannot describe the completion state of every package (Assemblée nationale, 2025, part I, section III).

3.2 Connecting scope, responsibility and cost control

Different breakdown structures answer different questions

The WBS describes the scope to be delivered. An organisational breakdown structure describes the organisational units or responsibilities through which delivery is managed. A cost structure classifies expenditure or budget for accounting and control. These structures may align at selected points, but they should not be assumed to be identical. One organisation can deliver work in several WBS branches; one work package can contain several cost categories; and several contributors can support a result for which one manager remains accountable. Clear mappings allow each view to serve its purpose while retaining a common understanding of the work.

Confusing these structures can distort the schedule. An accounting category such as 'materials' groups expenditure but does not describe a complete sequence of procurement, inspection, delivery and installation. An organisational label such as 'engineering' does not identify which drawings or decisions release downstream work. The planner should connect these classifications to scope and activities instead of replacing the delivery model with them. This allows a management report to show responsibility or expenditure without losing the underlying relationships that determine when the project can achieve its milestones.

> **Control Account.** 'A management control point where scope, budget, actual cost, and schedule are integrated and compared to earned value for performance measurement.' (PMI, 2019, p. 177)

The definition establishes an integration function, not simply a place to store invoices. Earned value is the budgeted value of work actually accomplished, allowing performance to be compared with the plan and actual expenditure. Detailed earned value calculations are developed later in the book; no prior study of the subject is assumed here. For this chapter, the important point is that meaningful comparison requires an agreed scope boundary and a consistent basis for measuring achievement. If the cost record includes work that the schedule omits, or the schedule claims work that the control account does not contain, the comparison is weakened before any formula is applied.

Scope and responsibility integration

Scope and organisational responsibility meet at selected control points.

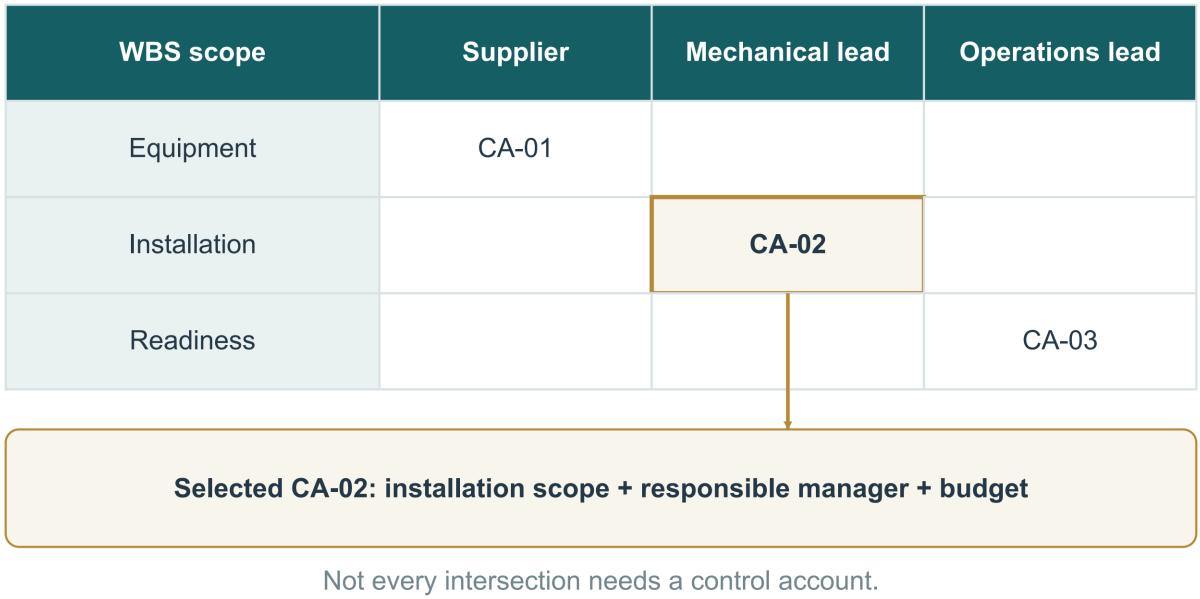


Figure 3.3. An original illustration of how selected intersections between scope and organisational responsibility can support control accounts. Not every matrix intersection must become a control account; the design follows the project's management and control needs.

Establish one accountable owner without denying collaboration

The control account manager needs a clear understanding of the scope, resources, budget and delivery responsibilities within the assigned boundary. This does not mean performing all the work personally. It means being able to explain the plan, obtain reliable progress information, recognise deviations and coordinate the decisions needed to address them. Several teams may contribute, but their participation should not dissolve accountability into a collective statement that everyone is responsible. The same principle applies at activity level: the person who reports and explains progress should be identifiable even when several resources perform the work.

A responsibility assignment matrix can help connect work with organisational roles. Its usefulness depends on the precision of its rows and the meaning of its entries. A row labelled 'All testing' may conceal technical tests, independent inspection, operational trials and regulatory decisions performed by different parties. Breaking the row into meaningful outputs or decision responsibilities can reveal an unowned acceptance step. The matrix should distinguish the delivery owner from contributors and approval authorities where those functions differ. An organisation chart alone cannot show whether every important part of the scope has someone accountable for its completion.

Reconcile packages and budgets without counting the work twice

Consider an illustrative control account with a budget of £120,000 and three work packages budgeted at £25,000, £35,000 and £60,000. Their total reconciles to £120,000. That arithmetic is necessary, but it does not prove that the scope is complete or that the allocation is realistic. If both of the first two packages include the same survey, the financial total can still balance while the work is duplicated. If neither includes the required acceptance test, the total can balance while scope is missing. Reconciliation must therefore check the meaning of the packages as well as their numerical totals.

The same caution applies when a schedule contains a summary activity and its detailed activities. The summary may display rolled-up cost or progress for the underlying work; it should not be treated as an additional delivery contribution when totals are combined. Otherwise, the same scope can appear twice in performance reporting. Data structures and reporting rules need to distinguish aggregation from additional work. This principle is particularly important when information is exported to spreadsheets or dashboards, where the visual difference between a summary row and a detailed row can be lost.

Table 3.2 | Connecting scope, responsibility and cost structures

Structure or record	Primary purpose	Important connection
Work breakdown structure	Organises the agreed scope and deliverables	Each package has a clear boundary and links to supporting activities
Organisational breakdown structure	Represents management and delivery responsibility	Named accountability is connected to the relevant scope
Cost structure	Classifies budget and expenditure for control	Cost categories map consistently to the work being measured
Control account	Integrates scope, budget, cost and schedule performance	Work packages, measurement rules and managerial accountability remain aligned
Responsibility assignment matrix	Makes the relationship between work and roles explicit	Contributors, accountable owners and approval roles are distinguishable

PMI distinguishes activity cost categories from project cost categories. Activity categories can distinguish labour, equipment, material and other costs; project categories support grouping account line items within the project's cost structure. These classifications do not replace scope or control-account identifiers. One activity can involve several cost types, while a category such as materials can span several deliverables. The mapping should support reconciliation without implying that each cost category is a separate piece of executable work (PMI, 2019, pp. 100, 121).

Maintain the mapping when the organisation or scope changes

Changing the contractor or responsible team does not necessarily change the identity of the work. A stable scope and activity reference helps preserve history while the responsibility mapping is revised. Conversely, retaining the same code does not prove that the scope remains unchanged. A package may acquire an additional system, location or acceptance obligation that materially changes the delivery requirement. The planner should therefore examine both identity and content. Changes to ownership, scope and budget should be recorded through the appropriate controls, with affected schedule assumptions and interfaces reviewed rather than left attached to an obsolete interpretation.

This integration is not confined to projects that implement a full earned value system. A project still needs to know who owns the work, which budget supports it and how its progress will be understood. Where formal control accounts are not used, the planner should preserve those management connections in the employer's chosen arrangements. The PMI-SP candidate should understand the formal terminology and its role, while the professional should avoid imposing an elaborate structure that the organisation cannot maintain or use. The objective is coherent control of scope and delivery, supported by arrangements proportionate to the project.

3.3 Defining activities that can be managed and measured

Translate a scope boundary into actions

> **Schedule Activity.** 'A discrete, scheduled component of work performed during the course of a project.' (PMI, 2019, p. 189)

A work package defines a managed portion of scope; its activities describe the actions needed to deliver that scope. The relationship is not necessarily one package to one activity. An accepted equipment package may require specification, technical review, purchase, manufacture, inspection, transport and receipt. Combining all of these into one bar can be acceptable for an early overview, but it may conceal the decisions and handovers needed for effective control. The decomposition should expose work that has a distinct owner, a meaningful completion condition or a dependency that affects another part of the project.

PMI describes activity definition as a process based on the WBS and elaborated by the team responsible for execution. Its guidance emphasises ownership, precise descriptions, continuity of work and durations appropriate to the update cycle (PMI, 2019, pp. 55-58). The planner therefore needs delivery knowledge as well as modelling knowledge. A generic activity library can prompt discussion, but it cannot establish whether a particular site requires an access permit, whether a review body meets only at certain intervals, or whether an installed system can be tested before another package is available. These conditions emerge through investigation and collaboration.

PMI specifies that each activity rolls up to one WBS element, while a work package may require several activities (PMI, 2019, p. 54). Multiple classification codes, contributors or interfaces do not create multiple primary WBS homes for the same activity. This protects scope aggregation while allowing other reporting views to remain flexible.

Write names that remain clear outside their original display

A strong activity name usually starts with a verb and identifies a specific object, with location or other qualifying information where necessary. 'Test' is ambiguous. 'Pressure-test cooling circuit C2' identifies an action and object, while the activity's supporting information should identify the applicable procedure and acceptance evidence. PMI recommends names that can be recognised without relying on their position in a particular presentation (PMI, 2019, p. 56). This matters when an activity is exported, filtered into an exception report or discussed with a team that does not see its surrounding WBS rows.

The name should be precise without becoming an entire specification. The identifier, scope definition, owner and acceptance information carry details that do not belong in a crowded label. The planner should also avoid naming work only by its intended date, such as 'June completion', because a date movement would then obscure the enduring identity of the activity. A clear description survives a change in timing. It enables the team to discuss what remains to be done rather than repeatedly interpreting whether differently worded reports describe the same work.

Activity definition card

ACT-210 | Install replacement fan	
WBS reference	1.2 Installation
Accountable owner	Mechanical lead
Required resource	Mechanical team
Start condition	Approved isolation
Finish condition	Installation inspection accepted
Progress evidence	Installed units and inspection evidence
Duration	Estimated when method and resources are known

Illustrative activity definition; confirm project-specific conditions.

Figure 3.4. An original activity-definition example. The card establishes identity, scope, ownership and evidence before duration and detailed logic are developed. Its conditions are illustrative and do not replace project-specific technical or safety procedures.

Research helps explain why activity descriptions are more than presentation choices. Amer, Hockenmaier and Golparvar-Fard studied 3,387 activities from three hospitality building projects, using descriptions and WBS information to help identify and critique activity relationships. Their findings suggest that meaningful language and classification can support automated review. They do not establish that an algorithm can certify complete scope or infer every project-specific dependency. The scheduler still needs to validate the proposed relationship against the actual delivery conditions (Amer et al., 2022).

Establish start and finish conditions

An activity's start condition should describe the circumstances needed for its work to begin meaningfully. These may include accepted information, available access, a completed predecessor or an authorised permit. Its finish condition should describe what the activity achieves and what evidence supports that claim. The two conditions create a usable boundary for estimating and reporting. Without them, one person may report the activity as started when a preparatory email is sent, while another regards it as started only when productive work begins. The apparent date difference then reflects inconsistent meaning rather than actual delivery performance.

Finish conditions need particular care. 'Installation complete' might mean physically positioned, connected, inspected or accepted for testing. If the receiving team needs inspected installation, a completion claim based only on physical positioning is insufficient. The planner can represent installation, inspection and acceptance as separate activities and milestones where the distinction matters. This provides a clearer forecast and allows progress to be reported honestly. It also prevents unresolved quality or documentation work from disappearing inside an activity that has already been marked complete.

Table 3.3 | Writing activities with measurable boundaries

Weak description	More useful activity description	Boundary or evidence to clarify
Design	Complete the approved-for-review layout for plant room P2	Required content, review status and the recipient of the layout
Procurement	Issue the authorised purchase order for pump P3	Approval required before issue and evidence that the order was placed
Installation	Install distribution board DB4 in plant room P2	Included connections, inspection boundary and access prerequisites
Testing	Execute the agreed functional test for control loop C7	Test procedure, required witnesses and treatment of outstanding failures
Training	Complete the operator training session for system S2	Required participants, competence evidence and any follow-up assessment

Germany: infrastructure completion still needs operational preparation

Deutsche Bahn's project company reported in November 2022 that the Wendlingen–Ulm high-speed line was physically complete while final preparations for operation continued, including route familiarisation involving approximately 250 drivers. Its stated December service date was a forecast in that publication, not proof of subsequent achievement. The example makes the distinction between an installed asset and an operating capability tangible. Training and familiarisation require identifiable activities and completion conditions; they cannot be inferred from the completion of track or systems (DB Projekt Stuttgart–Ulm GmbH, 2022).

Choose granularity that reveals decisions and interruptions

The source gives a typical guideline that an activity's duration should be less than twice the update cycle, while describing exceptions for continuous or aggregated work (PMI, 2019, pp. 56-58). This helps explain why a weekly reporting cycle may struggle to control a long activity whose only evidence is a subjective percentage. It is not a universal maximum duration. The planner should consider the actual work, the available evidence and the cost of maintaining detail. Artificially dividing a continuous operation into equal time slices can create more rows without improving understanding of the delivery sequence.

Natural boundaries are usually more useful than arbitrary divisions. A design activity may pause while a client reviews information; a manufacture activity may wait for an inspection release; an installation activity may require a new access window. Where such interruptions matter, separate the productive work, the review or release, and the work that follows. This allows different owners and conditions to be represented. It also avoids assuming that a single activity can proceed continuously when the real process contains a decision outside its owner's control. Calendar non-working periods, such as normal weekends, are a different matter and do not by themselves require separate activities.

The decomposition should preserve identifiable outputs. Splitting a twenty-day activity into four five-day activities called 'Part 1' to 'Part 4' contributes little unless those parts have meaningful scope and completion evidence. By contrast, splitting a design package into accepted releases for foundations, structural connections and controls may expose real interfaces with construction and manufacture. The team should be able to explain what each part enables, who owns it and how progress will be demonstrated. Chapter 4 develops duration estimates; the activity definition here establishes what those estimates will actually refer to.

Keep identity, classification and scope information distinct

An activity identifier distinguishes the activity from others; an activity label describes it; an activity code classifies it for analysis or reporting. The activity scope definition records the work boundary more fully. These fields serve different purposes even when a software interface places them next to each other. A label may be corrected for clarity without creating new work. A responsibility code may change when a team changes. Neither event necessarily requires a new identity. Conversely, a substantial change in scope should not be concealed merely because the existing identifier is convenient (PMI, 2019, pp. 99, 102, 107).

The project also needs a recognisable name and a description that explains its purpose and boundaries. These help prevent similarly titled projects or phases from being confused in a portfolio or data exchange. The WBS ID identifies the relevant scope element; the control account ID identifies the management control point; and the EVMS work package identifier connects to the work package used within the earned value system where that system applies. Their values can be mapped deliberately, but they should not be assumed to be interchangeable. A useful data design preserves the relationship between the records and explains which identifier remains authoritative for each purpose (PMI, 2019, pp. 109-110, 115, 122, 124, 136).

When information is missing, the activity record should expose that uncertainty with an owner and a route to resolution. An unconfirmed access condition, unknown acceptance authority or incomplete scope boundary should not be filled with an invented value merely to pass a software check. The project may legitimately use a planning package while knowledge develops, or record a clearly identified assumption subject to review. The professional test is whether the uncertainty is visible and managed before it can mislead a commitment. Apparent completeness of the data fields is not equivalent to completeness of the delivery plan.

3.4 Selecting the appropriate activity form

Different representations serve different purposes

A schedule can contain discrete activities, milestones, summaries and supporting activities, but these forms do not contribute to analysis in the same way. Some describe executable work; some represent events; others aggregate or support work described elsewhere. The planner needs to understand the purpose of each form and the behaviour of the chosen software. A bar that appears to span ten days could represent ten days of productive work, the envelope of several parallel activities, or an administrative support period. Its appearance alone does not establish its meaning or justify assigning progress and resources to it in the same way.

Discrete work produces an identifiable result that can be assessed against its defined scope. Its resources, duration and completion evidence should relate to that work. Preparing a test procedure, installing a component and carrying out a review are examples when each has a bounded result. The planner should avoid using a general support classification for work that has a clear deliverable and can affect the delivery sequence. Otherwise, the model may lose the ability to show when that work finishes, what it releases and whether its remaining duration threatens another activity.

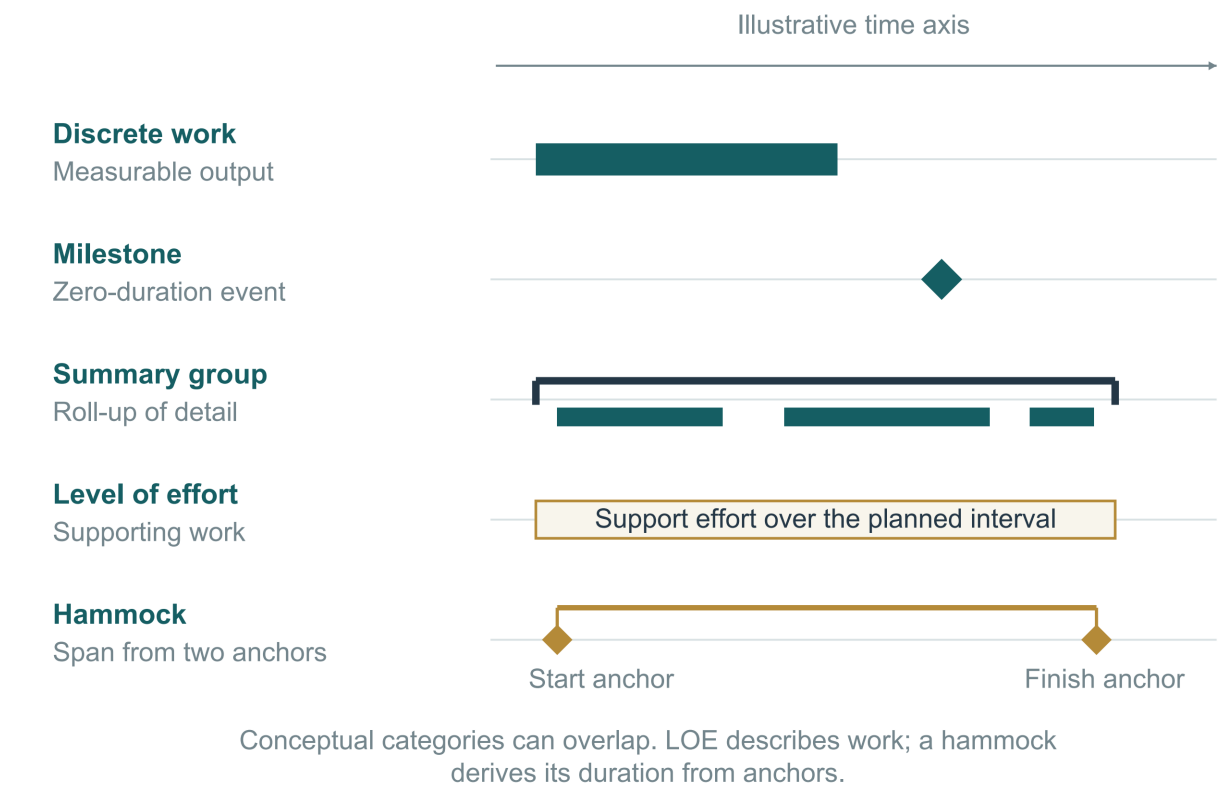


Figure 3.5. Original conceptual comparisons of activity forms. These are not a universal set of mutually exclusive software categories: level of effort describes supporting work, while a hammock describes a relationship-based representation of a span. The time positions are illustrative.

Summary activities aggregate information

> **Summary Activity.** 'A group of related schedule activities aggregated and displayed as a single activity.' (PMI, 2019, p. 192)

A summary can make a detailed plan understandable to a particular audience. Its displayed start and finish may be derived from the activities it contains, according to the tool's aggregation rules. Its duration is therefore not generally the sum of their durations. If two activities start together and finish after three and four working days on the same calendar, their combined envelope spans four working days, although their individual durations sum to seven. The summary communicates the span of the group; it does not establish that seven days of sequential work must occur.

PMI's main text also discusses broader uses of summary representations, including work that has not yet been decomposed and external procurement work whose internal progress is not directly observed (PMI, 2019, pp. 56-57). These uses require interpretation. A calculated roll-up of detailed work is different from a placeholder for work that still needs planning. The latter may contain uncertainty that a detailed-looking summary bar conceals. A summary should not be used as a substitute for essential executable logic, and direct links to summaries should be examined carefully because the resulting behaviour depends on the software and can obscure the actual dependency.

Level of effort represents support rather than a discrete product

> **Level of Effort.** 'An activity that does not produce definitive end products and is measured by the passage of time.' (PMI, 2019, p. 182)

Administrative support and continuing coordination can be represented as level of effort where that treatment matches the work. The activity can account for resources used over a support period without pretending that the passage of time creates a physical deliverable. It should be distinguished from specific management outputs such as an approved report or a completed decision review, which can be planned as discrete work when their completion matters. The name of the department does not determine the activity form: a project controls team can provide continuing support and also produce identifiable deliverables.

The source advises that support activities should not drive the project's critical path or end date, and cautions against applying constraints or resource levelling to level-of-effort activities (PMI, 2019, pp. 57-58). Their time span should respond appropriately to the work they support. The exact configuration must be checked in the chosen tool. A fixed support bar stretching beyond all delivery work can create a misleading completion date, while an incorrectly connected support activity can create artificial logic. The planning intention is to represent support demand faithfully while preserving the causal sequence of the discrete work.

Hammocks derive their span from related work

> **Hammock Activity.** 'An activity whose duration is aggregated by logical relationships from a group of related activities within the schedule model.' (PMI, 2019, p. 181)

A hammock spans selected work through relationships to its bounding activities or events. It can be useful for displaying or accounting for a period that should move when those boundaries move. Unlike a manually entered fixed bar, it is intended to respond to the linked work. Unlike a simple WBS roll-up, its boundaries are established through the chosen relationships rather than merely by placing activities underneath a common heading. The planner should identify precisely what the hammock represents and verify the effect of changes to each anchor before relying on the result.

The source describes a hammock using start-to-start and finish-to-finish bounding relationships, while its discussion of level-of-effort relationships varies across the surrounding text (PMI, 2019, pp. 57-58). The dependable distinction is the purpose and derivation of the representation, rather than assuming that every tool uses the terms identically. A hammock can represent a supporting span, but that does not make every support activity a hammock or every hammock a separate physical deliverable. If a required inspection or decision releases downstream work, represent that work and release explicitly rather than allowing them to disappear inside an aggregated span.

Table 3.4 | Distinguishing activity and summary forms

Form	What it represents	Main caution
Discrete activity	Bounded work producing an identifiable result	Define its owner, conditions and evidence rather than relying on a vague percentage
Milestone	A significant event or condition represented at a point in time	Schedule the work needed to achieve it; the marker performs no work itself
Summary activity	A combined representation of related activities or, in broader use, work awaiting detail	Distinguish a calculated roll-up from a placeholder and avoid double counting
Level of effort	Continuing support measured through the passage of time	Do not treat elapsed support time as proof of delivery achievement
Hammock	A span derived through relationships to related work	Check the anchors and tool behaviour; do not conceal discrete dependencies

3.5 Designing milestones around completion and acceptance

A milestone marks a condition, not the work required to create it

Milestone. 'A significant point or event in a project, program, or portfolio.' (PMI, 2019, p. 183)

PMI's milestone guidance includes identifiable project start and completion events, providing clear boundaries for the schedule model (PMI, 2019, p. 55).

In the source's scheduling guidance, a milestone has zero duration and no assigned resources. It marks a significant start, completion or external event and supports progress assessment (PMI, 2019, p. 55). The activities that achieve the milestone require their own representation. A four-day inspection is work; the acceptance reached after the inspection is an event. Combining them into a zero-duration milestone removes the time and capacity needed for inspection. Giving the acceptance milestone an arbitrary duration obscures the distinction in the other direction. The planner should identify both the work and the condition it is intended to establish.

A milestone should have a meaningful name, a clear basis and an identifiable authority or source of evidence. 'Ready for service' needs more explanation than a date in a presentation. It may depend on accepted tests, complete operational records, trained users and authorisation to operate. The exact conditions vary by sector and project. Their agreement should therefore involve the people who will accept and use the result, as well as those who build it. A delivery team cannot establish operational readiness solely by declaring that its own contract work has finished.

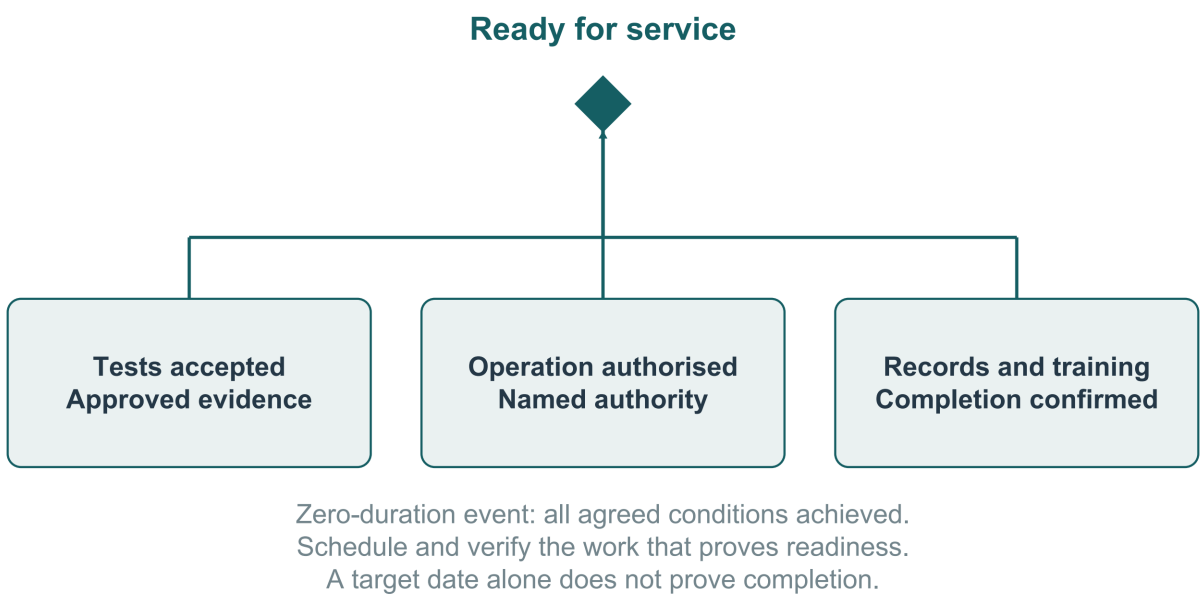


Figure 3.6. An original illustration of the conditions behind a readiness milestone. The required evidence and authority must be agreed for the actual project; the diagram is not a universal regulatory checklist.

Distinguish required dates, forecasts and achieved events

A contractual date expresses an obligation or reference established by the relevant agreement. A current forecast expresses when the model and available evidence indicate that the event is expected. An actual milestone records that the defined event has occurred. These dates can differ and should not be collapsed into a single convenient number. If the forecast is later than the required date, the difference needs explanation and action through the appropriate project and commercial arrangements. Forcing the marker to the required date without representing a feasible route to it conceals the scheduling problem.

An externally imposed date can be important even when the project does not control the event. A regulator's review, a third-party access window or another project's handover may constrain the delivery plan. The schedule should identify the source of that information, the uncertainty involved and the work that depends on it. The team should also distinguish a target review meeting from an expected decision and from the implementation of any conditions attached to that decision. An approval can be conditional, and the conditions may create further work before the intended activity can begin.

Plan milestones across the delivery life cycle

Technical milestones often receive the most attention because they correspond to visible outputs, but decision, procurement, regulatory and operational milestones can be equally significant. An authorised design release may enable manufacture; a successful factory test may enable shipment; an accepted installation may enable integrated testing; and an operational decision may enable service. Their importance comes from the work or commitment they release. A milestone list should therefore be reviewed against the delivery strategy and scope rather than copied uncritically from a previous project's report.

Table 3.5 | Defining milestones across the delivery life cycle

Milestone purpose	Event or condition to define	Supporting work that may be needed
Contractual commitment	The specific delivery or acceptance obligation	Scope reconciliation, agreed evidence and the applicable review process
Decision or approval	The decision made by the authorised body	Preparation, consultation, review and resolution of conditions
Procurement	The defined order, release, delivery or receipt event	Technical specification, authorisation, manufacture, inspection and logistics
Regulatory or statutory	The permission or accepted evidence required in the relevant jurisdiction	Submission, assessment, clarification and satisfaction of conditions
Commissioning	The agreed state demonstrated by tests and integration	Test preparation, execution, correction and acceptance
Handover or operational readiness	The receiving organisation's agreed acceptance condition	Records, training, support arrangements and authority to use the result

UAE and Egypt: permission, trial operation and public use

An official Abu Dhabi publication reported the operating licence for Barakah Unit 4 on 17 November 2023. The licence authorised commissioning and operation, with subsequent commissioning preparing the unit for commercial operation. The licence date should therefore not be interpreted as the commercial-operation date. Permission, the work enabled by it and the later operational achievement require distinct milestone meanings and evidence. This is a lesson in interpreting events, not a prescription for nuclear commissioning practice (Abu Dhabi Media Office, 2023).

Egypt's Ministry of Tourism and Antiquities announced trial operation of twelve main-gallery halls at the Grand Egyptian Museum, excluding the Tutankhamun galleries. A later State Information Service account identified the pilot opening as October 2024 and reported full public opening in November 2025, including those galleries. These publications describe different released scopes. Milestone names should preserve the distinction between trial access to specified galleries and a broader public opening. The accounts do not provide the internal activity network; their value here is the documented distinction between staged access and broader completion (Ministry of Tourism and Antiquities, n.d.; State Information Service, 2025).

Australia: payment and technical acceptance need separate evidence

The Australian National Audit Office's May 2023 Hunter class frigate audit reported five milestone payments totalling A$22.3 million where not all exit criteria were satisfied. It also recorded that the contract master schedule remained unapproved as at 22 March 2023, although related payments had been made in August 2022. These are dated audit findings, not a statement of the programme's current position. The scheduling lesson is to preserve separate commercial and technical states, retaining unresolved criteria as outstanding work. The findings do not justify assuming that payment establishes technical completion, or automatically concluding that payments were unlawful (ANAO, 2023, paragraphs 3.61–3.72).

Keep evidence and authority visible

A milestone can have different technical, commercial and management implications. Payment may be approved under a contract while some technical conditions remain subject to an agreed action. A facility may be accepted for limited use while further areas remain outside the released scope. These situations require precise records rather than a general declaration that everything is complete. The schedule should reflect the event that has actually occurred, retain outstanding work and distinguish any changes to the agreed acceptance basis. An apparent inconsistency should trigger clarification, not an assumption that all meanings of 'accepted' are equivalent.

Acceptance evidence should be proportionate and identifiable. It could be a signed inspection result, a recorded approval, a completed test report or another agreed record. The planner is not necessarily the person who judges technical compliance, but needs to know whose judgement supports the milestone and where it is recorded. If evidence is incomplete, the report should distinguish the claimed position from the verified position. This protects the usefulness of actual dates for later analysis and prevents a forecast from being built on work that has been marked complete without meeting the condition needed by its successors.

Milestone planning remains iterative. Early milestones provide a structure for discussion; activity definition then reveals additional releases, approvals and integration events. PMI recognises that milestones can be added as the model develops and that activities may sometimes be defined first (PMI, 2019, p. 55). The planner should therefore avoid treating the first milestone list as an immutable skeleton. It is a starting hypothesis about the delivery structure that should improve as scope, interfaces and acceptance become better understood, while changes to authorised commitments remain controlled.

3.6 Capturing interfaces and the work between organisations

An interface is more than a connecting arrow

A dependency describes a relationship between work or events; an interface identifies a boundary across which something must be coordinated, provided or accepted. The boundary may lie between technical systems, organisations, contracts, locations or projects. Information, equipment, access and authority can all cross it. An arrow in a network becomes useful only when its meaning is understood. If one team expects an accepted design and another intends to provide a draft, a finish-to-start link between their activities can calculate dates without representing the condition that the receiving team actually requires.

The planner should therefore identify the producing work, the required state of its output, the receiving work and the people who agree that the handover has occurred. Some interfaces need a milestone to make the accepted state visible. They may also need activities for review, clarification, inspection or preparation. Representing the interface only as a milestone can omit this work, while representing only the work can conceal the decision that authorises the next step. The appropriate model connects both, with sufficient detail to show who can act and what evidence supports that action.

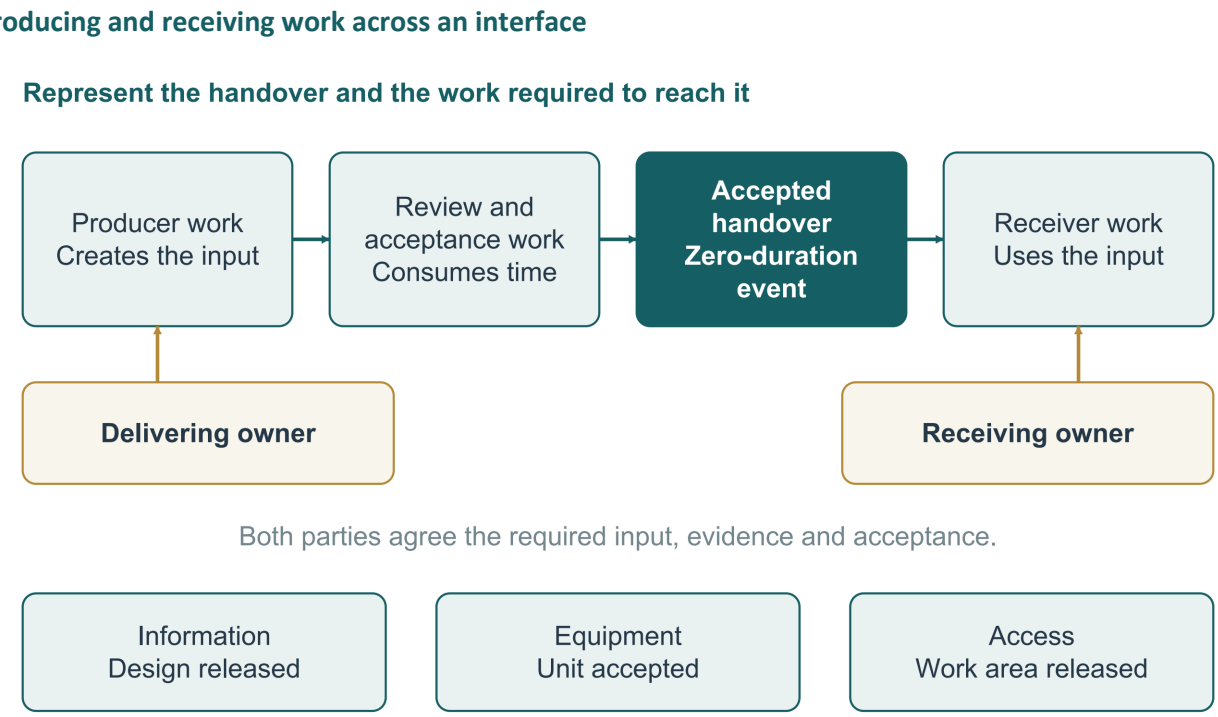


Figure 3.7. An original interface workflow. Preparation and review are work; accepted handover is an event; the receiving activity depends on the required state. The diagram illustrates meaning and ownership rather than a complete CPM network.

Look beyond the supplying contractor's boundary

A supplier's schedule may correctly describe its contracted deliverables while excluding work that remains essential to the project. The client may provide access, another contractor may provide power, and the operator may need to accept procedures. The integrated schedule must represent these contributions or controlled external interfaces to them. A contractual exclusion identifies where one party's obligation ends; it does not demonstrate that the excluded work is unnecessary. This is why scope review should involve both the parties delivering outputs and the parties receiving and using them.

Procurement interfaces deserve particular attention. A purchase order may release manufacture, but accepted technical information, customer inspection or a shipping release can create further conditions before delivery. Receipt on site can still precede installation readiness if storage, access or lifting arrangements are unresolved. A single activity called 'Procure equipment' can conceal all of these distinctions. The amount of detail should reflect the decision need and the visibility available, with explicit assumptions where supplier information remains limited. The planner should avoid inventing an internal manufacturing sequence that has not been confirmed by the responsible organisation.

England: Thameslink and the work needed for an operating railway

The National Audit Office's 2017 Thameslink report examined procedures, training, recruitment, timetable preparation and coordination with other operators alongside infrastructure delivery. It identified weaknesses in bringing some readiness activities and dependencies into an integrated critical-path view before the late-2016 readiness arrangements. This historical evidence shows why an infrastructure schedule needs the work that enables operation, with clear interfaces between asset delivery and service introduction. Planned service dates in the report should not be treated as subsequent achievements; the lesson concerns the scope and coordination required at the time of the audit (NAO, 2017, pp. 24–28).

Identify safety and environmental prerequisites as delivery conditions

Access, isolation, permits, environmental restrictions and other prerequisites can determine whether work is ready to proceed. The schedule should identify the relevant condition, its responsible owner, the activities needed to establish it and any known window of validity. This is a planning responsibility, not a substitute for the competent technical or statutory decision. Scheduling an approval does not grant it. Where a prerequisite is uncertain or conditional, the forecast should make that limitation visible and provide a route for obtaining the necessary evidence before downstream work is treated as executable.

The same principle applies to shared operating environments. A project within a functioning railway, hospital, factory or public building must coordinate with the existing service. Work may require a possession, outage, protected access period or a temporary operating arrangement. These conditions can involve parties outside the project's direct management authority. The activity list should include the work needed to agree and prepare them, while the interface record identifies the source and status of the relevant commitment. A calendar exception alone does not explain whether the access has been authorised or whether the associated preparations are complete.

Table 3.6 | Identifying interfaces and their evidence

Interface category	What crosses the boundary	Work or evidence to make visible
Design information	A defined package in an agreed state	Preparation, checking, review, release and the recipient's required content
Physical delivery	Equipment, material or an installed asset	Inspection, logistics, receipt conditions and readiness for the next operation
System integration	A functioning connection between components	Configuration agreement, interface tests and acceptance of combined behaviour
Operational access	Permission and conditions for work in a live environment	Requests, coordination, preparation, authorisation and restoration arrangements
Approval or assurance	A decision or accepted body of evidence	Submission, assessment, clarification and any remaining conditions
Inter-project dependency	An output or enabling condition supplied by another project	Shared milestone identity, owners, forecast basis and consequences of change

The UK Project Routemap's Systems Integration module addresses interfaces across existing and new systems, contracts and projects. It connects acceptance with criteria, evidence and testing rather than assuming integration occurs when components arrive. Applied to activity definition, it supports making producing and receiving conditions explicit and allowing time to demonstrate them. Integration belongs in the plan as work with ownership, although its assurance arrangements remain project-specific (IPA, 2021b, pp. 19–20).

Research also helps challenge missing information work. Afzal, Wong and Ahmadian Fard Fini's review of request-for-information management examines digital approaches alongside weaknesses in conventional processes and information exchange. A request, response and accepted clarification can represent different states; issuing an enquiry does not make its answer available to the receiving activity. The review supports attention to information flow, but does not establish a universal productivity gain from any particular tool (Afzal et al., 2024).

Lagos and colleagues developed a proof of concept for recommending make-ready constraints using records that included 1,000 tasks from 30 Chilean high-rise projects. Such research suggests how historical information might prompt checks for prerequisites overlooked in a new plan. Its context and retrospective evaluation limit generalisation: a suggested constraint still requires professional validation, and the study does not demonstrate a corresponding percentage reduction in project delays. The useful connection to this chapter is the distinction between identifying an activity and making that activity ready for execution (Lagos et al., 2024).

Whyte and colleagues examine digital twins as a way of understanding change across complex projects, including technical, contractual and organisational interfaces. Their contribution is a research agenda and analysis, rather than proof that a digital twin automatically improves completion dates. For the planner, it reinforces a conceptual point: changing a component can alter more than its own activity. Related information, responsibilities and acceptance conditions may also need review. A richer digital representation helps only if these relationships have meaningful content (Whyte et al., 2025).

Record the reason for the dependency

The planner should capture why a dependency exists, rather than merely which activity appears before another. Some relationships follow from physical or technical requirements; others reflect a chosen delivery method, resource arrangement or external commitment. These reasons affect whether the relationship can be changed when the team investigates alternatives. Moving a preferred sequence may be feasible after review; removing a necessary technical prerequisite would misrepresent the work. Chapter 5 develops formal relationship types and network calculations. At this stage, the priority is a defensible explanation of the dependency and the evidence supporting it.

Interface records also need a route for resolving disagreement. The producer and receiver may hold different assumptions about the required content, the acceptance authority or the forecast date. The planner should expose the difference, seek evidence and identify the person authorised to resolve it. Agreement should then be reflected in the affected scope, activities and milestones. Until that occurs, the uncertainty belongs in the planning information. Simply copying one party's preferred date into both schedules creates the appearance of integration while preserving the unresolved delivery problem.

3.7 Using rolling wave planning and testing completeness

Preserve the whole scope while developing the next detail

> **Rolling Wave Planning.** 'An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.' (PMI, 2019, p. 189)

Rolling wave planning allows the level of detail to reflect the quality of available knowledge. It does not authorise omission of the future work. The later portion of the project remains represented through scope, planning packages, milestones, resources and other information appropriate to the current stage. As knowledge improves, those packages are replaced by more detailed work. PMI stresses that detailed planning should occur at regular intervals and be completed before the next wave of execution begins (PMI, 2019, pp. 23-24). Waiting until work is due to start removes the opportunity to resolve missing information, access or resources in advance.

A planning package represents work that is known at a higher level but has not yet been developed into the necessary detail. It should retain a clear scope boundary and the assumptions needed to connect it to the wider plan. It is different from a calculated summary of already detailed activities, even if both appear as single bars. The distinction matters during review: one bar aggregates known detail, while the other

carries future planning work. The planner should make the planning horizon and the intended point of elaboration visible so that the organisation knows when better information is needed.

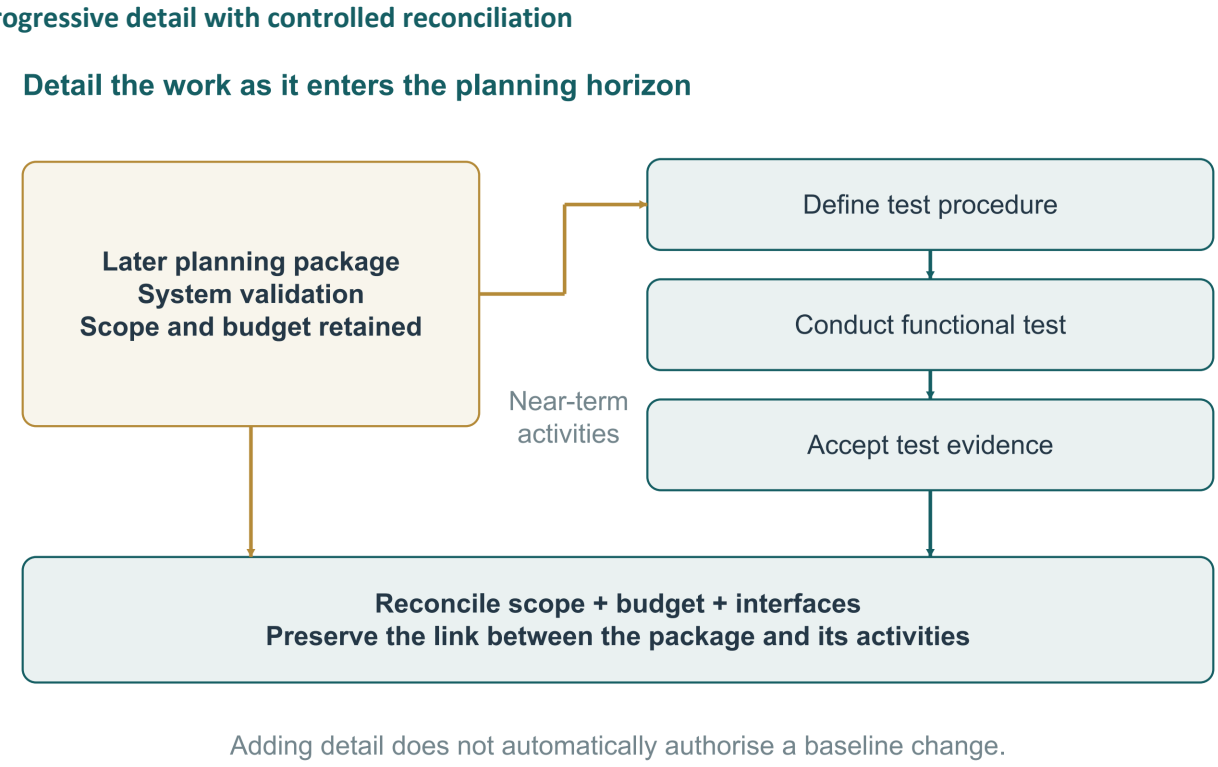


Figure 3.8. An original illustration of rolling wave planning. Detail replaces a planning package through a controlled reconciliation of scope, responsibility, budget and interfaces. Progressive elaboration does not automatically authorise a different baseline.

Reconcile the old and new representations

When a planning package is decomposed, its scope should be reconciled with the new activities and packages. Existing interfaces should be preserved or deliberately revised, rather than lost during the replacement. The new detail should retain ownership and show the work needed to achieve the inherited milestones. A scope gap can otherwise arise when each contributor assumes that another contributor will provide an enabling task. A duplicated activity can arise when both a central team and a contractor include the same work. The reconciliation should examine meaning, accountability and evidence before relying on totals.

In a separate illustrative example, an £80,000 planning package is divided into work packages of £30,000, £20,000 and £30,000. The budget reconciles, but this does not establish that the duration remains unchanged. Activities may overlap, depend on external releases or use the same scarce resource. Their duration estimates cannot simply be added or forced to fit the former bar. The detailed model should calculate the consequences of the newly understood work. If it exposes a conflict with the approved reference, the team should report and address that conflict through the appropriate controls rather than treating elaboration as permission to reset the baseline.

Rolling wave planning also applies beyond purely predictive delivery. A project can maintain agreed higher-level outcomes while progressively defining the next set of activities or releases. The planner still needs to understand boundaries, dependencies and acceptance. The technique should not be confused with uncontrolled scope growth, nor should it be used to defer difficult decisions indefinitely. The next wave needs enough detail to support its commitments before execution begins. The horizon is a

management choice informed by uncertainty, lead times, resource needs and the time required to make consequential decisions.

Test completeness from several directions

A completeness review should start with the authorised scope and trace it into the schedule. For each requirement or deliverable, the reviewer asks where the creating, checking and accepting work is represented. The review should then reverse direction: for each significant activity, the reviewer asks which scope element, external obligation or necessary management function justifies it. This two-way approach can reveal both omissions and work that has entered the plan without a clear authorised basis. A well-populated WBS code field is useful, but it is not proof that the mapping is correct.

The review should also inspect the boundaries between packages and organisations. Scope can be complete within individual packages while the handover between them remains unplanned. A designer's package can finish at issue, a contractor's package can begin at accepted information, and the intervening review can belong to neither. Similarly, a physical asset can be complete while its operating procedures and training remain outside everyone's activity list. These are often easier to detect by examining interfaces and acceptance conditions than by looking at individual bars. Completeness therefore requires several perspectives on the same delivery system.

Completeness and reconciliation model

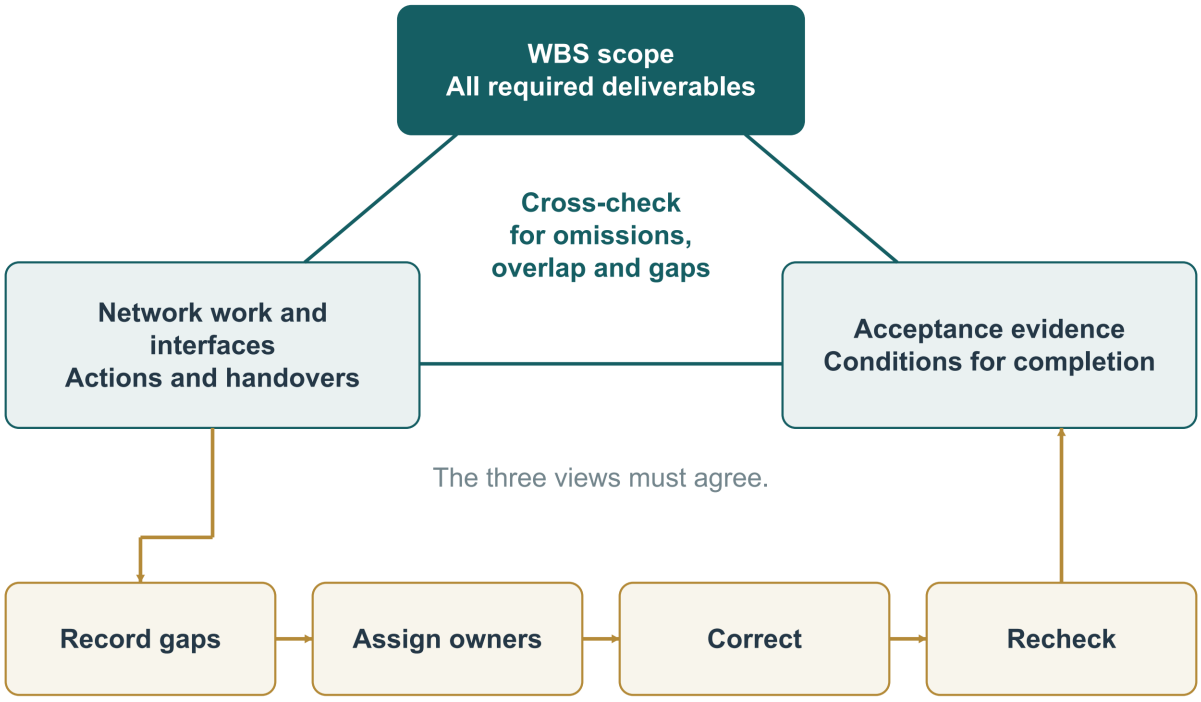


Figure 3.9. An original completeness-review model connecting scope, scheduled work and acceptance evidence. Findings require ownership, correction and rechecking; a completed checklist alone does not establish that the schedule is credible.

Table 3.7 | Testing the completeness of scheduled scope

Review perspective	Question to test	Evidence of a useful resolution
Scope coverage	Does each agreed deliverable have a traceable home?	WBS and dictionary entries mapped to the creating and accepting work
Reverse traceability	Why is each significant activity in the plan?	A link to authorised scope, an obligation or a necessary management function
Ownership	Who is accountable for delivery and progress information?	Identified owners and resolved responsibility gaps
Interfaces	What must pass between parties before work can proceed?	Agreed content, state, producer, receiver and supporting review work
Acceptance	What makes completion true and who confirms it?	Defined conditions, evidence and appropriate authority
Exclusions and assumptions	Is necessary work missing because it sits outside one party's scope?	A clear alternative owner or an explicit, controlled project exclusion
Progressive detail	Is the next wave ready before it is due to start?	Reconciled scope, resources, interfaces and decisions supported by adequate detail

The US GAO's Schedule Assessment Guide uses historical defence enterprise-system examples in which government work was separated or omitted, including testing and later milestones. Its broader principle is that a reliable schedule captures the work required to complete the programme, including contributions beyond a contractor's immediate scope. These examples do not prove that one omission caused every subsequent difficulty. They support a specific review question: where are the customer, government or operational activities on which delivery depends, and how are their interfaces represented (GAO, 2015, pp. 11–12)?

Treat findings as improvements to the delivery model

A review finding should identify the issue, its consequence, an owner and a route to resolution. 'Schedule incomplete' is too broad to help a team act. 'The receiving team's inspection is required before energisation but has no activity, owner or forecast duration' identifies a specific gap. The correction then needs to be checked in the context of the whole model. Adding the missing activity without connecting it to the dependent work may improve the activity count without improving the forecast. Closing the finding should mean that its delivery consequence has been addressed, not merely that a new row exists.

The review is also an opportunity to challenge unnecessary detail. A model with thousands of poorly distinguished activities can make responsibility and progress harder to understand. Removing duplicate or purposeless detail can improve control if the scope, interfaces and acceptance conditions remain visible. The objective is a representation that can be maintained and interrogated, with enough detail to support the decisions that matter. Professional judgement therefore operates in both directions: exposing hidden work and simplifying information that adds no useful distinction.

Knowledge check and examination practice

PMI's examination outline assigns 31 per cent to Schedule Planning and Development. Tasks 1, 2 and 9 cover breakdown structures, work packages, activities and milestone alignment with scope and contracts (PMI, 2012, pp. 4–5). These original practice questions are not PMI examination items. Choose the best answer.

Question 1 — From work package to activities

A work package covers the supply, installation and acceptance of a ventilation unit. Procurement, mechanical installation and commissioning have different responsible people and different completion evidence. What is the most appropriate approach to defining the schedule?

A Create one activity because every work package must correspond to exactly one schedule activity.
B Create three milestones and omit the work leading to them.
C Use the purchase order value to determine the number of activities.
D Decompose the work package into manageable activities with defined boundaries and responsibility, retaining traceability to its scope.

Question 2 — Completeness across contracts

A contractor's schedule includes the installation of new equipment but excludes operator training because the client's operations team will provide it. Training is necessary before the equipment can enter service. What should the integrated project schedule do?

A Represent the training and its interfaces, with an agreed owner and appropriate detail.
B Exclude it because it is outside the contractor's price.
C Record it only as a cost assumption.
D Assume that physical installation establishes operational readiness.

Question 3 — A summary duration

Two activities start together, use the same uninterrupted working calendar, and last three and four working days respectively. A calculated summary spans these activities from their earliest start to their latest finish. What is its duration?

A Three working days.
B Seven working days.
C Four working days.
D Twelve working days.

Question 4 — Level of effort

A scheduler finds that an ongoing administrative support activity has been entered as an independent task and is determining the reported project completion date. Its purpose is to support the delivery work throughout that work's duration. What is the best first response?

A Report the support activity as the final delivered product.
B Review its activity form and links to the work it supports, checking how the scheduling tool represents level of effort.
C Impose a mandatory finish date to remove the problem from the report.
D Delete all management and administration from the project scope.

Question 5 — Review and decision

A technical authority needs five working days to review an acceptance submission. The schedule currently represents this entire process as a five-day milestone called 'Approval'. What is the most appropriate correction?

A Remove the review because milestones cannot contain work.
B Retain the five-day milestone but remove its responsible owner.
C Replace it with a zero-duration milestone and assume that the review takes no time.
D Represent the review as an activity and its defined decision or acceptance point as a zero-duration milestone.

Question 6 — An information interface

A designer plans to issue a drawing on Monday. The installation team has scheduled work to begin on Tuesday, although the drawing must first pass a technical review. What should the scheduler establish before accepting this interface?

A The required state of the drawing, the review work and ownership, and the condition that releases installation.
B Only whether both organisations use the same scheduling software.
C Whether Monday appears in both organisations' milestone lists.
D Whether the drawing has a document number, regardless of its approval status.

Question 7 — Rolling wave reconciliation

A planning package is expanded into detailed activities. Its total budget remains unchanged, but the new logic, calendars and resource information indicate a later forecast finish. What should happen next?

A Keep the original forecast because an unchanged budget proves the original duration.
B Change the approved baseline automatically to match the new detail.
C Reconcile the detail and assumptions, report the supported forecast, and follow the applicable process for any proposed baseline change.
D Remove activities until the original date reappears.

Question 8 — Payment and technical acceptance

A payment milestone is approved while several technical exit criteria remain open. What is the most defensible scheduling response?

A Record all associated technical work as complete because payment has been approved.
B Distinguish the commercial event from technical acceptance and retain the outstanding work and evidence requirements.
C Assume that payment approval is necessarily unlawful.
D Remove the technical criteria because commercial milestones always take precedence.

Answer explanations

Question 1 — D

A work package is a scope and control unit; it need not be represented by one activity. Separate activities are justified when they expose meaningful differences in work, responsibility, sequence or completion evidence. A imposes an unsupported one-to-one relationship. B substitutes events for the effort that produces them, concealing procurement, installation and commissioning work. C uses a financial measure as an arbitrary rule for decomposition. Activity detail should support execution, measurement and control rather than satisfy a numerical convention.

Question 2 — A

The project requires training regardless of which organisation pays for or performs it. The integrated schedule should therefore make this work and its connections visible at an appropriate level. B confuses a contractual boundary with the project's total scope. C fails to represent the time and readiness implications. D assumes that a physical asset and an operational capability are the same completion state. This question tests the completeness of the delivery model across organisational boundaries.

Question 3 — C

The summary covers the interval from the common start to the end of the longer activity: four working days. A ignores the later finish, while B adds durations even though the work is parallel. D multiplies durations without any scheduling justification. The answer depends on the assumptions in the question: a shared calendar, simultaneous starts and uninterrupted execution. In a real schedule, calendars, interruptions and links must be examined before comparing a summary span with the durations below it.

Question 4 — B

The scheduler should first determine whether the supporting work has been modelled appropriately and how the tool derives its dates. A confuses support effort with the product it supports. C may hide the modelling problem behind a constraint without correcting it. D removes legitimate scope and resource requirements. The correct response preserves necessary support while testing whether its representation creates a misleading independent driver of delivery. The label alone does not establish that a software activity behaves as intended.

Question 5 — D

The review consumes time and should be represented as work. The milestone records a defined event or condition and has zero duration. A loses necessary work; B retains the modelling error and weakens accountability; C removes the review's duration from the model. A realistic schedule separates the preparation and review of evidence from the decision that evidence enables. The decision's acceptance criteria should also be stated so that completion can be reported consistently.

Question 6 — A

An issued drawing is not necessarily a drawing authorised for installation. Defining the information state, review and release condition exposes the work between the organisations. B may affect data exchange but does not establish readiness. C checks consistency of labels and dates without testing their meaning. D establishes identity but not suitability for use. The interface must connect what the producer actually provides with what the receiver needs before its work can start.

Question 7 — C

Rolling wave planning develops detail as knowledge improves. It does not justify concealing a supported forecast or changing an approved baseline without the applicable authority. A incorrectly treats budget reconciliation as proof of duration. B bypasses baseline governance. D deletes scope to obtain a preferred result. The professional response is to establish why the forecast has changed, check the model and communicate its implications while preserving the distinction between current expectations and approved commitments.

Question 8 — B

Commercial approval and technical acceptance may use different criteria. The schedule should preserve that distinction and represent the remaining work accurately. A treats a financial event as conclusive evidence of technical completion. C reaches a legal conclusion that the information does not support. D invents a universal priority rule. The scheduler's role is to make the states, evidence and consequences visible so that authorised decision-makers can act on a clear account of delivery readiness.

Preparing for Chapter 4

This chapter has established what the schedule must contain: identifiable scope, manageable activities, meaningful milestones and explicit interfaces. Chapter 4, Estimating Durations and Establishing Working Calendars, develops estimates for that work and examines how working time affects the resulting dates. Its calculations need the boundaries established here. An estimate cannot be defended if the activity's content is unclear, and a calendar cannot establish that access or an approval has actually been secured.

References and further reading

Abu Dhabi Media Office (2023) 'Federal Authority for Nuclear Regulation issues operating licence for Unit 4 of Barakah Nuclear Energy Plant', 17 November. Official publication.

Afzal, M., Wong, J.K.W. and Ahmadian Fard Fini, A. (2024) 'Towards digital approach for managing request for information (RFI) in construction projects: a literature review', *Construction Innovation*, online publication. https://doi.org/10.1108/CI-05-2023-0113.

Amer, F., Hockenmaier, J. and Golparvar-Fard, M. (2022) 'Learning and critiquing pairwise activity relationships for schedule quality control via deep learning-based natural language processing', *Automation in Construction*, 134, 104036. https://doi.org/10.1016/j.autcon.2021.104036.

Assemblée nationale (2025) *Avis no 2043, Tome III, Culture: Patrimoines*, by Jérémie Patrier-Leitus, registered 29 October, part I, section III. Official parliamentary publication.

Australian National Audit Office (ANAO) (2023) *Department of Defence's Procurement of Hunter Class Frigates*, Auditor-General Report No. 21 of 2022–23, 10 May, especially paragraphs 3.61–3.72. Official audit.

DB Projekt Stuttgart–Ulm GmbH (2022) 'Neubaustrecke Wendlingen–Ulm: Letzte Vorbereitungen für die Inbetriebnahme', press release 019/2022 JD, 10 November. Official project publication.

Egypt, Ministry of Tourism and Antiquities (n.d.) 'The Grand Egyptian Museum announces the trial operation of its main galleries'. Official ministry publication.

Egypt, State Information Service (2025) 'Grand Egyptian Museum opens its doors to the public', 4 November. Official publication.

Infrastructure and Projects Authority (IPA) (2021a) *Project Routemap: Requirements*. London: UK Government, especially pp. 8, 10 and 21–23. Official module.

Infrastructure and Projects Authority (IPA) (2021b) *Project Routemap: Systems Integration*. London: UK Government, especially pp. 19–20. Official module.

Lagos, C.I., Herrera, R.F., Mac Cawley, A. and Alarcón, L.F. (2024) 'An AI Copilot for Make-Ready Planning in the Last Planner System', *Proceedings of the 32nd Annual Conference of the International Group for Lean Construction*, pp. 365–376. https://doi.org/10.24928/2024/0155.

National Aeronautics and Space Administration (NASA) (2021) *NASA Work Breakdown Structure (WBS) Handbook*, NASA/SP-20210023927, revision D, November, especially pp. 33–35 and 38–43. Official handbook.

National Audit Office (NAO) (2017) *Update on the Thameslink programme*, HC 413, 23 November, especially pp. 24–28. Official audit.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Newtown Square, PA: PMI, Domain 2, pp. 4–5. Official examination outline. Consult the current PMI candidate information before booking an examination.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: PMI. Citations use printed pages, particularly sections 2.2.4, 3.2.1.1–3.2.1.2, Section 4 and the Glossary. Definitions retain the source wording.

United States Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G, December, especially pp. 11–12, 20–22 and 51–52. Official guide.

Whyte, J., Soman, R.K., Sacks, R., Mohammadi, N., Naderpajouh, N., Hong, W.T. and Lee, G. (2025) 'Using Digital Twins for Managing Change in Complex Projects', in *Proceedings of the International Conference on Smart and Sustainable Built Environment (SASBE 2024)*, Lecture Notes in Civil Engineering, 591, pp. 1575–1582. Springer. https://doi.org/10.1007/978-981-96-4051-5_150.

Case accounts retain their publication dates and distinguish reported achievements from forecasts. Diagrams, comparison tables, teaching frameworks, worked examples and practice questions are original educational material developed for this chapter; they are not PMI-prescribed models or official examination items.

CHAPTER 04

Estimating Durations and Establishing Working Calendars

Why ten days is not yet a delivery date

A duration estimate is a reasoned statement about the time needed to perform defined work. It becomes a forecast date only when the schedule also represents sequence, available resources and the periods in which work can occur. Ten working days could span two normal working weeks, several restricted night possessions or a much longer period interrupted by access closures. The same quantity of work can therefore produce different finish dates without anyone changing its estimated effort. Conversely, adding people or shifts can change the estimate only if the proposed resources and working arrangements can actually produce the required output.

This chapter develops the connection between the work described in Chapter 3 and the time represented in a schedule. It explains quantities, effort, productivity and duration; compares estimating methods; works through three-point estimates and PERT calculations; and shows how calendars turn working time into dates. It also examines the distinction between an original estimate and the time now required to complete unfinished work. No previous study of risk management is assumed. Uncertainty is introduced through practical examples, with the mathematical assumptions explained before the results are used.

For PMI-SP preparation, the chapter principally supports Schedule Planning and Development: estimating activity durations, representing calendar and resource constraints, and testing whether the model can meet its commitments. At Project Controls Professional Level 6, the important judgement is whether the estimate deserves confidence. A scheduler should be able to explain the evidence, units, delivery method, working conditions and limitations behind a number, challenge an unsupported acceleration assumption and recognise when a precise-looking result rests on weak information.

The chapter framework: from quantity to credible dates

Figure 4.1 follows six connected questions. What work is included? What evidence and estimating method are appropriate? How much effort and productive capacity are required? What working duration follows? When can that work occur? What date does the integrated model then forecast? The sequence is a teaching framework, not a substitute for the iterative development of the actual schedule. For example, an access restriction can require a different method, and a scarce resource can require a different sequence. The estimate should be revisited when those delivery assumptions change.

From quantity to credible dates

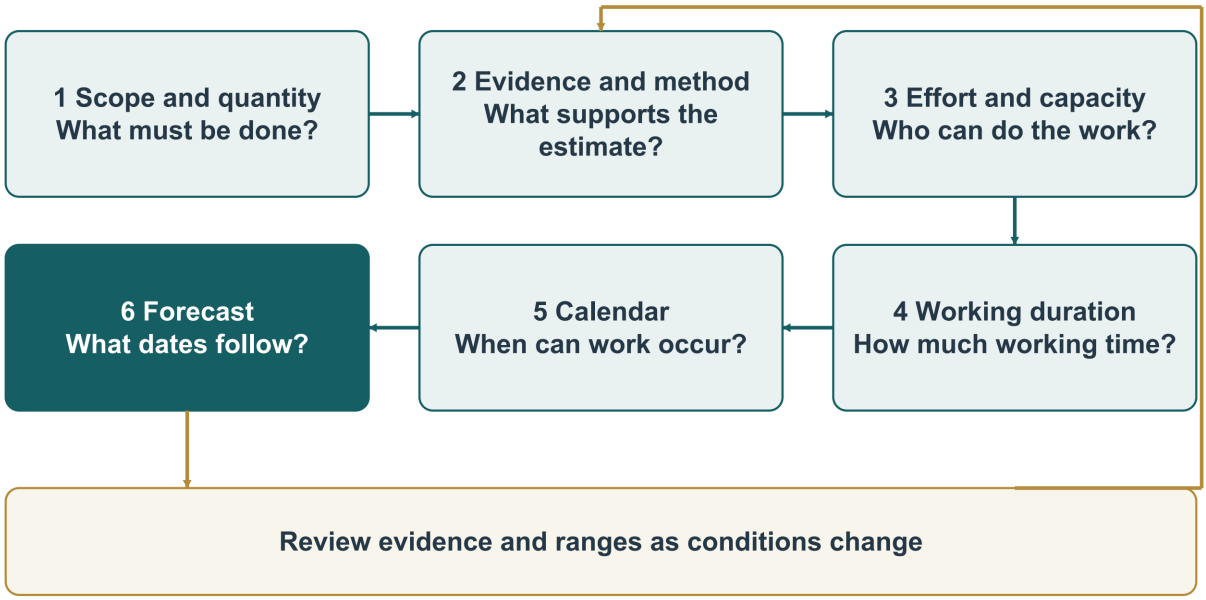


Figure 4.1. An original framework connecting scope, estimating evidence, capacity, duration and calendars. Review and uncertainty apply throughout; a calculated result does not by itself establish an achievable commitment.

The framework separates the amount of work from the opportunity to perform it, while preserving their connection. It also makes the basis of the estimate visible. An estimate with a clear source and explicit conditions can be challenged and improved; a number copied from another schedule may be difficult to explain even when it looks reasonable. The aim is not to eliminate judgement, which is unavoidable in uncertain work, but to make that judgement informed, reviewable and consistent with the delivery model.

4.1 Understanding what is being estimated

Separate duration from effort and elapsed time

Duration. 'The total number of work periods required to complete an activity or project, expressed in hours, days, or weeks. Usually qualified by one of the following: actual, baseline, current, original, remaining, scheduled, or target. See also effort.' (PMI, 2019, p. 179)

Effort. 'The number of labor units required to complete a schedule activity or work breakdown structure component, often expressed in hours, days, or weeks. See also duration.' (PMI, 2019, p. 180)

The same word, such as 'hours', can describe different quantities. Eight person-hours of effort might be provided by one person working for eight hours or two people working together for four hours, provided that the work can be shared in that way. The elapsed duration of the activity is not obtained merely by adding everyone's time. Equally, a test that must run continuously for twenty-four hours does not necessarily require twenty-four hours of human attendance. The planner should distinguish the required process time from the labour and equipment needed to support it.

Working time counts the periods that the relevant calendar permits. Elapsed time measures the passage of time between instants, including intervening nonworking periods. A task performed on Friday and Monday can occupy two working days while spanning a weekend. Neither measure is inherently wrong; the error occurs when an estimate expressed in one is entered or interpreted as the other. The basis

should therefore state both the unit and the convention. 'Five days' is incomplete information if one party means five eight-hour working days and another means five consecutive twenty-four-hour periods.

Establish quantities and productivity before using a formula

A quantity describes the output or extent of work: metres of cable, installed assemblies, reviewed documents or tested devices, for example. Productivity connects that output with the resource input used to achieve it. A rate stated as installed units per person-hour differs from a rate stated as installed units per crew-shift. Both can be useful, but they require different denominators. The planner should establish whether the historical rate includes mobilisation, routine interruptions, checking and rework before applying it to a new activity. Otherwise, allowances can be omitted or counted twice.

> **Unit of Measure.** 'A designation of the type of quantity being measured, such as work hours, cubic yards, or lines of code.' (PMI, 2019, p. 193)

The unit of measure component is a control on interpretation as well as arithmetic. PMI recommends consistent units across the schedule's components (PMI, 2019, p. 135). Consistency does not require every discipline to measure physical work in the same unit. It requires each measure to be identifiable and conversions to be explicit. A mechanical package can use installed items while an electrical package uses metres, provided that the quantities are not added as though they were equivalent outputs. Similarly, person-days must state the hours represented before they can be compared with person-hours.

Table 4.1 | Distinguishing quantity, effort, duration and productivity

Measure	What it expresses	Typical error to avoid
Quantity	The physical or informational output to be produced	Treating a count of items as a measure of their complexity
Effort	Labour input, such as person-hours	Reading the combined effort of several people as elapsed duration
Productivity	Output per specified unit of resource input	Mixing person-hour and crew-shift rates
Working duration	Time needed within permitted work periods	Assuming every working day has the same number of hours
Elapsed time	Continuous time between instants	Excluding weekends from a period explicitly stated as continuous
Forecast date	A calculated point in time in the delivery model	Treating a duration estimate alone as a committed finish date

Recognise different physical and organisational time drivers

Some activities respond substantially to labour capacity, while others are controlled by equipment throughput, a technical process, an external decision or a combination of these. A review may require only six hours of specialist effort but wait several days for the specialist to become available. An equipment test may have a fixed observation period even when extra technicians are present. A permit application may require preparation effort followed by assessment by an external authority. Combining these different drivers into a single unexplained duration makes it harder to identify which part could change.

PMI explicitly cautions that the relationship between resources and activity duration is not a simple straight line and gives a fixed-duration stress test as an example (PMI, 2019, p. 62). The practical

response is to identify the mechanism governing the work. Separate preparation, production, waiting and acceptance where the distinction matters to control or dependencies. Do not fragment work merely to create more rows, but do not assume that every hour in a long activity is an interchangeable hour of productive labour.

4.2 Selecting an estimating method and testing its evidence

Start with the activity boundary and delivery conditions

An estimate should refer to the same activity boundary that will later be used to report progress. If the estimate covers installation alone but completion will be judged by accepted installation, the time for inspection and correction needs an explicit home. The estimator should know the required output, location, quality expectations, access arrangements and any prerequisites that affect the delivery method. Chapter 3 established those boundaries; duration estimating tests whether they are sufficiently understood to support a credible number or range.

PMI recommends defining the activity, understanding its logical place in the schedule and then focusing on resources and duration (PMI, 2019, p. 62). This is iterative rather than a rigid sequence of isolated tasks. An early duration can help test a proposed sequence, while subsequent investigation of dependencies can expose a waiting period or force work into a different calendar. The estimate should be updated deliberately when its basis changes. Retaining an old number after the agreed method has changed preserves apparent consistency at the expense of an accurate forecast.

Use expertise as reasoned evidence

Expert judgement draws on people who understand the work and its conditions. Its quality depends on more than seniority or confidence. A useful discussion asks what comparable work the person has performed, which conditions were different, what typically interrupted production and what evidence supports the proposed range. Several specialists may be needed because the installation team, operator, supplier and approval authority understand different parts of the activity. Their estimates should be reconciled through the delivery assumptions, rather than averaged mechanically when they describe different scope or methods.

Judgement is especially valuable when a new activity lacks directly comparable records, but uncertainty should remain visible. A confident answer is not the same as a narrow distribution of possible outcomes. Asking for the conditions behind a short, normal and long duration often reveals more than asking for a single best number. Independent initial estimates can also help expose differences before a meeting converges on a convenient date. The scheduler's task is to establish why people disagree and whether the disagreement concerns evidence, scope, productivity or the required outcome.

Compare analogous, parametric and bottom-up approaches

Analogous estimating uses comparable completed work as a starting point, adjusting for differences that matter. A previous commissioning package might provide a useful reference if its technical scope, test sequence, team and acceptance process resemble the new work. A duration copied solely because two activities have similar names is a weak analogy. The record should identify the reference work and the adjustments made. A larger quantity does not necessarily justify a directly proportional duration if mobilisation, fixed review periods or different resource arrangements are involved.

Parametric estimating uses a defined relationship between measurable inputs and the estimated result. A quantity divided by a supported production rate is a simple example. More complex relationships may include several predictors, but mathematical complexity does not ensure validity. The relationship needs relevant data, compatible units and an appropriate range of application. A rate established for repetitive

work in an open area should not be applied unchanged to congested work in an operating facility. The apparent objectivity of a formula can conceal a poor choice of its inputs.

Bottom-up estimating develops the estimate from smaller, understood elements. A work package might be examined through its preparation, assembly, checks and release activities, with the required effort and resources considered for each. Effort can often be totalled across those elements, but their durations cannot automatically be added: some work may overlap, while other work depends on a shared resource or an external release. The scheduler needs the proposed sequence and calendars to determine the overall span. Bottom-up detail is valuable when it exposes real delivery distinctions, not simply because the estimate contains many lines.

Table 4.2 | Comparing duration-estimating approaches

Approach	Useful circumstances	Main challenge to the evidence
Expert judgement	Specialist or novel work; interpretation of local conditions	Is the judgement based on relevant experience and explicit assumptions?
Analogous estimating	Comparable completed work is available	Are scope, method, resources and working conditions sufficiently comparable?
Parametric estimating	Quantity and a defensible production relationship are known	Are the rate, units and range of application valid?
Bottom-up estimating	The work can be decomposed into meaningful elements	Have interfaces, shared resources and overlapping durations been reconciled?
Three-point estimating	Uncertainty needs to be represented explicitly	Do the three estimates describe the same work and consistent scenarios?

Baerenbold's review of reference class forecasting examines the importance of selecting appropriate historical comparisons. Its evidence is substantially concerned with megaprojects and infrastructure, including cost outcomes, rather than a controlled test of individual activity-duration estimates. The useful lesson is to make comparison criteria explicit and challenge an estimate against relevant completed work. Reference class forecasting is not simply another name for ordinary analogous estimating, and an outside view does not remove the need to understand the activity's scope, method and local conditions (Baerenbold, 2023).

Triangulate estimates without pretending that agreement proves accuracy

Methods can complement each other. A quantity-based estimate can be compared with a similar completed package and reviewed by the team that will execute it. If all three give different answers, the response should be investigation, not automatic averaging. The historical job may have used a second shift; the production rate may exclude testing; or the delivery team may have assumed that access is intermittent. Reconciliation is useful because it tests the assumptions that drive the result. Numerical agreement is less persuasive when all estimates ultimately use the same unverified source.

An illustrative comparison shows the importance of separating fixed and variable work. A previous package required one working day of preparation plus six days to install sixty similar items at ten items per day. For ninety items, the same supported method would suggest one day plus nine installation days: ten working days. Multiplying the entire seven-day previous duration by 90/60 would instead produce 10.5 days and scale the fixed preparation allowance unnecessarily. Neither calculation accounts for

different access, acceptance or crew conditions; those still require explicit review before the estimate is adopted.

Evidence should remain traceable to its date, source and context. Historical records may report a planned duration, an actual duration, a production average or a best shift, and these are not interchangeable. A record of exceptional output does not establish a sustainable average. Similarly, a dataset containing only successful packages can give a misleading impression of the outcomes that matter to the new project. The estimate should state the basis selected, why it is applicable and what unresolved information could materially change it.

4.3 Converting productivity and capacity into duration

Follow the units through the calculation

Consider a separate illustrative activity to install 120 identical units. The work is divisible between suitably skilled people, and the supported production rate is 0.5 installed units per person-hour devoted to this task. Four people are available, each for six task-hours per working day. The six hours represent time available to this particular activity, not a claim about the length of a paid shift or a universal efficiency allowance. The rate and available hours use the same basis: routine losses already included in the measured rate must not be deducted again from the available time.

Required effort = quantity / productivity = 120 / 0.5 = 240 person-hours.

Daily task capacity = 4 people × 6 task-hours per person = 24 person-hours per working day.

Working duration = 240 / 24 = 10 working days.

Quantity, effort and working duration

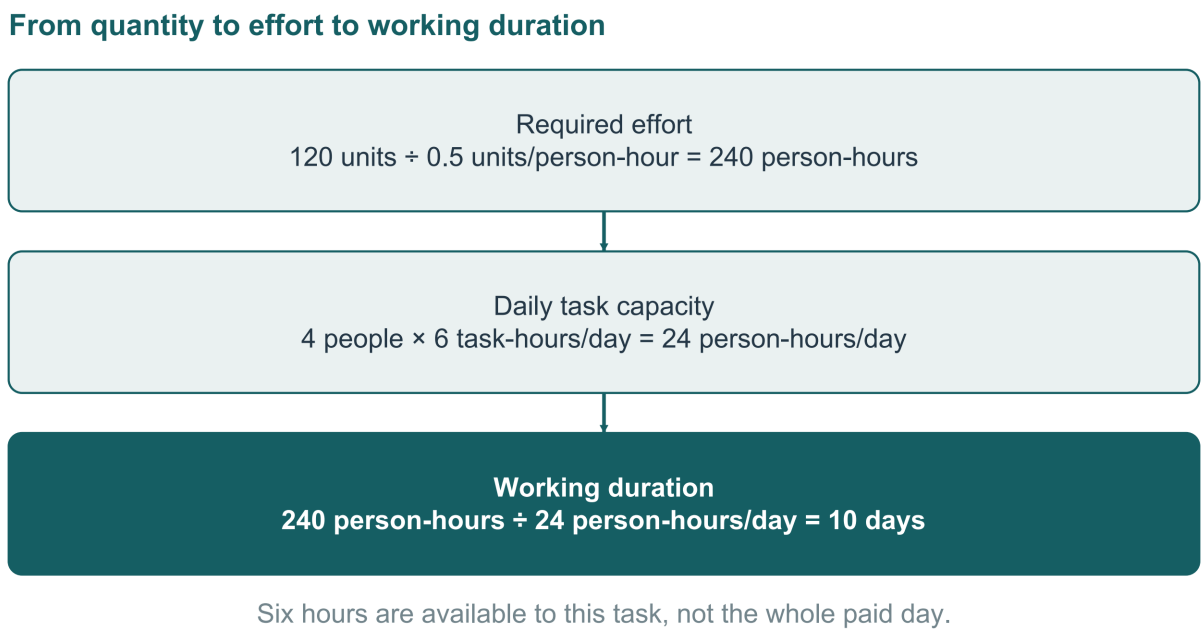


Figure 4.2. An original worked example with compatible units. The calculation assumes sufficient work fronts, materials and supervision, a stable production rate and the stated daily availability.

The numerical result is conditional on those assumptions. If only twelve person-hours become available each day, the same 240 person-hours would require twenty working days under the unchanged

productivity assumption. If the team is still available for twenty-four person-hours but the rate falls to 0.4 units per person-hour, the required effort becomes 300 person-hours and the working duration becomes 12.5 days. These are different causes of a longer duration. One changes capacity; the other changes the resource input needed for the output. The distinction helps the team choose a response that addresses the actual constraint.

Do not assume that adding people produces proportional acceleration

Eight people with the same six task-hours each would nominally provide forty-eight person-hours per day and reduce the example's calculated duration to five days. That result is defensible only if the work can be shared without changing its productivity. Restricted work fronts, specialist plant, inspection capacity and supervision can prevent this. Additional people may also create coordination demands or interference. The planner should test the delivery method and the bottleneck rather than simply replace four by eight in a formula and announce a five-day commitment.

Fixed process time creates another limit. Suppose a package contains four days of divisible installation followed by a mandatory two-day continuous test under its specified technical procedure. Halving the installation period would reduce the package to four days only if the sequence, calendars and test arrangements permit that result. It would not reduce the test to one day merely because the installation crew doubled. The calculation should distinguish resource-responsive work from time that is governed by a process, an external decision or a non-negotiable acceptance condition.

Sadatnya and colleagues used historical daily work reports to develop construction-crew productivity predictions, considering context such as weather, resources, crew composition and project characteristics. Their study supports recording the circumstances behind a production rate rather than retaining an isolated average. It does not demonstrate that one model or rate transfers reliably to every new project, or that changing a recorded factor necessarily causes a corresponding productivity improvement. Prediction needs validation against work sufficiently similar to the activity being estimated (Sadatnya et al., 2023).

Connect duration assumptions with the activity cost estimate

> **Activity Cost Estimate.** 'The projected cost of the schedule activity that includes the cost for all resources required to perform and complete the activity, including all cost types and cost components.' (PMI, 2019, p. 173)

At an illustrative labour rate of £35 per task-hour, the 240 person-hours in Figure 4.2 would give £8,400 for that labour element. This is not the full activity cost unless every relevant cost is included. Materials, equipment, mobilisation, supervision and other applicable categories need their own treatment. PMI's component guidance brings those categories together in the activity estimate (PMI, 2019, p. 100). A duration estimate and a cost estimate should therefore share the same resource and method assumptions, while retaining the difference between labour input, elapsed occupation of equipment and the cost of the completed activity.

Acceleration can change these assumptions. A second shift may require another supervisor, additional handovers, lighting or different equipment arrangements. Some costs depend on time, while others depend on quantity or a fixed commitment. A shorter working duration does not automatically mean lower total cost, and unchanged person-hours do not guarantee unchanged expenditure. The planner should describe the proposed operating arrangement so that the relevant specialists can estimate its consequences consistently. Detailed resource optimisation is developed later; the foundation here is a coherent relationship between scope, capacity, duration and cost.

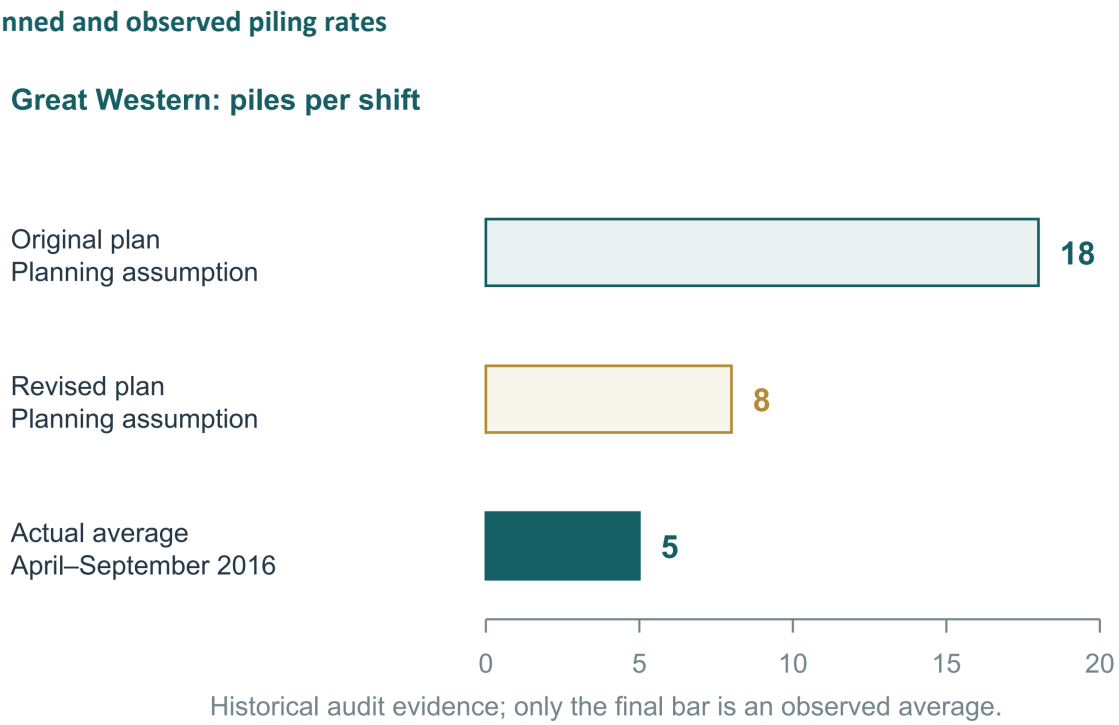


*Figure 4.3. Original presentation of the National Audit Office's reported Great Western piling rates: an original planning assumption of 18 piles per shift, a revised assumption of 8, and an observed average of 5 during April-September 2016. The categories represent different kinds of evidence, not three comparable experiments (NAO, 2016, p. 35).**

England and Australia: distinguish demonstrated performance from intended improvement

The Great Western audit reported that a peak demonstration of up to twenty-four piles in a shift had not become routine performance. Figure 4.3's original and revised assumptions therefore need to be distinguished from the observed April-September 2016 average. The lesson is to test whether a rate is repeatable under the actual conditions. The ratios between these figures cannot be used to calculate the whole programme's delay: the work mix and delivery methods also differed, and the audit identified multiple difficulties (NAO, 2016, paragraph 3.7).

The Australian National Audit Office's June 2026 Snowy 2.0 report distinguishes forecasts reflecting current performance and unmitigated risks from forecasts incorporating estimated acceleration and further potential efficiencies. It records difficulty realising productivity gains assumed at the programme reset. This recent case supports a specific estimating discipline: an intended improvement needs evidence before it is treated as established capacity. The audit's weighted overall progress measures are not physical crew production rates and should not be substituted into a units-per-hour calculation or extrapolated mechanically into a completion date (ANAO, 2026, paragraphs 4.34-4.37).

4.4 Representing uncertainty with three-point estimates

Ask for consistent scenarios, not three unrelated guesses

> **Three-Point Estimating.** 'A technique used to estimate cost or duration by applying an average or weighted average of optimistic, pessimistic, and most likely estimates when there is uncertainty with the individual activity estimates.' (PMI, 2019, p. 192)

Uncertainty means that the outcome is not known precisely when the estimate is made. Variations in production, ground conditions, information quality or review effort can affect the work even when the

scope remains unchanged. A three-point estimate makes part of that uncertainty explicit. All three durations should refer to the same activity, unit and stated delivery arrangement. If the short estimate assumes two crews and the long estimate assumes one crew, the range combines a management choice with performance uncertainty. That can be analysed, but the distinction must be visible rather than embedded silently in the numbers.

Optimistic Duration. 'An estimate of the shortest activity duration that takes into account all of the known variables that could affect performance. See also most likely duration and pessimistic duration.' (PMI, 2019, p. 183)

Most Likely Duration. 'An estimate of the most probable activity duration that takes into account all of the known variables that could affect performance. See also optimistic duration and pessimistic duration.' (PMI, 2019, p. 183)

Pessimistic Duration. 'An estimate of the longest activity duration that takes into account all of the known variables that could affect performance. See also most likely duration and optimistic duration.' (PMI, 2019, p. 184)

The source's activity components associate these estimates with the work periods allocated under different performance conditions and with schedule risk calculations (PMI, 2019, pp. 103-104). Their practical use requires explicit scenario boundaries. The estimator should explain which adverse conditions are included, which events are treated separately and what evidence supports the limits. A stated pessimistic value does not make a longer outcome physically impossible. If an exceptional event is excluded from the range, its treatment should remain visible in the wider analysis. Otherwise, an apparently complete range can conceal a material source of exposure.

Before calculating, check that $0 \le O \le M \le P$, that units and scope agree, and that the meanings of the endpoints are documented. Elicited percentile values such as P10 and P90 cannot silently replace the endpoint assumptions of a classical three-point calculation. For work already in progress, the uncertainty assessment concerns the remaining work; the completed portion is not redrawn as a future uncertain duration (PMI, 2019, pp. 103-104).

Mohammadi and colleagues' tunnelling study uses daily records to distinguish ordinary performance variability from minor machinery and crew-related interruptions. It illustrates why a duration range should state what kinds of variation it includes. Its fitted distributions are findings from a particular case, not a rule that every activity is lognormal. Exceptional hazards and other excluded events need separate consideration. The distinction also helps prevent an interruption being counted within a measured production rate and then added again as an unrelated allowance (Mohammadi et al., 2025).

Calculate the weighted and triangular estimates

Let O denote optimistic duration, M the most likely duration and P pessimistic duration. The conventional PERT weighted estimate gives the most likely value four times the weight of either end value. The triangular estimate uses the arithmetic mean of the three values. The scheduling standard presents both calculations and explains that the selected distribution should fit the supporting evidence (PMI, 2019, pp. 74-75). Neither formula makes weak inputs reliable; the calculation summarises an estimating judgement whose basis still needs review.

PERT weighted estimate = (O + 4M + P) / 6.

Triangular mean = (O + M + P) / 3.

For an illustrative activity with O = 4, M = 7 and P = 16 working days, the PERT calculation is (4 + 28 + 16) / 6 = 8 working days. The triangular mean is (4 + 7 + 16) / 3 = 9 working days. The most likely duration remains seven days. The three results differ because they answer different questions and apply

different weighting assumptions. The right-hand range is longer than the left-hand range, so the weighted mean is greater than the most likely value. It would be misleading to rename the eight-day estimate 'most likely' simply because it is the value entered into a deterministic schedule.

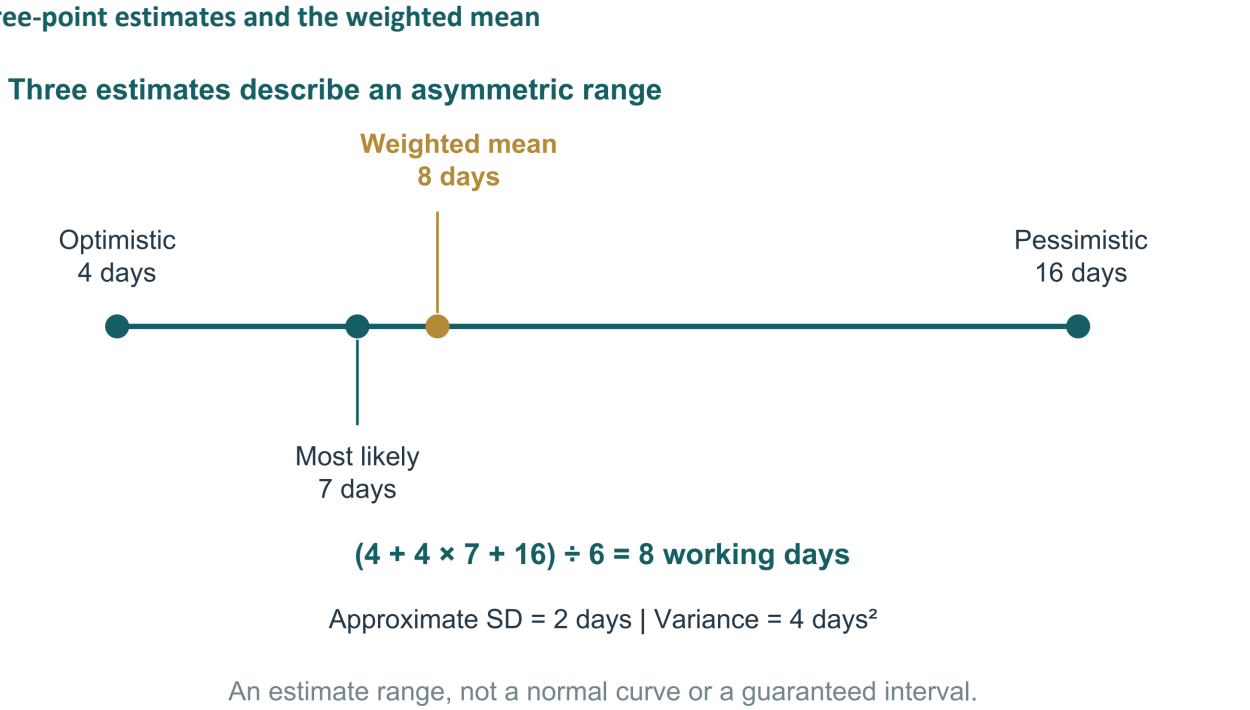


Figure 4.4. An original illustration of three-point inputs and their PERT weighted estimate. The line shows positions in working time, not a fitted probability-density curve or a stated confidence interval.

Understand spread, variance and their units

The usual classical PERT approximation estimates an activity's standard deviation as (P - O) / 6 and its variance as the square of that result. Standard deviation describes spread in the same units as duration; variance uses squared units. For Figure 4.4, the approximate standard deviation is (16 - 4) / 6 = 2 working days, and the variance is $2^2 = 4$ working-days squared. These are conventional approximations based on the three-point model, not exact properties of every possible beta distribution and not evidence that the underlying work follows a normal distribution (Kanabar and Warburton, 2011).

Approximate PERT standard deviation = (P - O) / 6.

Approximate PERT variance = $[(P - O) / 6]^2$.

Table 4.3 | Interpreting spread and variance in the example

Quantity in the example	Result	Interpretation
Most likely duration, M	7 working days	The most probable duration in the stated estimate
PERT weighted estimate	8 working days	A mean estimate under the conventional weighting
Triangular mean	9 working days	A mean under a different distribution assumption
Approximate standard deviation	2 working days	A conventional estimate of spread
Approximate variance	4 working-days squared	The squared measure used in variance aggregation

Standard deviation must also be distinguished from the standard error of an estimated mean. The first concerns variation in outcomes; the second concerns uncertainty in the mean estimated from a sample. Under appropriate independent sampling assumptions, the standard error of the mean decreases as the sample size increases, even though individual activity outcomes can remain variable. NIST's statistical guidance distinguishes a distribution's standard deviation from the sampling uncertainty of its mean. These quantities should not be used interchangeably when discussing the confidence attached to a duration estimate (NIST/SEMATECH, n.d.a; n.d.b).

Do not attach an unsupported completion probability

The familiar proportions of approximately 68.3, 95.4 and 99.7 per cent within one, two and three standard deviations apply to a normal distribution. They do not automatically apply to a skewed activity-duration estimate. A central interval around a mean is also different from the probability of finishing by a particular upper date. NIST emphasises the distributional assumptions behind normal calculations (NIST/SEMATECH, n.d.a). The weighted PERT estimate is therefore not, by itself, a 95 per cent confidence duration, a P80 commitment or even necessarily the median outcome.

For an introductory schedule interpretation, P80 means a duration or date by which the adopted model assigns an 80 per cent probability of completion. Obtaining it requires a justified distribution and, for project completion, a model of the relevant network and dependencies. Merely adding a percentage to the mean does not establish that probability. A project may choose a management allowance, but it should be identified as that choice rather than described as a calculated percentile without supporting analysis. Chapter 8 develops schedule uncertainty and risk analysis in more detail.

Aggregate carefully and retain the network context

Consider two activities on a fixed sequential path with compatible working-time units. The first has the Figure 4.4 values: mean eight days and approximate variance four. The second has O = 6, M = 9 and P = 12 days, giving a weighted mean of nine days, approximate standard deviation one and variance one. If their durations are independent, the path mean is 8 + 9 = 17 working days, its variance is 4 + 1 = 5, and its standard deviation is the square root of five, approximately 2.24 days. Standard deviations are not simply added under the independence assumption.

Independence is a substantive assumption. Common weather, access, design information or supplier conditions can make durations move together. With a correlation of 0.5 between the example's two

durations, covariance would be 0.5 × 2 × 1 = 1, and the sum's variance would be 4 + 1 + 2 × 1 = 7. This illustrative calculation shows why ignoring common influences can understate spread. A whole project creates further complications: the controlling path may change between scenarios, and calendars or shared resources may alter the result. Adding the means on today's critical path is therefore not a complete analysis of project completion uncertainty; PMI's published comparison of PERT and simulation explains why alternative paths and merging paths matter (Hulett, 2000).

4.5 Establishing working calendars

A calendar is a calculation rule as well as a working arrangement

> **Calendar.** 'Defines periods when work can or cannot occur during a project and the length of the work period, holidays, and exceptions.' (PMI, 2019, p. 177)

The calendar determines which periods the model can use when placing work in time. It should represent the intended working week, shifts, breaks, holidays, shutdowns and other applicable exceptions. PMI also identifies overtime and time zones as relevant calendar elements and recognises that multiple calendars can make critical-path and float calculations more complex (PMI, 2019, pp. 49-50). A single calendar may be easy to maintain but inaccurate for a project involving different locations, operations or resource patterns. Several calendars can be justified, provided that their purpose and assignments remain understandable.

A calendar does not establish authority to work. A night shift entered in software does not secure access, obtain a permit or make a specialist available. Those conditions require evidence and, where appropriate, supporting activities and milestones. Equally, an authorised access window does not mean that every resource can work for its entire span. The calendar should describe the permitted working pattern, while the resource and interface information explains whether the necessary delivery conditions have been secured.

Distinguish project, activity and resource calendars

> **Project Calendar.** 'A calendar that identifies working days and shifts that are available for scheduled activities.' (PMI, 2019, p. 185)
>
> **Activity Calendar.** 'The project calendar or another specifically defined calendar from the calendar library assigned to the schedule activity that defines the work periods and nonwork periods in calendar format; used to replace the project calendar during schedule network analysis. See also calendar library.' (PMI, 2019, p. 173)
>
> **Resource Calendar.** 'A calendar that identifies the working days and shifts upon which each specific resource is available.' (PMI, 2019, p. 188)

The project calendar establishes the default pattern. A specifically assigned activity calendar can represent work that follows another pattern, such as a continuous test or a restricted access period. Resource calendars describe the availability of the people or equipment assigned to the work. PMI's detailed components distinguish these functions and state that an assigned activity calendar replaces the project calendar for the activity's schedule calculation (PMI, 2019, pp. 99, 121, 127). This is different from assuming that every calendar is always intersected with every other calendar in every scheduling product.

Calendar selection and scheduling rules

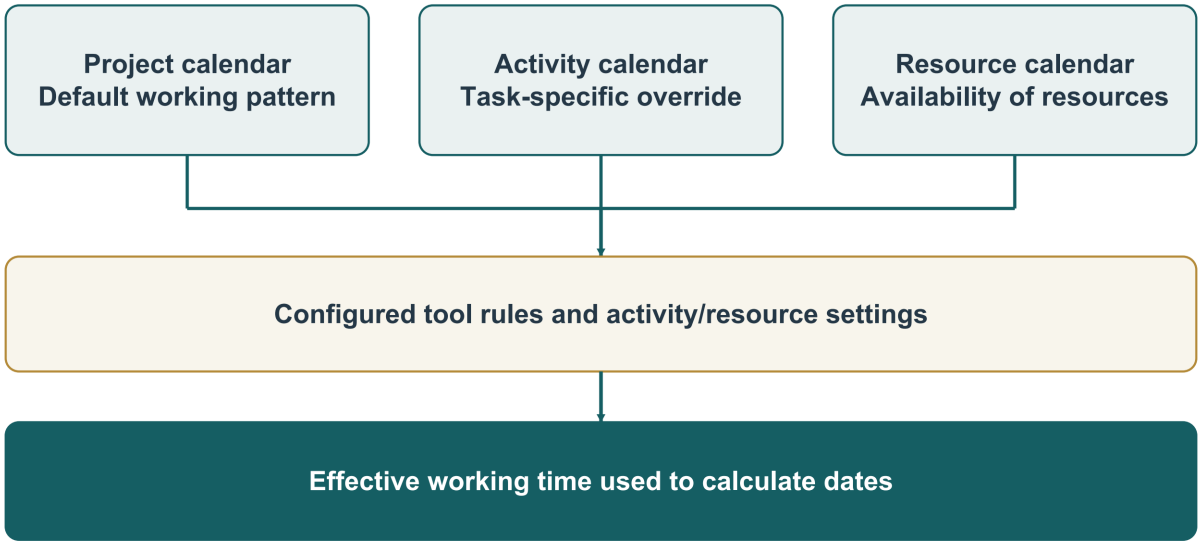


Figure 4.5. An original model of calendar responsibilities. Actual calculation depends on the selected activity, resource and scheduling settings; the diagram does not prescribe a universal intersection rule.

Software behaviour needs verification. Microsoft documents that an automatically scheduled task with a task calendar and a different resource calendar normally uses their overlapping working time, but an option can make the task ignore resource calendars. It also distinguishes manually scheduled tasks, whose entered dates may not respond to calendar changes in the same way. These are product-specific rules, not general permission to schedule unavailable resources. The professional check is to inspect the settings and confirm that the resulting dates represent the agreed delivery arrangement (Microsoft, n.d.b).

Table 4.4 | Project, activity and resource calendars

Calendar layer	Planning purpose	Question before relying on it
Project default	Establishes the normal working pattern	Does the default fit the project's actual operating arrangements?
Activity-specific	Represents a different pattern for selected work	Is the assignment intentional and justified by the work or access conditions?
Resource-specific	Represents availability of a particular person, crew or item	Are leave, shifts and other commitments reflected appropriately?
Exceptions	Changes specified dates or periods	Is the exception confirmed, dated and applied to the affected work?
Calculation settings	Determine how the tool uses those calendars	Do the selected rules preserve the intended constraints?

The US GAO's schedule guide illustrates the need to validate calendars through the Transportation Worker Identification Credential pilot. It reported that 259 of 302 activities used seven-day calendars without holidays, although site officials had not validated the resource assumptions. A seven-day

calendar is not inherently wrong; it is unreliable when the model assumes working arrangements that the responsible parties have not confirmed. Calendar assurance should therefore ask who will perform the work and whether the assigned periods reflect that availability (GAO, 2015, pp. 66-68).

Work through a calendar example in hours

Consider an illustrative activity requiring twenty-four working hours. It starts at 09:00 on Thursday 5 November 2026. Calendar A permits work from 09:00 to 17:00 each Monday to Friday, with no interruption within that eight-hour window and no other holidays or exceptions. Thursday provides eight hours, Friday another eight, and Monday 9 November the final eight. The finish is therefore Monday at 17:00. The activity uses twenty-four working hours, or three eight-hour working days, while the continuous interval from start to finish is 104 elapsed hours.

Calendar B is identical except that Friday 6 November is a project-specific closure introduced solely for this example. Thursday provides eight hours, Monday another eight and Tuesday 10 November the remaining eight. The finish becomes Tuesday at 17:00, with 128 elapsed hours between start and finish. The estimated working time remains twenty-four hours. The changed forecast is caused by a calendar exception, not a reduction in productivity or an increase in the quantity of work. There is no daylight-saving change within either example interval.

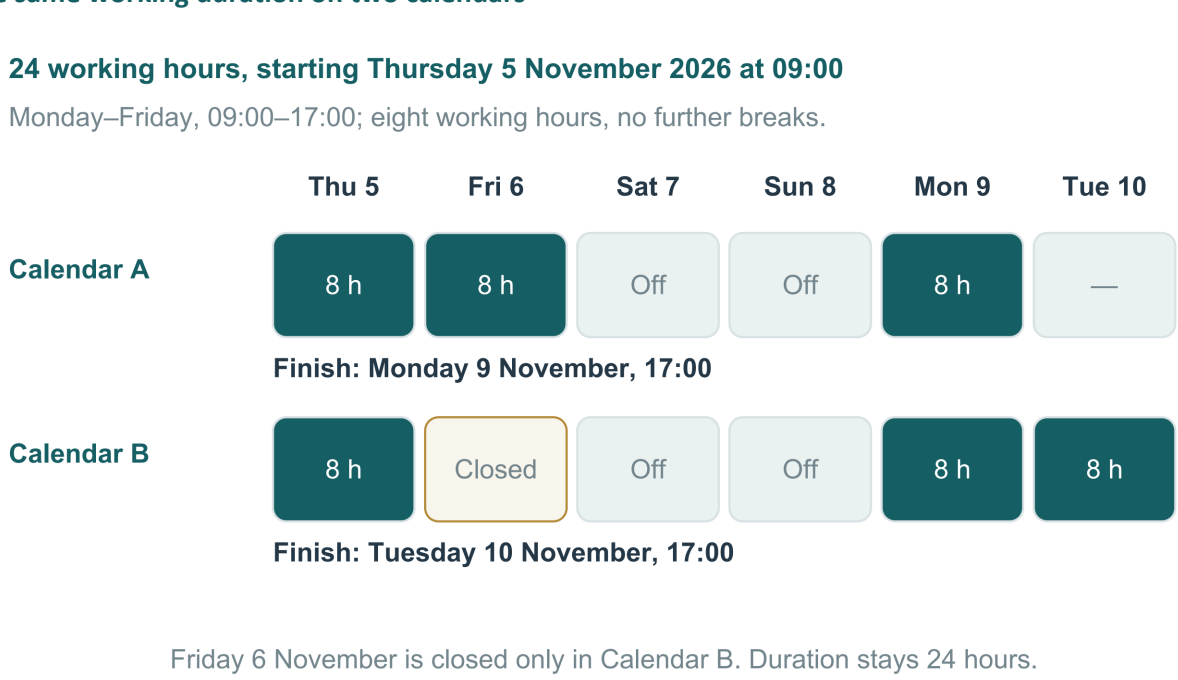


Figure 4.6. An original calendar calculation. Both cases require 24 working hours; a single additional closure changes the finish date. Friday's closure is illustrative and is not presented as a public holiday.

Control conversions, shifts and exceptions

Display units can conceal an inconsistency between an entered duration and the assigned calendar. If a tool interprets one entered day as eight hours, entering three days produces twenty-four hours. Assigning a six-hour working pattern does not necessarily make the original entry mean eighteen hours; its calculation depends on the tool's conversion settings. The scheduler should inspect stored hours, working intervals and display conventions together. Changing a label or an hours-per-day preference should not be assumed to alter the underlying work requirement in the intended way.

Shifts should include realistic handovers, breaks and any nonworking intervals, with the relationship to the productivity denominator kept clear. An overnight shift crosses a date boundary, so its end belongs to the following date. A shift spanning a daylight-saving transition may also require special attention to elapsed and local clock time. International work adds time-zone and local-holiday differences: an information release late in one location's day may arrive after the receiving team has finished. These are delivery conditions to represent deliberately, not rounding differences to ignore in an apparently daily schedule.

Calendar maintenance needs ownership and version control. An unexpected holiday, revised shift or confirmed shutdown can change forecast dates without any duration field being edited. The planner should identify which activities and resources use the affected calendar, recalculate the model and explain the resulting changes. Archived schedule instances should retain enough information to reproduce their original calendar basis. Otherwise, a later reviewer may be unable to distinguish an actual performance change from a change in the rules used to calculate time.

4.6 Planning access windows, lead times and seasonal conditions

Distinguish the booked window from productive execution time

A possession, outage or access window establishes an outer opportunity for work. Part of it may be needed for preparation, isolation, mobilisation, checks, restoration and handover. These activities should have realistic durations and ownership. The productive interval is what remains after the necessary surrounding work is represented, not the full booked window by default. The planned sequence must also preserve the conditions needed to return the asset or service. A deadline for handback does not justify assuming that all work will fit without testing the method and available capacity.

In the original example in Figure 4.7, a six-hour window contains one hour of preparation, four hours of execution and one hour of restoration and handback. If the work requires five execution hours at the supported rate, the proposal does not fit merely because five is less than six. The team needs a feasible change to scope, method, resources, sequence or access arrangements. Preparation and handback allowances must be established for the actual operation; the example's one-hour blocks are explanatory assumptions, not railway procedures or universal allowances.

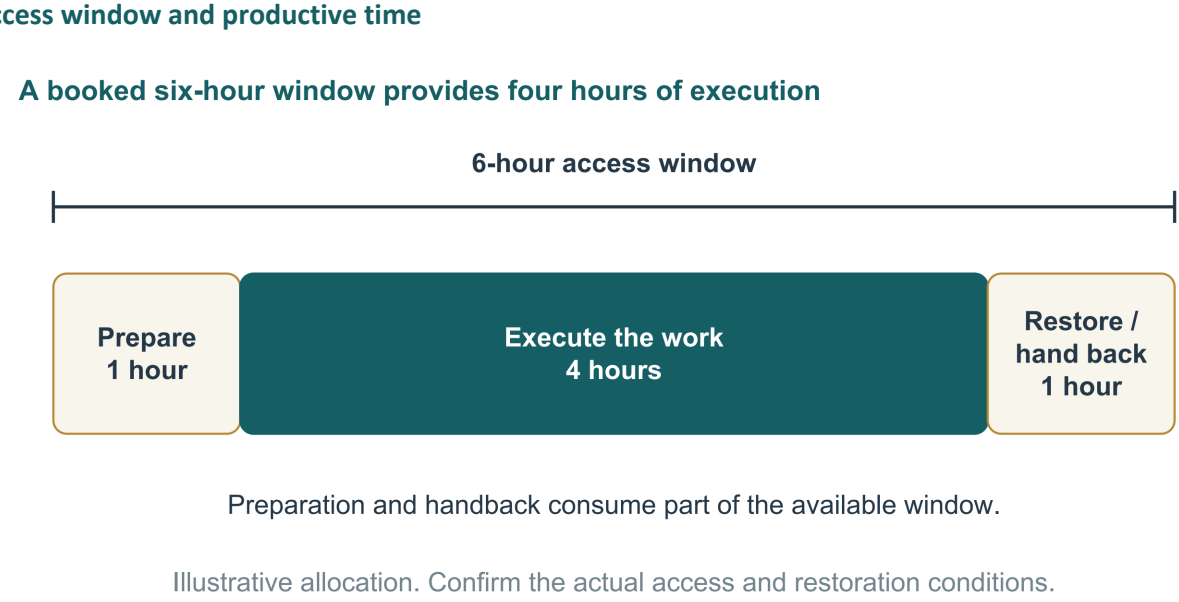


Figure 4.7. An original six-hour access-window illustration. The clock interval available to the project and the time available for productive execution are different quantities.

Network Rail's High Speed Developers Handbook requires allowance for taking and giving up possessions and for isolation arrangements. It also identifies advance planning and resource issues that affect access. The guidance supports separating access-planning lead time from the time available within an approved window. Its route-specific arrangements should not be generalised to every railway. The scheduler should obtain the relevant infrastructure owner's confirmed requirements, then represent the preparation, execution and handback work in the model (Network Rail, 2025, sections 6.6-6.11, pp. 42-44).

Germany and Egypt: an access period is not an activity estimate

DB InfraGO's July 2024 advance notice identified a full Riedbahn closure from 15 July to 14 December 2024 and warned of heavily used diversion routes with limited additional freight capacity. This historical planning notice establishes an access interval and a separate logistical constraint. It does not establish that every activity lasted five months or that crews could work continuously. A scheduling interpretation distinguishes the outer closure, the durations and calendars of work within it, and the transport capacity needed to supply that work. The notice is not evidence of subsequently achieved completion (DB InfraGO, 2024).

Egypt's Ministry of Water Resources and Irrigation reported a June 2026 direction concerning 2.6 km of bottleneck-widening work on Al-Nasr Canal, including 1.5 km intended for the next winter closure. The publication provides a scope quantity and a seasonal access intention, but no exact closure dates, crew sizes or production rates. A credible duration cannot be calculated from those lengths alone. The example shows why the estimator must establish working windows and delivery capacity before judging whether the proposed scope fits the season. The reported quantities are planned work, not claimed completed output (Ministry of Water Resources and Irrigation, 2026).

Separate procurement lead time into meaningful causes

An item's quoted lead time can cover different boundaries: order acceptance to dispatch, approved information to manufacture, or order placement to delivery on site. The planner should establish its start condition, included reviews, calendar basis and delivery endpoint. Manufacturing capacity, inspection appointments, shipping, customs and site receipt can create distinct dependencies. A supplier's eight-week quotation is not enough to establish an installation date if technical approval has not occurred or the promised date excludes transport. Conversely, adding a generic procurement allowance to a quotation that already includes the same work can double count time.

The US Federal Highway Administration's guidance on construction contract time connects production evidence with factors such as fabrication, curing, permits, utilities and material assembly periods. Its advice supports looking beyond the main production operation and adapting estimates to the project conditions. It is established guidance published in 2002, not a newly imposed workweek or a universal rule for every sector. The transferable principle is to make the time drivers explicit, including periods that cannot be shortened simply by adding site labour (FHWA, 2002, sections 5-10).

UAE and France: distinguish a fixed exception from a conditional response

The official announcement of the UAE's 2026 midday work policy specified 15 June to 15 September and a daily 12:30-15:00 restriction for covered outdoor work in direct sunlight, with specified exceptions and protective requirements. That 2026 seasonal period had ended by this chapter's September source check. For planning, the example demonstrates a recurring calendar restriction applied to relevant work, rather than a universal deduction from every project activity. The announcement does not establish an output rate outside those hours or permission to extend working shifts (Dubai Media Incorporated, n.d.; MoHRE, 2025).

France's official 2026 guidance explains a heat framework effective from July 2025, using Météo-France vigilance levels and measures that can include adjusted hours, exposure limits, rest and changed working arrangements. It does not prescribe one nationwide daily closure period. The scheduling implication is conditional: the responsible team must translate the applicable alert, exposure and selected arrangements into calendar and productivity assumptions. A fixed daily exception and a weather-triggered response are different modelling situations, even though both can affect the time available for work (DILA, 2026; DREETS Hauts-de-France, 2026).

Table 4.5 | Calendar conditions in official international examples

Official example	Evidence available	What remains to be estimated or confirmed
UAE, 2026 heat policy	A seasonal daily restriction for covered work, with exceptions	Applicability, actual shifts and output under the agreed arrangements
France, guidance published in 2026	Conditional measures responding to heat exposure and alerts	Local assessment, selected measures and their scheduling effects
Germany, Riedbahn 2024 notice	A planned asset-closure interval and constrained diversion capacity	Activity durations, working patterns and logistical commitments
Egypt, Al-Nasr Canal 2026 direction	Planned quantities and intended winter access	Confirmed dates, resources, production rates and readiness

Seasonal expectations also need to be distinguished from confirmed nonworking periods. Australia's Bureau of Meteorology explains northern rainfall onset using probabilities and regional variation. Its

2022 explanatory publication does not provide a fixed construction closure calendar or a live forecast for this project. A planner can use relevant weather evidence to inform a seasonal working assumption while representing residual uncertainty separately. Converting every possible wet day into a fixed closure, or treating a seasonal probability as a guaranteed date, would misstate what the evidence establishes (Bureau of Meteorology, 2022).

Jamal and colleagues examined 29,539 daily work reports from 161 completed projects of one US state highway agency to develop an approach to adverse-weather-day estimation. Their conference study supports using local, seasonal records of effects on work, rather than generic weather allowances detached from activity conditions. Reporting practices, geography and the activity mix limit transfer to other settings. Historical weather interruptions are evidence for an estimate, not exact future closure dates. Known closures, reduced output during workable periods and uncertain lost days should have distinct, non-overlapping treatment (Jamal et al., 2024).

4.7 Distinguishing original, actual, remaining and total duration

Preserve the original estimate while improving the forecast

> **Original Duration.** 'The activity duration originally assigned to a schedule activity and not updated as progress is reported on the activity. Typically used for comparison with actual duration and remaining duration when reporting schedule progress.' (PMI, 2019, p. 183)

The original estimate provides a reference for understanding how the work was expected to proceed. It is not automatically identical to a separately approved baseline duration. PMI's detailed activity component recognises that software implementation varies and recommends retaining the basis used to determine the estimate (PMI, 2019, p. 104). A model can therefore need both an original estimating record and a controlled baseline reference. Renaming a current forecast as the original estimate loses the comparison that helps explain what has changed.

> **Actual Duration.** 'The time, in calendar units, between the actual start date of the schedule activity and either the data date of the project schedule, if the schedule activity is in progress, or the actual finish date if the schedule activity is complete. See also activity actual duration and project actual duration.' (PMI, 2019, p. 175)

Actual duration is a time measure, not the sum of labour hours charged to the activity. It should be interpreted with the applicable calendar and the tool's treatment of interruptions or suspensions. A six-day actual duration does not prove that six days of continuous production occurred or that a particular quantity was installed. Progress information must preserve the difference between the time that has passed, the resources used and the output achieved. The detailed update processes are developed later in the book, but this distinction is essential from the first estimate onwards.

> **Remaining Duration (RD).** 'The time, in calendar units, which is (a) equal to the original duration for an activity that has not started or (b) between the data date of the project schedule and the finish date of a schedule activity that has an actual start date. This represents the time needed to complete a schedule activity where the work is in progress. See also activity remaining duration and project remaining duration.' (PMI, 2019, p. 188)

Once work has started, the remaining duration should be a current assessment of what is still needed. It need not equal original duration minus actual duration. The remaining quantity, demonstrated production rate, available resources, unfinished reviews and relevant calendar can differ from the original assumptions. PMI's component guidance requires a determination of remaining time when an

activity continues beyond an update cycle (PMI, 2019, p. 105). Automatically subtracting elapsed time can produce an optimistic forecast precisely when the evidence indicates that the work is taking longer.

Reconcile the current total without confusing time and progress

> **Activity Total Duration.** 'The total number of work periods, in calendar units, to complete a schedule activity. For schedule activities in progress, it includes the activity actual duration plus the activity remaining duration.' (PMI, 2019, p. 175)

In Figure 4.8, an activity originally estimated at ten working days has accumulated six working days of actual duration. The responsible team now estimates seven further working days, using the same working-time basis. Its current total duration is therefore thirteen working days. This does not mean that the original estimate has been overwritten or that the project finish has necessarily moved by three days. The network, available float and subsequent calendars determine the wider effect. Nor does the six-day actual duration establish a physical completion percentage: the completed quantity or accepted output must be measured separately.

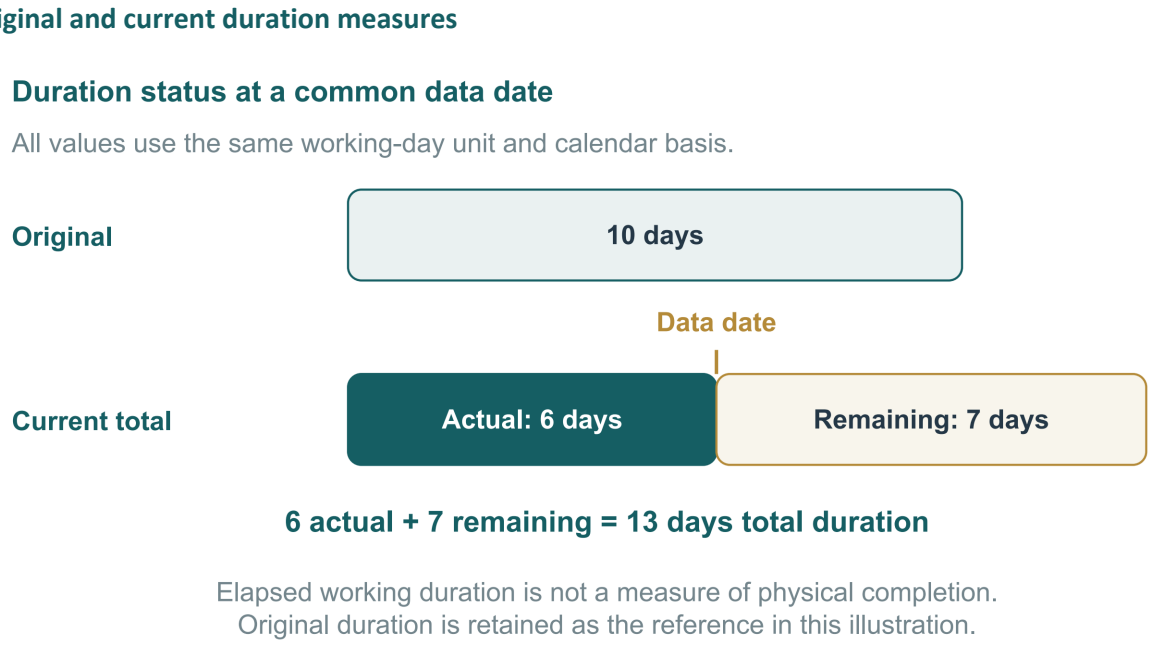


Figure 4.8. An original duration-status example. Actual plus remaining gives the current total on a consistent basis; the original estimate remains a separate reference.

> **Project Total Duration.** 'The total number of work periods, in calendar units, to complete a project. For a project in progress, it includes the project actual duration plus the project remaining duration.' (PMI, 2019, p. 187)

Project total duration is not the sum of all activity durations. Parallel work overlaps, different paths compete to determine completion and calendars affect how activity time maps into project time. PMI records project total duration separately from the activity measure (PMI, 2019, pp. 107, 126). A report that adds every activity's ten-day duration to produce a project duration would therefore confuse the amount of scheduled work with the project's span. The project measure should be derived and interpreted according to the model's defined calculation basis.

Software settings can also alter the relationship between duration, work and resource allocation. Microsoft distinguishes fixed-work, fixed-duration and fixed-units task types and documents which values are recalculated when inputs change. These settings express how the model should respond; they

do not establish the physical feasibility of its result. Before accepting an unexpected change, the scheduler should examine the task type, resource assignments, effort-driven behaviour and calendars, then compare the result with the intended delivery method (Microsoft, n.d.a).

4.8 Documenting and assuring the basis of the estimate

Make the reasoning reproducible

A useful basis of estimate explains the scope boundary, quantity, method, source evidence, units, resource arrangement, productivity and calendar assumptions behind a duration. It also identifies exclusions, uncertainty treatment, the estimator and the date of the assessment. These items should connect to the activity and to the wider basis of schedule. Their purpose is practical: another competent person should be able to understand the result, test important assumptions and determine whether changed circumstances require a revision. A bare number with an author's name is not enough to reproduce the reasoning.

The evidence behind a duration estimate

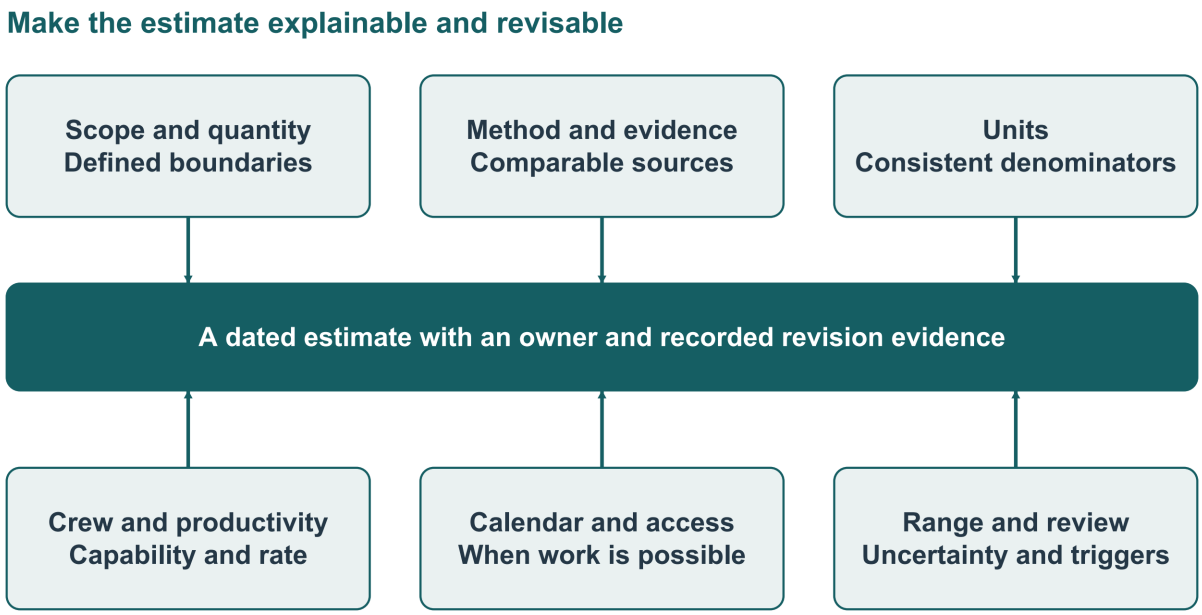


Figure 4.9. An original information model for the basis of a duration estimate. It connects the calculation with its source and delivery conditions, supporting review and subsequent revision.

The estimate should distinguish confirmed information from assumptions and outstanding decisions. An agreed outage, a supplier's indicative quotation and an untested production target have different evidential status. Recording that status helps the team direct attention to assumptions that could change a consequential date. The precision reported should also suit the evidence. A result of 12.483 days is not intrinsically more credible than a reasoned range of eleven to fourteen working days. Keep adequate calculation precision internally, then round or express the outcome in a way that supports the actual planning decision.

Table 4.6 | Testing the basis of a duration estimate

Review question	Example of evidence to examine	What a weak answer could conceal
Is the work boundary complete?	Quantity, included checks and acceptance endpoint	Missing preparation or completion work
Is the rate applicable?	Comparable records, crew, location and denominator	An exceptional shift presented as normal production
Is capacity available?	Resource commitments and work-front assumptions	Double-booked specialists or a physical bottleneck
Is the calendar justified?	Shifts, exceptions, access and tool settings	Work scheduled when it cannot actually occur
Is uncertainty treated consistently?	Scenario descriptions and allowance boundaries	Double-counted effects or omitted exceptional events
Can the estimate be reproduced?	Dated sources, calculations and revision reasons	An unexplained number retained after its basis changed

Challenge the estimate before using it as a commitment

Independent review should test the assumptions with the greatest effect on delivery, rather than merely checking arithmetic. A correct calculation using an unsupported production rate remains weak. A review can compare the estimate with observed performance, challenge the availability of a driving resource and examine a plausible alternative calendar. The resulting sensitivity shows what matters most and where better information would be useful. It should not be presented as a probability analysis unless the scenario weights and distributions have actually been established.

A deterministic model uses specified activity durations for a given calculation. A probabilistic model represents uncertain durations through distributions and examines possible outcomes; PMI distinguishes these approaches in its duration guidance (PMI, 2019, p. 62). Both require credible scope, logic, resources and calendars. Neither removes the need to explain assumptions. As work proceeds, observed performance should improve the remaining estimate, while proposed changes to approved commitments follow the applicable controls. The professional outcome is an intelligible forecast that can withstand challenge and support a decision.

Knowledge check and examination practice

These original questions support PMI-SP Schedule Planning and Development, particularly Task 3 on duration estimation and Tasks 4, 6 and 7 on calendars, constraints and resources (PMI, 2012, p. 4). They are not PMI examination items. Choose the best answer and retain the units and assumptions stated in each question.

Question 1 - Effort and working duration

An activity requires 240 person-hours. Four suitably skilled people can each devote six hours per working day to it. The work is divisible, productivity remains constant and no other constraint applies. What is the estimated working duration?

A Six working days.
B Ten working days.
C Forty working days.
D Sixty working days.

Question 2 - A calendar exception

A task requires 24 working hours and starts at 09:00 on Thursday 5 November 2026. Its calendar permits uninterrupted work from 09:00 to 17:00, Monday to Friday, but Friday 6 November is closed. There are no other exceptions or constraints. When does it finish?

A Friday 6 November at 09:00.
B Friday 6 November at 17:00.
C Monday 9 November at 17:00.
D Tuesday 10 November at 17:00.

Question 3 - PERT calculations

An activity has optimistic, most likely and pessimistic estimates of 4, 7 and 16 working days. What are its conventional PERT weighted mean and approximate standard deviation, respectively?

A 8 working days and 2 working days.
B 8 working days and 4 working days.
C 7 working days and 2 working days.
D 9 working days and 2 working days.

Question 4 - Remaining work

An activity originally estimated at ten working days has six working days of actual duration. Following review of unfinished work, its owner estimates seven further working days on the same basis. Which statement is most defensible?

A Remaining duration must be four days.
B Physical progress must be 60 per cent.
C Current total duration is thirteen days; the original estimate remains a separate reference.
D The project finish must move by exactly three days.

Question 5 - Additional resources

A manager proposes doubling a crew to halve an installation duration. The activity uses a restricted work front and one specialist item of plant. What should the scheduler do first?

A Accept the halved duration because effort and time always have a linear relationship.
B Test the proposed method, bottleneck capacity and resource availability before revising the duration.
C Reject any duration improvement because crews can never be enlarged.
D Retain the original date and record the extra people only in the cost report.

Question 6 - Net access time

A six-hour access window requires one hour of preparation and one hour of restoration and handback. The proposed method needs five execution hours. What does the estimate show?

A The plan fits because five hours is less than six.
B Handback can be omitted from the schedule.
C The execution duration should be reduced to four hours without changing its basis.
D The plan does not fit the stated window and requires a feasible revision to its delivery arrangements.

Question 7 - Interpreting confidence

A team calculates a PERT weighted mean of eight working days and labels it a '95 per cent confidence duration', without any further probability analysis. What is the best response?

A Challenge the label: a weighted mean alone does not establish that completion probability.
B Accept the label because the PERT formula always returns P95.
C Replace eight by the most likely estimate and retain the label.
D Add ten per cent and call the result P95 without further evidence.

Question 8 - Fixed and variable work

A comparable activity required one day of preparation and six days to install sixty items at ten items per day. The new activity contains ninety similar items. Preparation remains one day, with the same supported production rate, resources and working conditions. What is the resulting estimate?

A Nine working days.
B 10.5 working days.
C Ten working days.
D Fifteen working days.

Answer explanations

Question 1 - B

Daily task capacity is 4 × 6 = 24 person-hours. Dividing 240 by 24 gives ten working days. A does not follow the stated calculation. C divides effort by one person's daily hours while ignoring the other people. D divides by the number of people without converting their effort allocation into days. The answer relies on the question's assumptions about divisible work, constant productivity and unrestricted execution.

Question 2 - D

Thursday provides eight working hours. Friday is closed and the weekend is nonworking, so Monday provides the next eight and Tuesday the final eight. Completion is Tuesday at 17:00. A treats working time as a continuous elapsed interval. B ignores both the amount of work and the closure. C would be correct without Friday's exception, but not under the stated calendar. The working duration remains twenty-four hours.

Question 3 - A

The weighted mean is (4 + 4 × 7 + 16) / 6 = 8 days. The conventional standard-deviation approximation is (16 - 4) / 6 = 2 days. B confuses the variance, four days squared, with standard deviation. C substitutes the most likely estimate for the weighted mean. D substitutes the triangular mean. These calculations do not establish a particular probability of completing within eight days.

Question 4 - C

The current total is actual plus remaining duration: 6 + 7 = 13 working days. A assumes that the original estimate dictates unfinished work despite the new evidence. B confuses elapsed working time with physical achievement. D ignores the network, calendars and available float. The updated activity estimate needs to be incorporated into the schedule before its effect on project completion can be assessed.

Question 5 - B

The restricted work front and specialist plant may prevent the larger crew from achieving proportional acceleration. The proposed method and capacity should be tested before changing the estimate. A imposes an unsupported linear assumption. C rejects a potentially useful change without examining it. D separates cost and schedule information without resolving how the added resources would affect delivery. The correct response investigates the mechanism governing production.

Question 6 - D

The window provides only four execution hours after preparation and handback. Five execution hours therefore do not fit the stated arrangement. A compares the wrong quantities. B removes necessary work. C changes the number without establishing a different production basis. A defensible revision might involve method, scope, resources, sequencing or authorised access, but the information given does not establish which alternative is feasible.

Question 7 - A

A mean is not automatically a completion percentile. The probability claim requires an appropriate model and interpretation of its distribution, with network effects considered for a project finish. B invents a property of the formula. C confuses most likely duration with a percentile. D adds an arbitrary allowance and then assigns it unsupported statistical meaning. The team may choose an allowance, but should describe its actual basis.

Question 8 - C

Ninety items at ten per day require nine production days, plus one preparation day: ten working days. A omits preparation. B scales the entire previous seven-day duration by 90/60, including preparation that the question states is fixed. D does not follow the supplied rate. The calculation is conditional on the stated comparability; a real estimate would still test whether changed quantity affects access, resources or acceptance.

Preparing for Chapter 5

The chapter has established how to estimate working time, represent uncertainty and configure the periods in which work can occur. Chapter 5, Building Logic Networks and Analysing the Critical Path, connects those activities through dependencies and develops the calculations that determine early and late dates and float. Retain the distinction between a duration and a date: even a well-supported duration requires credible logic and calendars before the model can forecast delivery.

References and further reading

Australian National Audit Office (ANAO) (2026) *Delivery of Snowy 2.0*, Auditor-General Report No. 39 of 2025-26, 18 June, paragraphs 4.34-4.37. Official audit.

Baerenbold, R. (2023) 'Reducing risks in megaprojects: The potential of reference class forecasting', *Project Leadership and Society*, 4, 100103. https://doi.org/10.1016/j.plas.2023.100103.

Bureau of Meteorology (2022) 'Planning for the northern rains', 19 August. Official explanatory publication.

DB InfraGO AG (2024) 'Erinnerung: Kapazitäten für unterjährigen Güterverkehr während der Totalsperrung Riedbahn', 11 July. Official infrastructure-operator notice.

Direction de l'information légale et administrative (DILA) (2026) 'Chaleur : quelles obligations pour l'employeur ?', *Service Public Entreprendre*, 27 May. Official guidance.

DREETS Hauts-de-France (2026) 'Chaleur et canicule au travail', 25 May, updated 2 September. Official regional-government guidance.

Dubai Media Incorporated (n.d.) 'MoHRE announces return of Midday Work Ban' [announcement for the 2026 season]. Official public-broadcaster publication.

Federal Highway Administration (FHWA) (2002) *FHWA Guide for Construction Contract Time Determination Procedures*, Technical Advisory T 5080.15, 15 October, sections 5-10. Official guidance.

Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-16-89G, December, pp. 63-68. Official guide.

Hulett, D.T. (2000) 'Project schedule risk analysis: Monte Carlo simulation or PERT?', *PM Network*, 14(2), pp. 43-47. PMI publication.

Jamal, M.S., Abdelaty, A., Shrestha, K.J. and Zaman, A.A.U. (2024) 'Improving the Reliability of Adverse Weather Day Estimation in Project Planning: A Framework Utilizing Daily Work Reports', in *Construction Research Congress 2024: Contracting, Delivery, Scheduling, Estimating, Economics, and Organizational Management and Planning in Construction*, pp. 273-282. ASCE. https://doi.org/10.1061/9780784485286.028.

Kanabar, V. and Warburton, R.D.H. (2011) 'Leveraging the new practice standard for project estimating', PMI Global Congress 2011 - North America, Dallas, 22 October. PMI conference paper.

Microsoft (n.d.a) 'Change the task type for more accurate scheduling'. Official product documentation.

Microsoft (n.d.b) 'How Project schedules tasks: Behind the scenes', especially 'How do calendars affect the schedule?'. Official product documentation.

Ministry of Human Resources and Emiratisation (MoHRE) (2025) 'Social Protection and Well-Being Assurance', subsection 'Heat Stress Prevention Policy', reviewed 13 November. Official UAE ministry publication.

Ministry of Water Resources and Irrigation, Egypt (2026) *Minister Sweilem inspects irrigation and pumping stations in Alexandria*, 13 June [Arabic; descriptive English translation of the title]. Official ministry publication.

Mohammadi, M., Vandyousefi, H., Askari, M. and Spross, J. (2025) 'Modelling construction performance variability for probabilistic time estimation of tunnelling projects', *Georisk: Assessment and Management of Risk for Engineered Systems and Geohazards*, 19(3), pp. 497-512. https://doi.org/10.1080/17499518.2024.2422496.

National Audit Office (NAO) (2016) *Modernising the Great Western railway*, HC 781, 9 November, p. 35, paragraph 3.7. Official audit.

Network Rail (High Speed) (2025) *The Developers Handbook*, C-05-OP-32-3001, January preparation records, sections 6.6-6.11, pp. 42-44. Official handbook.

NIST/SEMATECH (n.d.a) 'Normal Distribution', *e-Handbook of Statistical Methods*, section 1.3.6.6.1. Official statistical guidance.

NIST/SEMATECH (n.d.b) 'Confidence Limits for the Mean', *e-Handbook of Statistical Methods*, section 1.3.5.2. Official statistical guidance.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*, p. 4. Official examination outline. Check current candidate information before booking the examination.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: PMI. Citations use printed pages, particularly sections 3.1.2.6, 3.2.1.5, 3.4.3, Section 4 and the Glossary. Formal definitions retain the source wording.

Sadatnya, A., Sadeghi, N., Sabzekar, S., Khanjani, M., Nekouvaght Tak, A. and Taghaddos, H. (2023) 'Machine learning for construction crew productivity prediction using daily work reports', *Automation in Construction*, 152, 104891. https://doi.org/10.1016/j.autcon.2023.104891.

Cases retain their publication context; planned work is distinguished from achieved results. Figures, worked examples, comparison tables and practice questions are original educational material. They are not PMI-prescribed models or official examination items.

CHAPTER 05

Building Logic Networks and Analysing the Critical Path

From a list of activities to a model of delivery

A schedule becomes useful for forecasting when it explains how the work fits together. An activity list can identify every required output and contain carefully estimated durations, yet still fail to show what must happen before another activity can proceed. Dates entered independently may produce an attractive presentation while concealing the consequences of change. A logic network makes those consequences calculable by representing the dependencies between work, decisions and milestones. Its value depends on whether the relationships describe the intended delivery method and the conditions that actually enable progress.

This chapter connects the scope and duration work developed earlier with a dynamic model of delivery. It examines dependency types, the four precedence relationships, forward and backward calculations, critical and near-critical paths, float, date constraints, leads and lags. It then explains how to detect incomplete or misleading logic and test alternative delivery scenarios. A self-contained worked example follows the calculations step by step. The mathematics uses a deliberately simple calendar so that the reasoning is visible before the chapter considers the complications of multiple calendars, external interfaces and progress updates.

For PMI-SP preparation, the central capability is to interpret the network rather than merely recognise its symbols. A scheduling professional should be able to explain why a relationship exists, which predecessor controls a merge, why float is shared and what a change would do to the forecast. At Project Controls Professional Level 6, that explanation should also recognise limitations: a calculated critical path does not establish that resources are available, and a required finish date does not make the planned work achievable. The model provides evidence for decisions when its assumptions remain visible and defensible.

The chapter framework: build, calculate, challenge and maintain

The original framework in Figure 5.1 follows the development of a credible network. Defined scope is translated into justified dependencies, those dependencies are expressed through appropriate relationships, dates are calculated, and the resulting paths and float are interpreted. Validation then challenges both the calculation and the delivery meaning. The process repeats when information, methods, resources or actual progress change. A technically valid network can still represent the wrong sequence, so validation must involve people who understand the work as well as people who understand the scheduling tool.

Logic development and validation framework

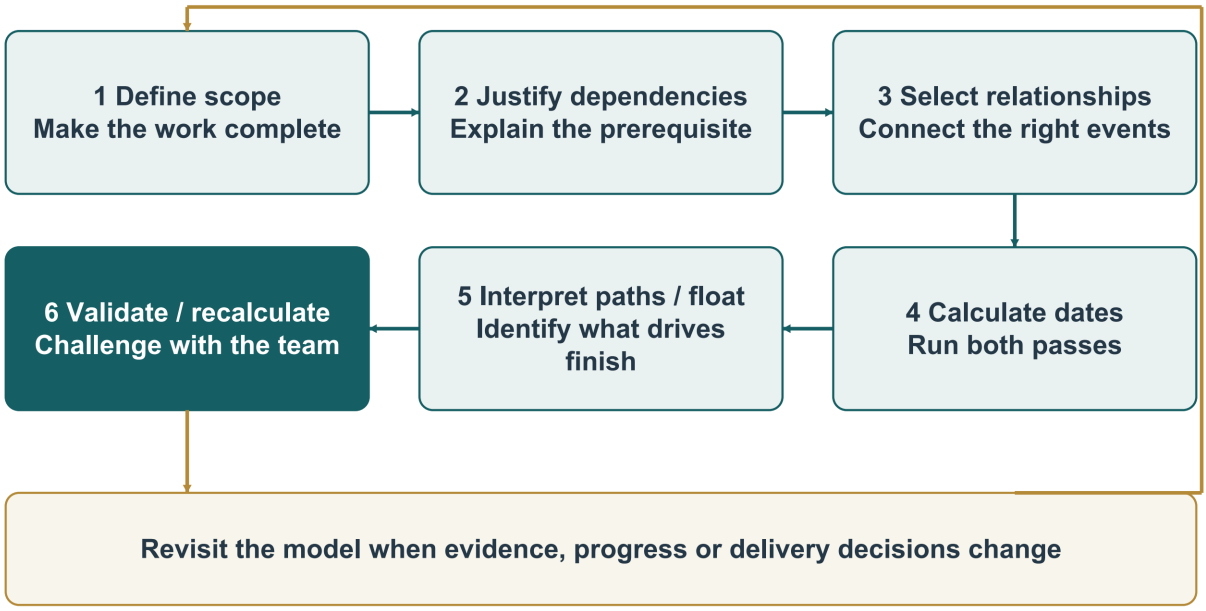


Figure 5.1. An original framework for developing and maintaining network logic. Calculation produces a forecast; challenge and evidence establish whether that forecast represents a credible delivery plan.

5.1 Establishing defensible dependencies

Explain the condition that enables the next activity

> **Logical Relationship.** 'A dependency between two activities or between an activity and a milestone. See also finish-to-finish, finish-to-start, start-to-finish, and start-to-start.' (PMI, 2019, p. 182)

A useful dependency identifies an enabling condition. A foundation must reach the required accepted state before a supported element can be installed; a verified information release may be needed before manufacture; an operational decision may be required before a new service can begin. The relationship should explain which event or state matters, not merely reproduce the order of rows in a spreadsheet. Two activities being managed by the same department does not establish that one must follow the other. Conversely, work in different organisations can have a strong dependency that must be represented in the integrated plan.

The receiving team's requirement is particularly important. 'Drawing issued' may not mean 'drawing accepted for construction'. If the successor needs accepted information, the review and release work must be represented somewhere in the model. A finish-to-start arrow cannot compensate for incompatible meanings of completion. Chapter 3 established activity boundaries and acceptance conditions; the network uses those boundaries to connect the output actually produced with the input actually required. This is why logic workshops should examine the content and state of handovers as well as dates.

Distinguish the reason for a dependency from its location

Mandatory and discretionary dependencies concern the reason for the sequence. Mandatory dependencies arise from a necessary technical, physical or other binding condition. Discretionary dependencies reflect a selected approach where another sequence might be feasible. The distinction affects how alternatives are evaluated. A preference to complete one area before another may be changed after review; a required test or permission cannot be removed simply because it delays the preferred finish. The planner should record the rationale and the authority needed to change it, rather than rely on an unexplained classification code.

Internal and external dependencies concern the boundary across which the relationship operates. An internal relationship connects activities within the project; an external relationship connects project and non-project activities, usually involving a condition outside the team's direct control. Limited control over contracted work does not by itself place that work outside the project boundary. These classifications form a different dimension from mandatory and discretionary. An external regulatory decision can be mandatory, while an internal sequence can be discretionary. Treating the four labels as mutually exclusive categories loses this distinction and can obscure which changes require agreement with another party.

Table 5.1 | Interpreting dependency classifications

Dependency perspective	What it asks	Example of the planning implication
Mandatory	Is the sequence required by a necessary condition?	Preserve the prerequisite unless its underlying requirement is legitimately changed
Discretionary	Does the sequence reflect a chosen method or preference?	Examine feasible alternatives and their consequences before revising it
Internal	Is the enabling work managed within the project boundary?	Connect accountable owners and maintain the relationship during updates
External	Does the relationship connect project and non-project activities?	Identify the source, owner, evidence and status of the external commitment

Connect the network through identifiable boundaries

PMI's sequencing guidance calls for connected activities and milestones, with the project start and finish providing the appropriate boundary exceptions (PMI, 2019, pp. 17, 59). A project-start milestone establishes the entry point; a project-finish milestone collects the work required to achieve the defined completion state. Intermediate milestones can make important releases visible, but they do not perform the preparation, review or testing that creates those releases. Those time-consuming actions require their own activities when they matter to the forecast.

A network should represent all required routes to completion. It is not sufficient to connect only the construction sequence while leaving training, information, integration or approvals outside the calculation. Nor should the planner force unrelated work into an artificial chain merely to eliminate open ends. The correct connection follows the actual delivery condition. If an activity has no clear predecessor or successor, the first response is to investigate its scope and purpose. A missing relationship can reveal missing work, an unclear completion condition or an activity that has been placed in the model without a defensible basis.

5.2 Selecting and interpreting precedence relationships

Read the relationship from the predecessor's event to the successor's event

> **Precedence Diagramming Method (PDM).** 'A technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed. See also node and project schedule network diagram.' (PMI, 2019, p. 184)

The two letters in a relationship identify the relevant predecessor event followed by the relevant successor event. Finish-to-start therefore connects the predecessor's finish to the successor's start. Start-to-finish connects the predecessor's start to the successor's finish. The arrows represent requirements that must be satisfied; they do not necessarily mean the successor occurs immediately when the predecessor event occurs. Other predecessors, calendars, resources or constraints can make it occur later. Reading each relationship as a minimum condition prevents several common misunderstandings.

> **Finish to Start.** 'The logical relationship where initiation of work of the successor activity depends upon the completion of work of the predecessor activity.' (PMI, 2019, p. 117)

Finish-to-start, usually abbreviated FS, is appropriate when the successor needs the completed predecessor output. For example, installation may require accepted delivery of the specific equipment to be installed. PMI identifies FS as the most commonly used relationship and notes that it generally provides the simplest calculation (PMI, 2019, p. 59). Simplicity is useful, but the choice should still describe the work. Requiring an entire large design package to finish before any installation starts can be unnecessarily restrictive when separately accepted releases genuinely permit phased execution.

> **Start-to-Start.** 'A logical relationship in which a successor activity cannot start until a predecessor activity has started. See also finish-to-finish, finish-to-start, start-to-start, and logical relationship.' (PMI, 2019, p. 191)

An SS relationship can represent a supported overlap, such as beginning a follow-on operation after the preceding operation has started and established the required working front. It does not mean both activities must start at the same time, maintain the same production rate or finish together. If the predecessor later takes much longer, an SS link alone may leave the successor's finish unaffected. The planner should examine whether the successor also depends on later outputs and whether the work should be divided into more meaningful releases.

> **Finish-to-Finish.** 'A logical relationship in which a successor activity cannot finish until a predecessor activity has finished. See also finish-to-start, start-to-finish, start-to-start, and logical relationship.' (PMI, 2019, p. 181)

An FF relationship constrains the successor's finish. For example, a final compilation of operating records may need the final test results before it can be completed, although preparation can begin earlier. The relationship does not establish every condition needed to begin that preparation. If the successor also needs an initial approved information package, its start needs the appropriate connection. FF is therefore not a substitute for examining the whole activity boundary. A network can contain many visible arrows while leaving important start or finish conditions unrepresented.

> **Start-to-Finish.** 'A logical relationship in which a successor activity cannot finish until a predecessor activity has started. See also finish-to-finish, finish-to-start, start-to-start, and logical relationship.' (PMI, 2019, p. 191)

An SF relationship is uncommon but can describe a transfer of continuing coverage: the outgoing coverage cannot finish until the incoming coverage has started. Here the incoming activity is the logical predecessor even though the outgoing activity may have begun earlier in clock time. The condition must reflect the actual transfer requirement; a nominal start is insufficient if accepted readiness or a period of overlap is required. The scheduler should avoid SF merely to make dates appear in a desired order when a clearer sequence of preparation and handover activities is available.

The four precedence relationships

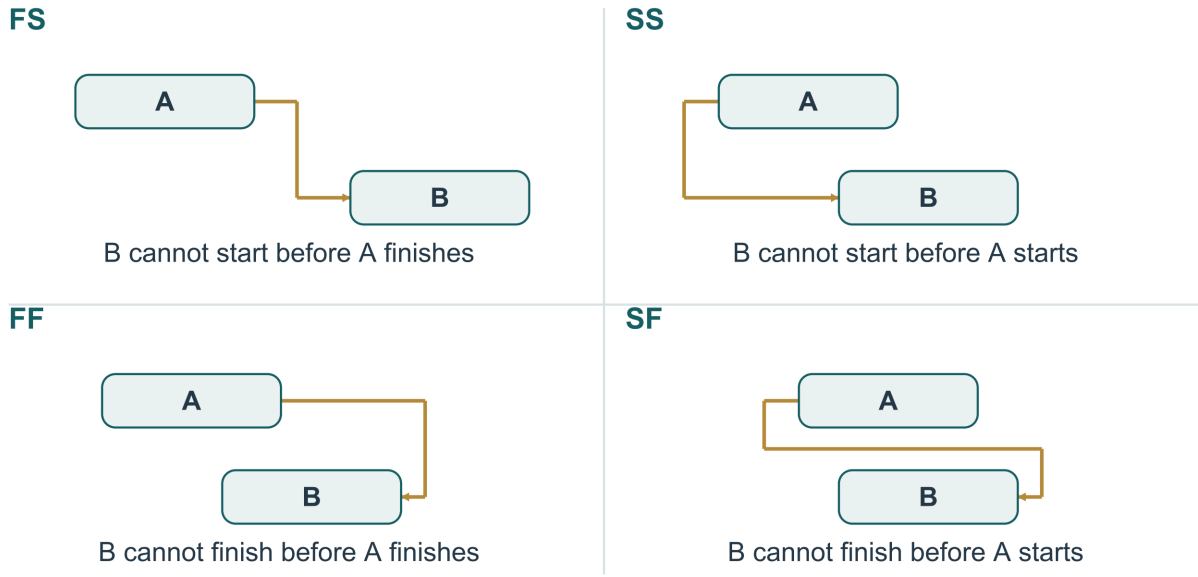


Figure 5.2. Original relationship illustrations. A is the predecessor and B the successor. Each arrow connects the specified events and establishes a lower-bound condition; it does not require immediate equality of their dates.

Use algebra to check the meaning, then apply the calendar

For two activities A and B on a common continuous working-time scale, the following expressions show the minimum condition when a lag L is added. S means start and F finish. A positive lag delays the relevant successor event; a negative value represents a lead. These expressions clarify the logic, but applying a lag to calendar dates requires the scheduling tool's chosen lag calendar and calculation rules. They should not be used to add ordinary clock days indiscriminately to dates in a model containing different working patterns.

Table 5.2 | The four precedence relationships

Relationship	Minimum condition on the common time scale	What it does not establish by itself
FS	S(B) ≥ F(A) + L	That B starts immediately after A finishes
SS	S(B) ≥ S(A) + L	That A and B finish together or progress at the same rate
FF	F(B) ≥ F(A) + L	That every prerequisite for B's start has been satisfied
SF	F(B) ≥ S(A) + L	That a nominal start is sufficient evidence of an accepted transfer

Generalised relationships can produce behaviour that is less intuitive than a simple FS chain. Suppose A starts at time zero and lasts ten days, while B lasts two days and has only an FF zero-lag relationship from A. B cannot finish before day ten; with a fixed two-day duration, its earliest placement under that relationship is day eight to day ten. This does not demonstrate that day eight is a practically valid start: any separate input or access condition still needs to be represented. Calculations should expose the implications of the chosen logic, while review tests whether the logic is complete.

Bianco, Caramia and Giordani (2022) develop a mathematical method for examining criticality and flexibility in networks with generalised precedence relations. Their analysis includes minimum and maximum temporal lags, fixed non-preemptive activities and unlimited resources, and uses constructed examples to demonstrate problems with earlier classifications. For the scheduling professional, the useful lesson is that richer relationship structures require more careful interpretation: shortening an activity need not produce the intuitive effect on completion. This theoretical work does not invalidate elementary CPM; it explains why the assumptions behind a calculation must be stated before its conclusions are applied elsewhere.

5.3 Calculating the network step by step

> **Critical Path Method.** 'A method used to estimate the minimum project duration and determine the amount of scheduling flexibility on the network paths within the schedule model. See also critical path.' (PMI, 2019, p. 178)

The critical path method answers two related questions. First, given the dependencies and durations, when could the represented work finish? Second, how late could each activity occur without violating the chosen completion requirement? The first question requires a forward pass; the second requires a backward pass. Comparing the results reveals the flexibility in the network. A calculation is only as credible as the inputs and assumptions behind it: omitted work, unrealistic durations or unavailable resources can invalidate the delivery interpretation even when every numerical operation is correct.

Establish the example and its time convention

Consider a small control-system readiness package with eight activities. Interfaces must be agreed before the hardware, application and operating instructions are developed. Hardware needs bench testing before integration, and integration needs the application. Operators can be briefed after the instructions are prepared. The acceptance demonstration needs both completed integration testing and briefed operators. This is an independent teaching example with invented durations; it is not a reconstruction of any real project described later in the chapter.

All activities use one common working-day calendar, fixed durations and FS relationships with zero lag. Resources are assumed sufficient, no intermediate date constraints apply, and the network has one start and one finish milestone. Time is measured from boundary zero. An activity starting at zero with a duration of three finishes at boundary three, and its successor may begin at three. This boundary convention avoids the inclusive-date adjustment sometimes used in examination questions that label the first working day as Day 1. Before calculating, establish which convention the question or scheduling system uses and apply it consistently.

Table 5.3 | Activities and assumptions for the worked network

ID	Activity	Duration: working days	Immediate predecessors
S	Start milestone	0	None: network boundary
A	Agree interfaces	3	S
B	Configure hardware	4	A
C	Develop application	6	A
D	Bench-test hardware	3	B
E	Integration test	4	C and D
G	Prepare instructions	2	A
H	Brief operators	1	G
F	Acceptance demonstration	2	E and H
Z	Finish milestone	0	F

The worked logic network

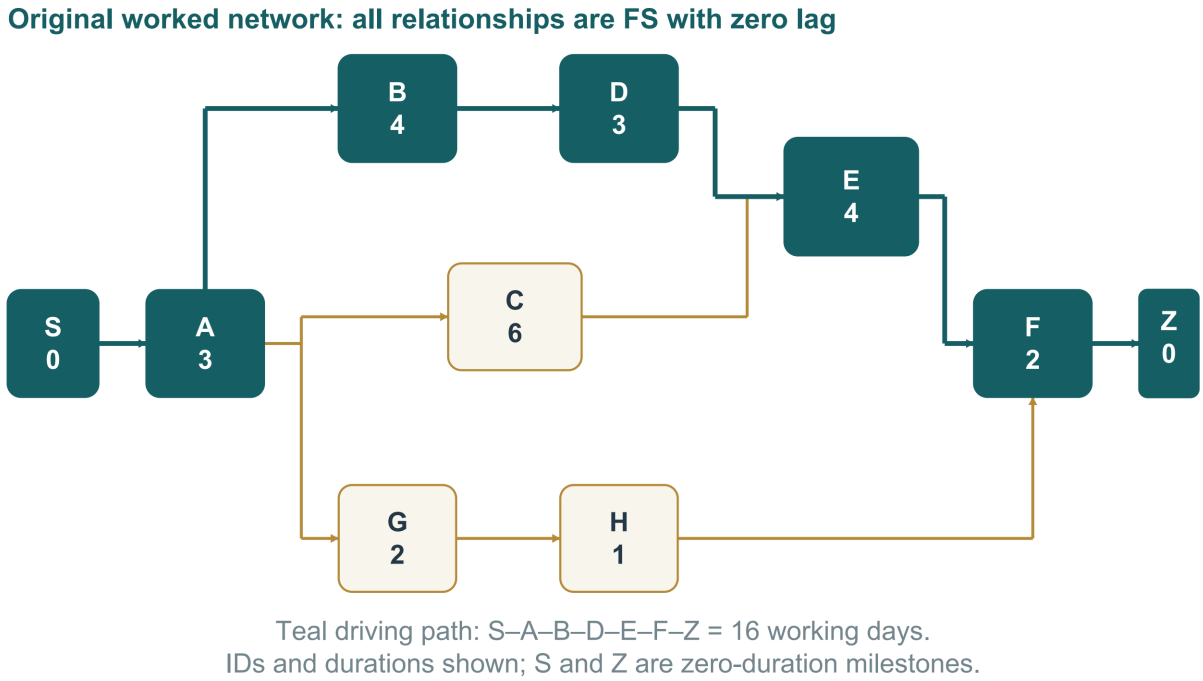


Figure 5.3. The original control-system example. The highlighted hardware, integration and acceptance sequence determines the earliest finish of 16 working days under the stated assumptions.

The forward pass: satisfy the latest arriving prerequisite

> **Forward Pass.** 'A critical path method technique for calculating the early start and early finish dates by working forward through the schedule model from the project start date or a given point in time. See also backward pass.' (PMI, 2019, p. 181)

The activity early start and early finish fields describe the earliest placement permitted by the current model. For this simple network, early finish equals early start plus duration: **EF = ES + duration**. Where an activity has several predecessors, its early start is the largest of their early finishes: **ES = maximum predecessor EF**. The maximum is necessary because every required prerequisite must be satisfied. Taking the smallest value would allow the successor to start while another required input was still incomplete.

Activity A starts at zero and finishes at three. B, C and G can therefore begin at three; their early finishes are seven, nine and five respectively. D follows B and finishes at ten. E must wait for both C and D, so its earliest start is the greater of nine and ten: ten. E then finishes at fourteen. H follows G, starting at five and finishing at six. F waits for E and H, so its earliest start is fourteen and its finish is sixteen. The finish milestone Z is therefore at sixteen. The shorter preparation branch is necessary for acceptance, although it does not control the earliest acceptance date in this initial calculation.

At project level, the project early start is the early boundary from which the represented project can begin; here it is zero. The project early finish is the earliest finish produced at the project boundary; here it is sixteen. A project start constraint can supply the forward-pass starting boundary, but it should not be used as a substitute for modelling genuine predecessors. These early dates are calculated consequences of the model, not contractual commitments or evidence that the organisation has authorised execution (PMI, 2019, pp. 101, 122 and 126).

The backward pass: respect the tightest downstream requirement

> **Backward Pass.** 'A critical path method technique for calculating the late start and late finish dates by working backward through the schedule model from the project end date. See also forward pass.' (PMI, 2019, p. 176)

For the initial unconstrained example, set the finish milestone's late date equal to its early date of sixteen. The backward pass then establishes the latest activity dates consistent with that finish. For the same simple FS network, **LS = LF − duration**, while **LF = minimum successor LS**. The minimum is necessary because an activity must finish in time for every successor that depends upon it. Choosing a larger downstream value would protect one successor while potentially delaying another.

F must finish by sixteen, so its late start is fourteen. E and H must both finish by fourteen; their late starts are ten and thirteen respectively. C and D must finish by E's late start of ten, giving late starts of four and seven. B must finish by D's late start of seven, so B's late start is three. G must finish by H's late start of thirteen, giving a late start of eleven. A feeds B, C and G, whose late starts are three, four and eleven. The minimum is three: A must finish by three and start at zero.

The activity late start and late finish fields therefore describe permissible late placement relative to the selected end requirement and other model conditions. They do not automatically prescribe the preferred execution dates. Starting all noncritical activities at their late dates would consume flexibility and may create resource or interface difficulties. At the project boundary, the project late finish is sixteen in this first calculation, and the backward-derived project late start is zero. A different finish requirement changes the late-date calculation; it need not change the earliest achievable forward forecast (PMI, 2019, pp. 63, 102 and 123).

Forward and backward calculation at the integration merge

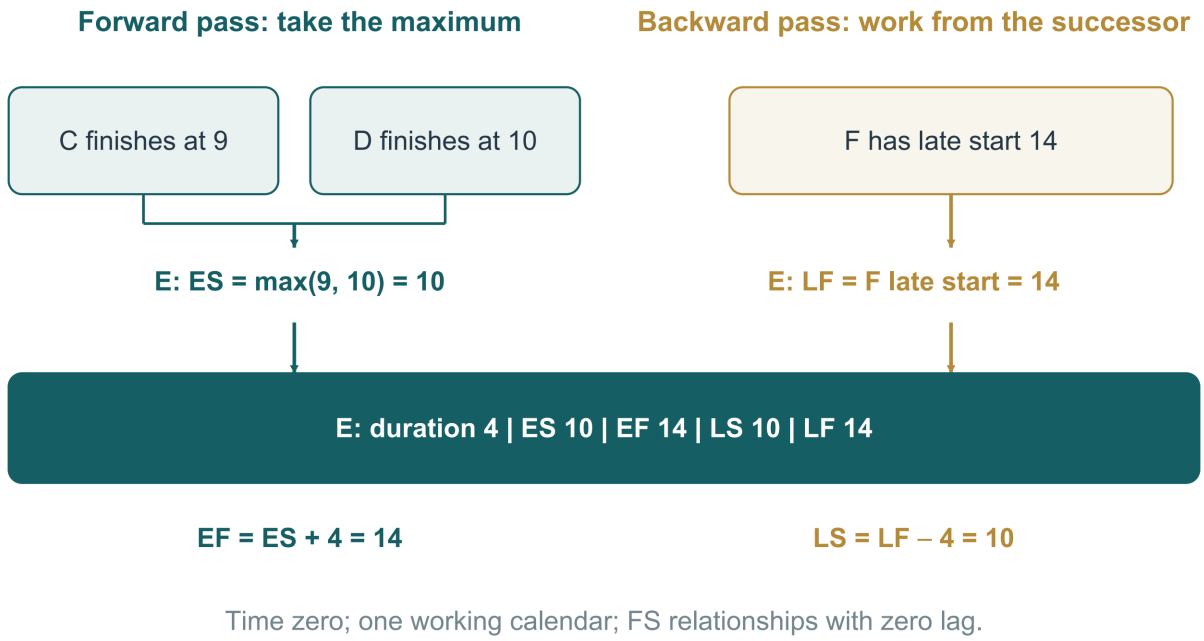


Figure 5.4. The forward pass uses the latest prerequisite arrival. The backward pass uses the earliest downstream requirement. In this example E starts at ten and finishes at fourteen in both passes.

Calculate and interpret the complete result

In this network, total float is **TF = LS − ES = LF − EF**. Free float is **FF = minimum immediate-successor ES − EF**. These elementary expressions apply here because the links are FS with zero lag, all activities share one working-time basis, and the boundary treatment is consistent. They should not be transferred unchanged to SS, FF or SF relationships, lagged links or different calendars. For a terminal activity, the explicit finish milestone provides a successor against which the final interface can be assessed.

Table 5.4 | Complete critical path and float results

ID	Duration	ES	EF	LS	LF	TF	FF
A	3	0	3	0	3	0	0
B	4	3	7	3	7	0	0
C	6	3	9	4	10	1	1
D	3	7	10	7	10	0	0
E	4	10	14	10	14	0	0
F	2	14	16	14	16	0	0
G	2	3	5	11	13	8	0
H	1	5	6	13	14	8	8

The table is a calculation record, but the professional explanation lies in the relationships between its values. C has one day of flexibility because the hardware branch reaches E one day later. G has eight days of total float but no free float because H is scheduled immediately after it. Moving G alone therefore moves H's early dates, even though acceptance can remain unchanged. A, B, D, E and F have no flexibility relative to the initial sixteen-day finish. Their connected sequence, rather than their appearance in a sorted table, explains the current controlling path.

The start milestone has early and late dates of zero; the finish milestone has early and late dates of sixteen. Summing durations along each complete FS path gives sixteen for S–A–B–D–E–F–Z, fifteen for S–A–C–E–F–Z and eight for S–A–G–H–F–Z. This path-length check independently supports the pass calculations. It is suitable for this example; adding every full activity duration along a sequence containing overlaps would not produce an equivalent check without accounting for the relationship endpoints and lags.

5.4 Interpreting critical paths and float

Critical Path. 'The sequence of activities that represents the longest path through a project, which determines the shortest possible duration. See also critical path activity and critical path method.' (PMI, 2019, p. 178)

The critical path identifies the sequence currently governing the selected completion point under the model's assumptions. It is not a permanent label attached to particular activities. A duration change, different delivery sequence, calendar revision or progress update can transfer control to another path. The selected endpoint also matters: the path governing an intermediate regulatory release may differ

from the path governing final completion. A useful critical-path narrative therefore identifies the endpoint, describes the connected driving sequence and explains the evidence supporting its durations and dependencies.

Total Float. 'The amount of time that a schedule activity can be delayed or extended from its early start date without delaying the project finish date or violating a schedule constraint. See also free float, critical path, and near-critical activity.' (PMI, 2019, p. 192)

Free Float. 'The amount of time that a schedule activity can be delayed without delaying the early start date of any successor or violating a schedule constraint. See also total float, critical path, and near-critical path.' (PMI, 2019, p. 181)

Total float and free float protect different boundaries. Total float relates an activity to the relevant downstream completion requirement; free float concerns its immediate successor interface. Both are calculated outcomes, not additional work allowances. The source of flexibility should be understood before it is used. A large value may reflect a genuinely shorter branch, but it may also result from missing logic, a remote imposed finish or a disconnected milestone. Neither value establishes that delaying the activity is desirable, that a supplier can absorb the change, or that the activity's resources are available at the later time.

Float is shared through the path

G and H each show eight days of total float in the worked example, but their branch does not contain sixteen spare days. G can move from day three to day eleven only if H also moves, finishing at fourteen just before F begins. Once this happens, the branch has used its available eight-day separation from acceptance. Giving another eight days to H would delay F. The same principle applies when float is used through duration growth rather than a postponed start. A planner must recalculate the whole affected chain after a change instead of treating each row's original float as a separately available allowance.

Shared total float and immediate interface float

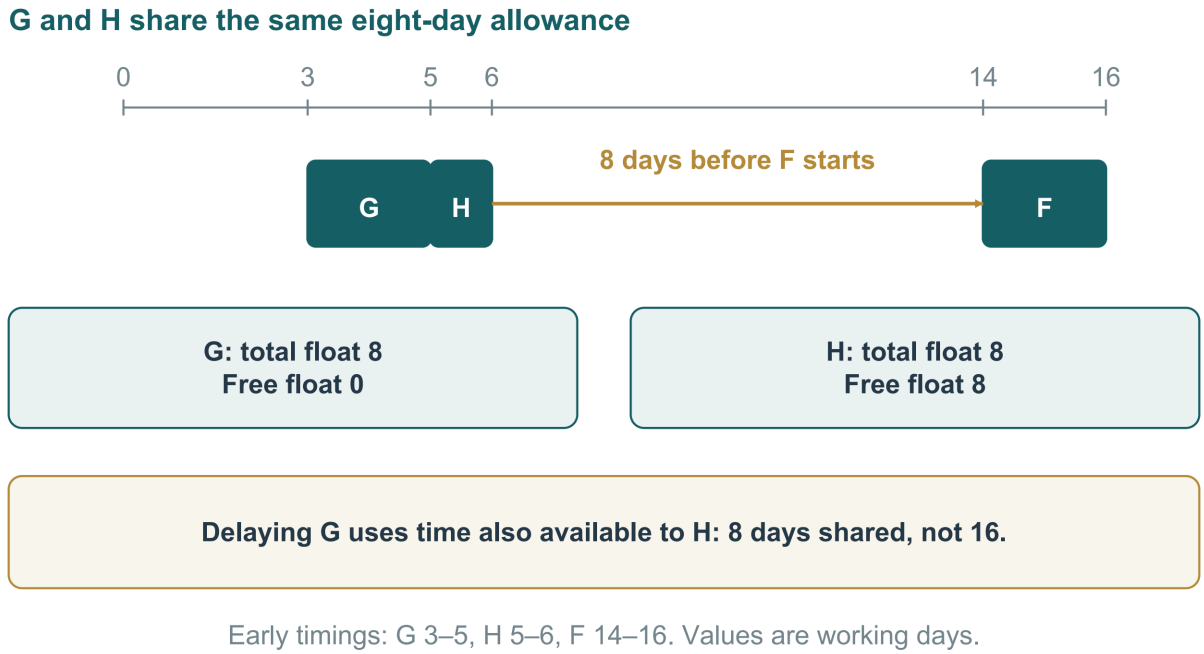


Figure 5.5. G and H share eight days of total float. G has zero free float because H follows immediately. H has eight days of free float before acceptance starts at fourteen.

Calendar interpretation is equally important. On a Monday-to-Friday calendar working 09:00–17:00, a predecessor finishing at 17:00 on Friday 6 November 2026 and a successor starting at 09:00 on Monday 9 November 2026 have no intervening working hours. The ordinary elapsed gap is 64 hours, with no daylight-saving change during that interval, but it is not 64 hours of usable working float. With different activity or relationship calendars, even apparently simple date subtraction requires care. State the calendar basis and inspect the calculation settings before explaining a float value to decision-makers.

Near-critical and multiple critical paths

> **Near-Critical Path.** 'A sequence of activities with low float which, if exhausted, becomes a critical path sequence for the project. See also critical path, free float, and total float.' (PMI, 2019, p. 183)

The application branch is initially one day shorter than the controlling hardware branch. If C increases from six to seven days, both branches reach E at ten and two equally long paths govern the same final milestone. Multiple critical paths do not require multiple project finishes. If C increases to eight days, E starts at eleven and project completion moves to seventeen; the application branch then controls. Conversely, shortening B by two days brings the hardware branch to E at eight, but C still arrives at nine. Completion improves by only one day, to fifteen. The benefit of acceleration is limited by the next controlling path.

There is no universally suitable number of days for a near-critical threshold. A one-day margin may be significant for a short installation; a longer project may need a wider review band because of update intervals, uncertainty and interface exposure. The threshold should support the decision being made and be disclosed in reporting. Vazquez et al. (2023), combining a network model with data from 77 projects, show that delay propagation involves the wider activity network. Their study supports monitoring connections and paths beyond those initially labelled critical. It does not mean that every noncritical delay changes completion or that deterministic CPM calculations can be ignored.

Separate the driving path from the critical-colour display

A software flag may classify activities as critical using a total-float threshold, while another setting traces the longest path. These are related but not identical questions. Oracle's P6 Professional documentation, for example, provides both approaches and notes the complications created by multiple calendars. An activity can appear critical because a local imposed date generates negative float even when it does not govern the overall earliest finish. Equally, a driving path can show positive float if the chosen required finish is later than the calculated earliest finish. Review the selected endpoint and trace the actual drivers instead of treating a colour filter as a complete explanation (Oracle, n.d.).

Mathematical criticality also differs from importance to safety, acceptance, cost or public service. Briefing operators remains essential even when it has substantial float. A Level 6 professional should explain how scheduling priorities interact with these other obligations, rather than interpreting noncritical as optional. Float calculations alone do not determine contractual ownership, compensation or entitlement to an extension of time. Those questions require the relevant agreement and evidence; the network contributes timing analysis rather than a legal conclusion.

5.5 Representing date constraints without hiding the forecast

A dependency expresses a relationship between events; a date constraint places a boundary on when an event may occur. The distinction matters because a date does not explain the work required to achieve it. A verified access release may justify a start boundary, while a required operational opening may justify a finish requirement. Neither should silently replace the relevant delivery logic. Record the constraint's source, reason, owner and review condition, then examine how the chosen scheduling tool applies it to the forward and backward calculations (PMI, 2019, pp. 76–77).

Compare the constraint families

The following comparison organises the standard's date fields by the event affected and the type of boundary. It describes their intended scheduling role, not a universal promise about software behaviour. Products may distinguish settings that have similar names, and some fixed-date treatments can override logic or suppress useful float signals. A scheduler should test the actual product and configuration with a small, understood example before using a constraint to represent an important commitment.

Table 5.5 | Comparing date-constraint families

Constraint family	Intended role in the model	Question for professional review
Start Not Earlier Than; Finish Not Earlier Than	A lower boundary on the relevant start or finish, considered in early-date calculation	What genuine release or availability condition prevents an earlier event?
Start Not Later Than; Finish Not Later Than	An upper requirement for the relevant event, considered in late-date calculation	Can the calculated early dates meet the requirement, or does a conflict need resolution?
Start On; Finish On	Fixed-date treatment affecting start or finish; the standard warns of overriding CPM logic	Is fixing the event necessary, and will the setting conceal an unmet prerequisite?
Mandatory Start Date; Mandatory Finish Date	Strong imposed dates whose treatment can override calculated logic	What does this product do to early dates, late dates and float when logic conflicts?
Project Start Constraint	Boundary from which the project's forward calculation begins	Is the start authorised and are genuine external prerequisites still connected?
Project Finish Constraint	Required project-end boundary for backward calculation	How does the required finish compare with the calculated project early finish?

Constraint comparison based on PMI (2019), pp. 115–119, 123, 126 and 132–133. Similar labels should not be assumed to behave identically across scheduling products.

A start-not-earlier-than condition may be appropriate where site access begins on a verified date and the external access process is outside the model. If access depends on a changing enabling project, however, a dated constraint can become stale. An owned interface milestone with a maintained forecast can make the dependency easier to manage. A finish-not-later-than requirement can preserve the distinction between an achievable forecast and a required date when the tool uses it in late-date calculation. It does not physically accelerate the preceding activities. Fixed-on or mandatory dates require particular care because apparent compliance in the displayed bar may coexist with incomplete prerequisites.

ASAP, ALAP and Expected Finish are different decisions

As Soon As Possible and As Late As Possible describe placement preferences within the scheduling model. ASAP schedules work at its permitted early position; it does not mean that every activity starts on the project start date. ALAP places work towards its permissible late position, subject to the product's calculation rules. That may support a justified delivery approach, such as avoiding premature availability, but can consume flexibility and concentrate resource demand. Choosing ALAP does not remove dependencies or establish that delayed execution is prudent. The standard identifies both components as tool-dependent, so the planner must understand their behaviour in the actual model (PMI, 2019, p. 108).

Expected Finish has a more specialised meaning in the standard than the everyday phrase 'expected completion'. It is a date constraint associated with an in-progress activity's early and late finish, and its use can influence the remaining duration calculated by the tool (PMI, 2019, pp. 115 and 180). It should not be confused with a forecast derived independently from measured remaining work. If a preferred finish date is entered and the resulting duration is then presented as evidence that the date is achievable, the reasoning becomes circular. Establish the remaining work and productive capacity, understand the field's behaviour, and explain whether the date is an input or an output.

An earlier required finish exposes negative float

Return to the worked network and introduce a required finish at day fourteen while retaining the forward-pass forecast of sixteen. For this teaching comparison, use fourteen as the late-finish boundary in the backward pass; do not force the early finish to fourteen. F must now finish by fourteen and start by twelve. E must finish by twelve and start by eight. D must finish by eight and start by five; B must finish by five and start by one; A must finish by one and start at minus two. The calculation has exposed a two-day conflict between the earliest represented delivery and the requirement.

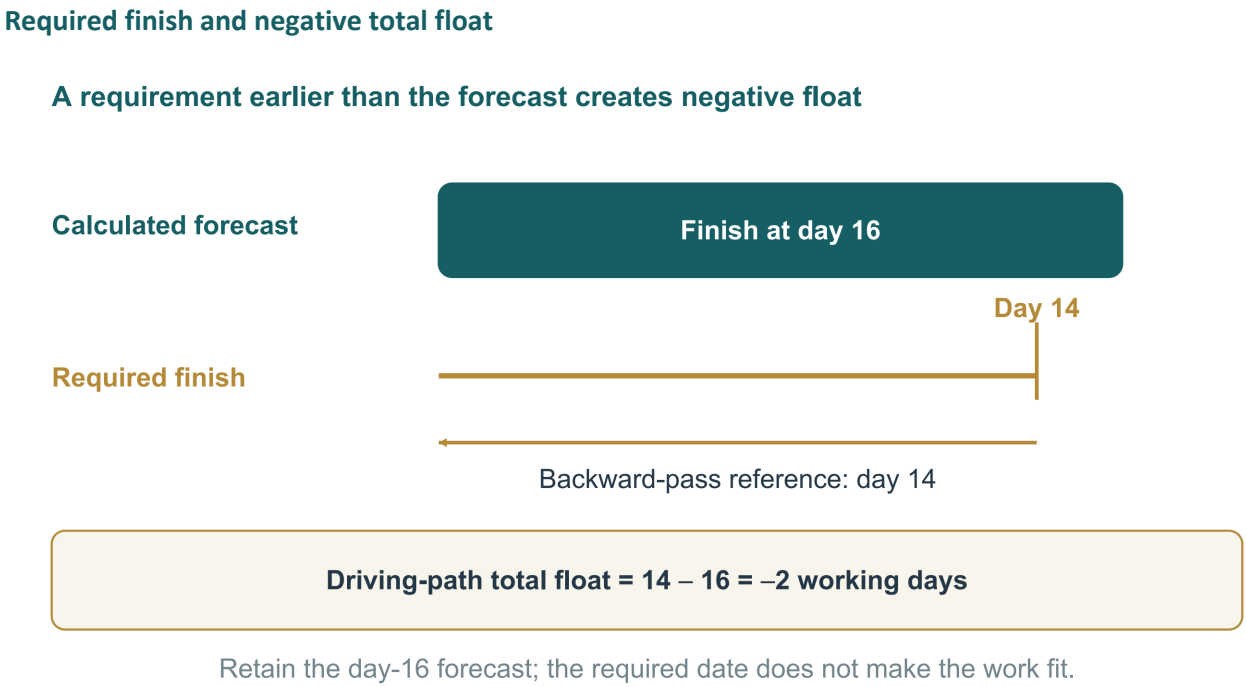


Figure 5.6. An earlier backward-pass requirement changes late dates and float. The forward forecast remains sixteen. The two-day difference is evidence of a problem to resolve, not evidence that completion has been accelerated.

The main driving sequence A–B–D–E–F now has total float of minus two. C has late start two against early start three, giving minus one. G and H each have six days of total float. Several activities can therefore have negative float without all belonging to the same longest path. The project's late start of

minus two means the unchanged plan would have needed to begin before the chosen time-zero boundary to satisfy the new finish requirement. It is not permission to backdate actual progress or assume that an unauthorised earlier start occurred.

In this comparison the early dates, and thus the elementary free-float values derived from them, remain unchanged. H still has eight days before F's early start, even though its total float against the tighter required finish is six. This illustrates why a general statement that free float must always be less than total float is unsafe outside a consistent unconstrained calculation. The response to negative float is to investigate a credible change to scope, sequence, resources, duration or the requirement, and assess the consequences. Changing settings merely to remove the warning leaves the delivery problem unresolved.

5.6 Using leads and lags transparently

Lag. 'The amount of time whereby a successor activity will be delayed with respect to a predecessor activity. See also lead.' (PMI, 2019, p. 182)

Lead. 'The amount of time whereby a successor activity can be advanced with respect to a predecessor activity. See also lag.' (PMI, 2019, p. 182)

A lag modifies the interval between the two events named by a relationship. In a simple FS relationship with a three-day lag, the successor cannot start until the predecessor finishes plus the specified interval. With SS, the interval is measured from the predecessor's start; with FF, it relates the finish events. The calculation must use the intended calendar and units. Three working days, three elapsed days and a percentage of an activity duration are different rules, and a schedule containing multiple calendars can produce unexpected dates if that distinction is overlooked.

Make identifiable work visible

Suppose a submission is followed by FS plus three days before the next activity. If the three days represent an identifiable review, the network is more informative when it contains 'Review submission' as an activity, with an owner, estimated duration and accepted completion condition. A lag cannot record the reviewer's remaining effort or explain whether comments have been resolved. Replacing it with visible work also allows the schedule to represent uncertainty and progress at the appropriate point. Under the same calendar and duration assumptions, the initial dates may be identical; the management information is substantially different (PMI, 2019, pp. 59–61 and 81–82).

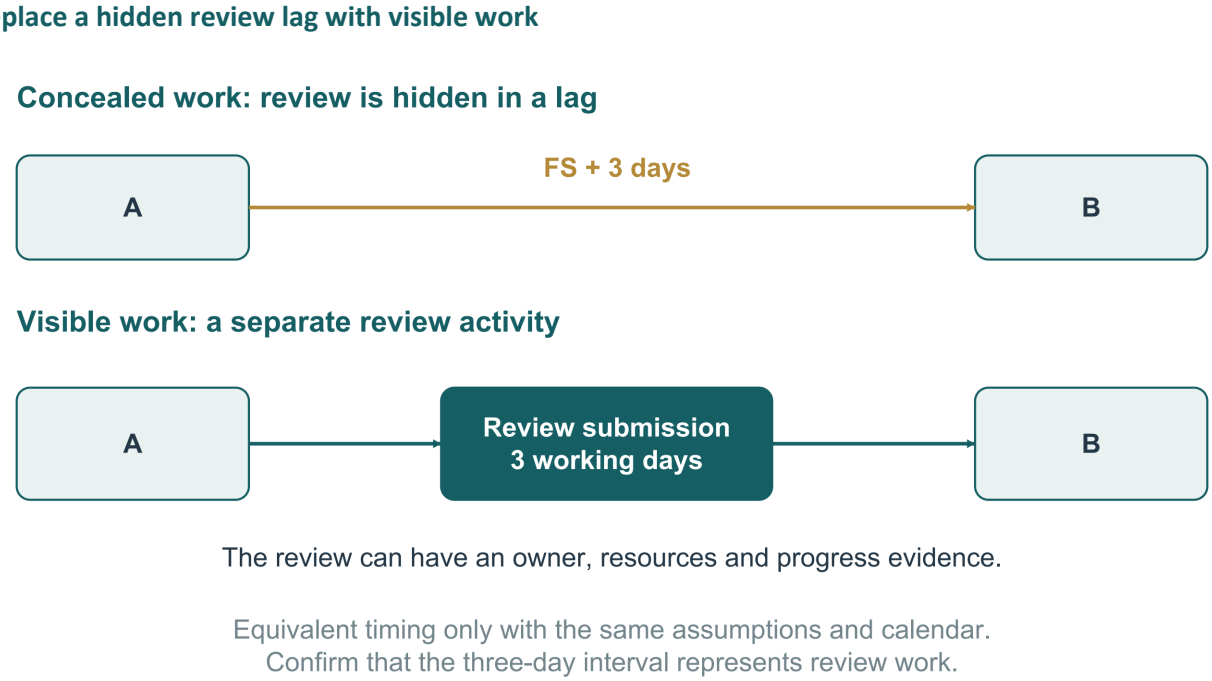


Figure 5.7. The three-day interval becomes an explicit review activity. Equivalent initial timing depends on retaining the same calendar and assumptions; the revised structure makes ownership and progress visible.

Some intervals represent physical or administrative waiting rather than productive effort. A lag may be a reasonable representation where the interval is stable, simple and clearly documented. An explicit activity may still be preferable when the waiting period is uncertain, has its own calendar, needs monitoring or governs an important milestone. The decision should be based on the information needed to manage the interval. It should not be driven solely by reducing the number of rows or obtaining a favourable schedule-quality score.

Model genuine overlap instead of unexplained acceleration

A lead is often entered as a negative lag. An FS relationship with a two-day lead allows the successor to begin two working days before the predecessor's finish under the specified time basis. This arithmetic does not demonstrate that the necessary input is available. If installation can begin after an approved first batch is released, a separate partial-release milestone and an appropriate breakdown of the work may express the delivery method more clearly. If installation actually requires the full approved output, a negative lag conceals an invalid prerequisite rather than creating a feasible acceleration.

Overlap needs more than a plausible first start. The model should account for the continuing flow of information or material, the risk of rework and the condition for completing the successor. An SS relationship may describe initial release, while a further completion dependency may be necessary to protect final acceptance. Do not add both links mechanically: identify the actual start and finish conditions, then use the smallest clear structure that represents them. This is especially important when copying a network from another project with different package boundaries or production rates.

Historical schedules can help identify possible sequences, but they can also preserve restrictions that belonged to an earlier delivery arrangement. Cohen (2024) combines process mining and decision rules using recurring residential-construction datasets to distinguish inherited sequencing assumptions from other requirements. The study reveals modelled flexibility when some restrictions are relaxed, while recognising that resource-constrained scheduling remains necessary. Its practical implication is to

question copied discretionary logic with the people responsible for delivery. It provides no justification for deleting technical or acceptance dependencies merely because doing so produces an earlier date.

5.7 Finding and repairing defective logic

> **Open End.** 'An activity with no predecessor, successor, or both.' (PMI, 2019, p. 183)

An open end may be an intentional network boundary, but unexplained open ends usually undermine the model's ability to transmit change. Work with no effective predecessor may start without the information, access or release it actually needs. Work with no effective successor may finish late without affecting the delivery milestone it should support. The apparent float can then be misleading. The corrective action is to identify the real interface, not to add a convenient arrow solely to make the validation report green.

Inspect both activity boundaries

A link-count check is useful but incomplete. An activity can have an incoming FF link while its real start prerequisite remains absent. An activity with only outgoing SS links may be able to finish much later without moving the milestone that requires its completed output. These are examples of the broader problem of ineffective or 'virtual' open ends. The network needs to represent what authorises the start and what depends upon completion, including the effects of progress and the scheduling tool's treatment of remaining work (PMI, 2019, pp. 77–78).

Circular logic in a conventional activity network is another serious defect. Consider three positive-duration activities linked by FS zero-lag prerequisites: A requires B to finish, B requires C to finish and C requires A to finish. None can begin by satisfying those prerequisites. A cycle may arise through incorrect links, duplicated interfaces or dependencies placed on summary activities. Investigate the delivery meaning before removing a link. If the apparent cycle represents repeated review and revision, break the work into meaningful iterations or model the agreed allowance transparently. Deleting an arbitrary relationship can remove the software error while leaving an incomplete account of the work.

A practical logic assurance workflow

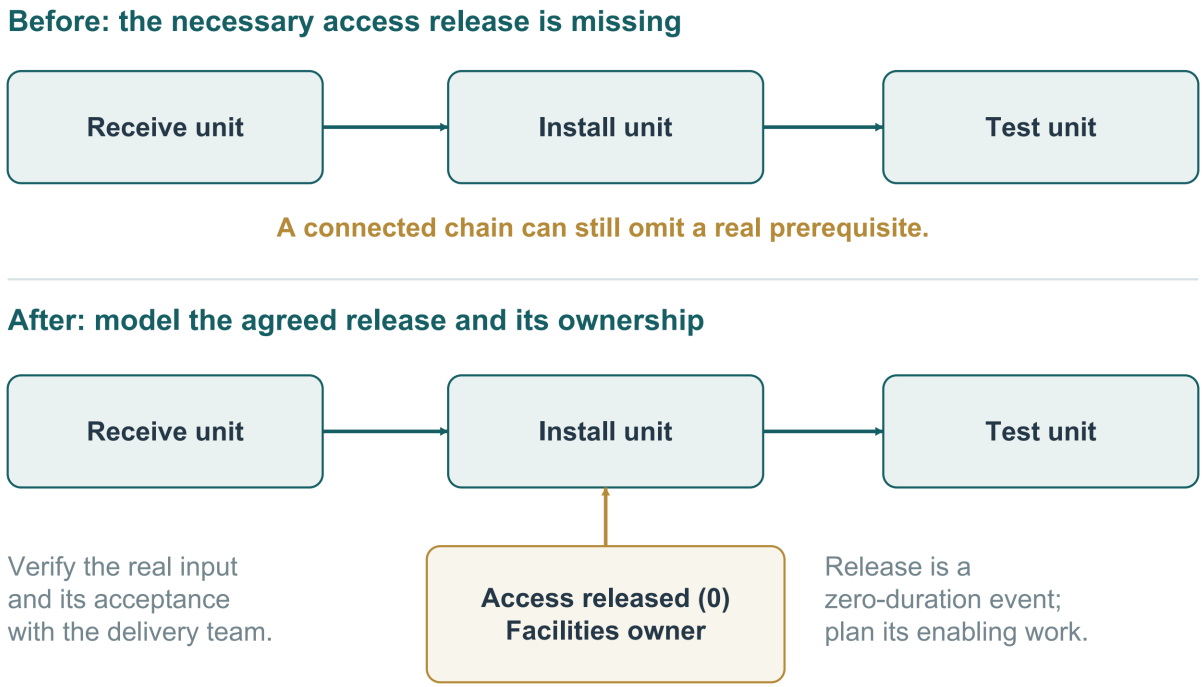


Figure 5.8. Original logic-review workflow: identify the defective condition, recover the real release or acceptance requirement, repair the representation and test whether change now propagates correctly.

Summary activities help organise information but often make poor dependency endpoints. A summary may contain many detailed activities, and its calculated dates can shift when its contents change. Linking a successor to the summary can conceal which output actually enables it or introduce a circular relationship through the hierarchy. Connect the relevant detailed activity or a clearly defined interface milestone, then use summaries for reporting. Redundant links also deserve review: some document a genuine additional requirement, while others merely repeat transitive logic and obscure the current driver. Remove only relationships shown to be unnecessary, with the reasoning retained (PMI, 2019, p. 83).

What a recent US audit reveals

The US Government Accountability Office's June 2026 review of the Census Bureau's Enterprise Data Lake programme examined, among other evidence, a November 2024 schedule. More than 26 per cent of its remaining activities lacked a predecessor or successor, and 37 per cent had unjustified constraints. GAO concluded that such weaknesses prevented a valid critical path and distorted float assessment (GAO, 2026, Table 9). These are findings about the schedule reviewed, not measurements of its September 2026 condition. The example demonstrates why a populated file and a displayed finish date are insufficient evidence of reliable network logic.

The broader GAO Schedule Assessment Guide provides a useful assurance perspective: a reliable schedule should connect the necessary work and support meaningful critical-path and float analysis (GAO, 2015). For practical review, combine automated checks with delivery questions. When a release moves, does the receiving work move as expected? When a completion is delayed, does the affected acceptance milestone respond? If the answer is no, inspect missing links, inappropriate relationships, constraint overrides and calendar assumptions. A numerical quality threshold can identify candidates for investigation; it cannot establish that the sequence is technically feasible.

Son et al. (2024) examined schedule-quality problems from the perspective of Texas Department of Transportation reviewers. Their study analysed 30 usable responses and found that incorrect critical-path settings and illogical relationships were perceived as high-impact problems. Reviewers using printed information alone had more unknowns about technical settings than those also examining electronic models. The study concerns practitioner perceptions within one organisation and does not establish a universal defect rate. It nevertheless supports a clear professional practice: examine the underlying model, calculation options and relationships as well as the printed presentation.

Updating must preserve the meaning of the remaining network

Once work has started, the question is no longer simply what was intended at the outset. Actual starts or finishes may occur out of the planned sequence, and the remaining work needs a credible account of what still constrains it. Recording an actual start does not prove that all prerequisites for continued work have been satisfied. Investigate whether the delivery method genuinely changed, whether partial release was available, or whether progress has been entered incorrectly. Update the logic and remaining-work assumptions through the agreed control process. Detailed treatment of status and out-of-sequence calculation belongs with schedule updating, but the underlying principle is already essential: the remaining network must represent the work still to be done.

5.8 Testing alternatives and maintaining credible paths

A useful network responds to a changed assumption in a way that can be explained. Controlled what-if analysis provides a practical test. Retain an identified reference version, change one assumption, recalculate and compare the completion date, driving path and float distribution. The purpose is to understand cause and effect before selecting an option. A software result should lead to questions about delivery feasibility, resource availability and acceptance conditions, rather than being treated as a recommendation on its own.

Test the worked example before proposing acceleration

The following alternatives each start from the original sixteen-day network. They are separate experiments, not cumulative changes. Durations, relationships and calendars remain unchanged except for the one stated adjustment. This isolation makes it possible to explain why the result changes and prevents an improvement in one branch from being confused with a simultaneous deterioration elsewhere.

Table 5.6 | Testing alternative network scenarios

Scenario	Calculated finish	Interpretation
Original durations	16	Hardware, integration and acceptance govern completion
Increase C from 6 to 7	16	Application and hardware branches become equally long
Increase C from 6 to 8	17	Application branch becomes the controlling route into integration
Reduce B from 4 to 2	15	Application now controls; a two-day local reduction yields one day of project benefit
Reduce E from 4 to 3	15	Shortening a shared downstream activity advances both principal routes

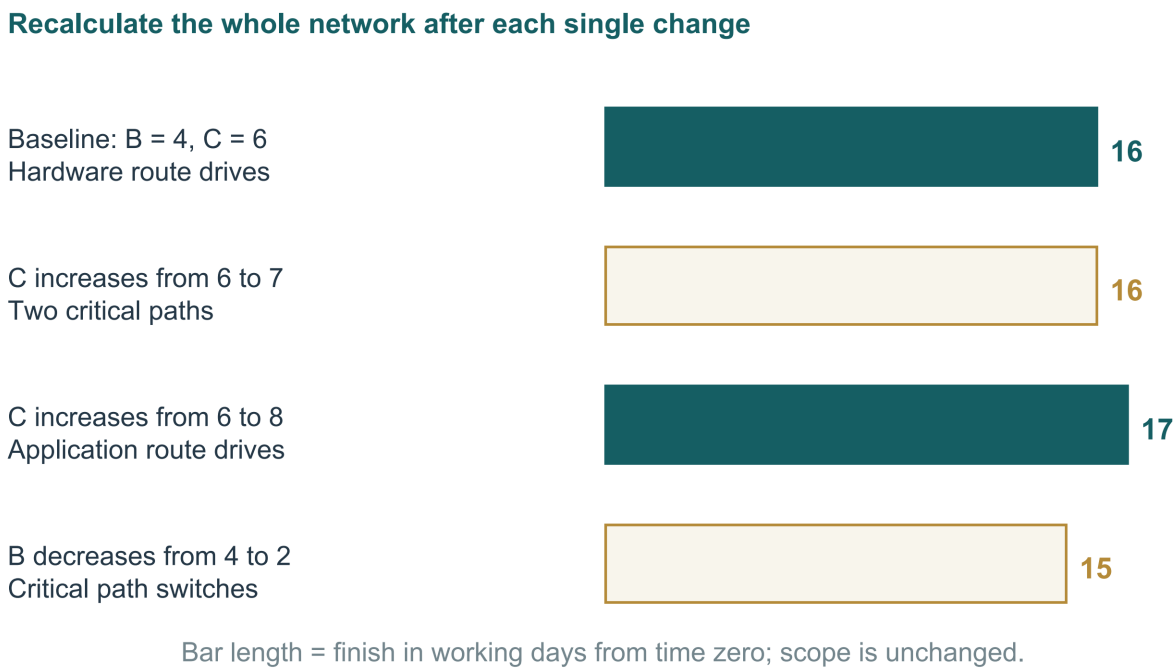


Figure 5.9. Each scenario is recalculated independently from the original network. The result depends on the whole network, including paths that were not initially critical.

Before adopting the two-day reduction in B, the team would need evidence that configuration could be completed in two days without transferring unresolved work to testing. Additional resource might be unavailable, changes could create rework, or a faster local method might alter the interface. If the proposed change is feasible, the model shows that its project benefit is one day under the stated assumptions. This distinction between local productivity and system-level benefit is central to sound project controls. It also explains why focusing only on the longest activity can produce a poor recovery decision.

Keep interface evidence current

An external dependency requires an accountable information exchange. Identify the supplying output, the receiving activity, the acceptance criterion, the responsible parties and the source of the current forecast. Agree how often the information will be refreshed and what change triggers escalation. A date copied from another organisation's schedule can remain visually stable long after the underlying forecast has moved. The UK's Project Routemap delivery-planning guidance emphasises the visibility of assumptions, constraints and interdependencies in establishing a credible delivery plan (Infrastructure and Projects Authority, 2022).

The Bank of England's renewal of its Real-Time Gross Settlement system provides a documented English example. The National Audit Office describes both internal dependencies, including the need for a programme-specific technology platform, and external scheduling interaction with the European Central Bank's migration. The report also describes central dependency tracking and regular coordination. The renewed system launched in April 2025 (NAO, 2025, pp. 11 and 29–31). The published account does not provide a full CPM network. Its teaching value lies in the need to manage technical readiness and external change together rather than infer readiness from a single programme date.

Australia's 2026 audit of cyber security readiness for the Census offers a complementary warning. Following an August 2025 readiness exercise, wider ICT dependencies were not clearly tracked; governance arrangements were subsequently brought together, while a February 2026 briefing reported no contingency before the main event for some assessments (ANAO, 2026, paras 2.102–2.107). This is an audit observation about readiness planning, not a published calculation of total float or a statement of the eventual Census outcome. It shows why dependency ownership and the time available to resolve findings matter alongside the dates of individual activities.

International examples of release, testing and staged readiness

The following comparison uses dated official accounts to examine different kinds of interface. The publications do not supply detailed activity durations or logic files, so no critical-path calculation is attributed to them. The scheduling implications are teaching interpretations: they show questions that a planner should ask when constructing an equivalent type of model. A published completion milestone can be an important fact without proving that every prerequisite or subsequent stage is represented in the public account.

Table 5.7 | International evidence of staged readiness

Official case	Documented sequence or boundary	Scheduling implication
UAE: Dubai Metro Route 2020	RTA's 19 December 2020 notice reported four testing categories completed and announced an initial four-station service for 1 January 2021, with other stations later	Distinguish testing evidence, operator readiness and the scope of each opening stage; do not assume the four testing categories formed a simple serial chain
France: Flamanville EPR	ASN's 7 May 2024 authorisation enabled fuel loading and start-up testing; its accompanying sequence retained further regulatory agreement points	Model an authorisation as release for a defined stage, with later approvals retained; it is not evidence of unrestricted final operation
Germany: Berlin Brandenburg Airport	The airport operator's history records April 2020 building release, trials, the 31 October terminal opening, the 4 November southern-runway opening and 8 November cessation of Tegel flights	Distinguish physical release, operational trials and staged transition milestones; cessation of flights is not the same as final legal closure
Egypt: Cairo Metro Line 3, Phase 3C	NAT's 12 May 2024 notice announced passenger trial operation from 15 May after reporting integrated-system and dynamic train testing	Distinguish non-passenger testing, passenger trials and final acceptance; the announcement does not establish exact test dependencies or final acceptance dates

In the UAE example, a readiness milestone should identify which stations and services are included. In the French example, the accepted output of one stage permits specified subsequent work while further gates remain. The German example shows that a transition can contain several operational dates even when the public recognises one opening. The Egyptian notice distinguishes testing modes that should not be collapsed into a single vague 'commissioning' row. Across these cases, the common professional task is to define the event precisely enough that its predecessors and successors can be justified (RTA, 2020; ASN, 2024a, 2024b; FBB, n.d.; NAT, 2024).

A proportionate release decision for the network

Before using the network to support an important decision, establish that its scope is complete enough for the purpose, that significant relationships have an explainable basis, and that the dates respond sensibly to change. Trace the project finish and relevant intermediate milestones, review low-float branches, and investigate unexpected float or constraints. Record the calculation settings and the limitations of the analysis. Australia's Digital Transformation Agency similarly treats a maintained schedule and active understanding of interdependencies as part of delivery confidence, rather than relying on the existence of a schedule alone (DTA, n.d.).

The judgement at the end of this chapter is therefore wider than finding a red line through a diagram. A credible scheduling professional can show how the forecast was produced, explain what would change it and identify the evidence still needed before the plan is relied upon. The network remains a model of a delivery method, with explicit assumptions about resources, durations, calendars and interfaces. Maintaining those assumptions and testing their consequences makes the calculation useful for management and provides a strong foundation for later work on schedule development, resource feasibility and uncertainty.

Knowledge check and examination practice

These original practice questions support the sequencing, critical-path and schedule-analysis capabilities described in the PMI-SP Examination Content Outline, particularly Schedule Planning and Development (PMI, 2012, pp. 4–5). They are not official PMI examination questions. Select the single best answer from the information given. Where a question refers to the worked network, use the original assumptions and durations unless the question explicitly changes them. Distinguish the calculation from any further judgement about feasibility.

Question 1 - Classifying a dependency

A project cannot begin a particular test until an external regulator issues the required authorisation. Which description best characterises this dependency?

A Discretionary because it is outside the project team's control.
B Mandatory and external; the classifications describe different dimensions.
C Internal because the test appears in the project schedule.
D Start-to-start because both organisations have activities in progress.

Question 2 - Interpreting a relationship

Activity A lasts ten days and starts at time zero. Activity B lasts two days and has only an FF relationship with zero lag from A. Both use the same continuous working-time scale and have no other restrictions. What is B's earliest placement under this relationship?

A Start at zero and finish at two.
B Start at ten and finish at twelve.
C Start at eight and finish at ten.
D Start at nine and finish at eleven.

Question 3 - Calculating a merge

In the original worked network, C finishes at nine and D finishes at ten. E lasts four days, depends on both through FS zero-lag relationships, and must finish by F's late start of fourteen. What are E's early start and late start?

A Early start nine; late start ten.
B Early start ten; late start fourteen.
C Early start nine; late start nine.
D Early start ten; late start ten.

Question 4 - Understanding shared float

G and H each have eight days of total float in the original worked network. G has zero free float. Which interpretation is correct?

A A delay to G can move H's early dates before it moves acceptance, and the branch has eight days of shared flexibility.
B The two activities together can absorb sixteen additional days without changing completion.
C Zero free float means G is necessarily on the project's longest path.
D H's early dates cannot move until G has used all eight days of total float.

Question 5 - An earlier required finish

The original network forecasts completion at sixteen. A new required finish of fourteen is used as the backward-pass boundary, with the forward forecast retained. What should the scheduler report first?

A The project will finish at fourteen because a required date has been entered.
B The two days of negative float prove a two-day contractual entitlement.
C The unchanged model forecasts sixteen against a requirement of fourteen, producing negative float that requires a credible response.
D Remove the required date so that the schedule can be reported as feasible.

Question 6 - Testing acceleration

In a separate scenario based on the original network, B is reduced from four days to two. All other durations, logic and assumptions remain unchanged. What happens to project completion?

A It becomes fourteen because B has been shortened by two days.
B It becomes fifteen because the application branch now governs integration.
C It remains sixteen because B is no longer critical after the change.
D It becomes seventeen because the critical path has changed.

Question 7 - Making work visible

A model uses FS plus five working days between 'Submit design' and 'Begin manufacture'. The five days represent an engineer's review whose effort, progress and acceptance are actively managed. What is the most useful improvement?

A Change the relationship to SS so manufacture can start earlier.
B Apply a mandatory start to manufacture at the desired date.
C Delete the lag because all lags are invalid.
D Represent the review explicitly, with its duration, owner and accepted completion connected to manufacture.

Question 8 - Investigating a critical-path display

A multi-calendar schedule has a red critical-activity filter, but the displayed rows do not form a convincing chain to the project finish. Several activities have imposed dates. What is the best next step?

A Inspect criticality settings, date constraints, calendars and driving relationships to the selected endpoint in the underlying model.
B Accept the filter because scheduling software always uses one universal definition of criticality.
C Delete all non-red activities from the review because they cannot influence completion.
D Set every duration on the red list to zero to reveal the true delivery date.

Answer explanations

Question 1 - B

The authorisation is a required condition and therefore mandatory in this scenario, while the regulator lies outside the project boundary and makes it external. A confuses lack of control with discretion: an externally controlled condition can still be compulsory. C confuses inclusion of the receiving activity with ownership of the authorisation. D selects a relationship type without examining the events that enable the test. The existence of simultaneous work in two organisations does not establish SS logic; the relevant release is the required authorisation.

Question 2 - C

The FF zero-lag condition requires B's finish to be no earlier than A's finish at ten. With a fixed two-day duration, B can therefore occupy eight to ten. A violates the finish condition. B would be consistent with a simple FS zero-lag interpretation but is not the earliest placement permitted by the stated FF relationship. D is possible as a later placement, but it is not the earliest one. The answer concerns the mathematical condition provided; practical start readiness would still need to be checked in a real plan.

Question 3 - D

The forward pass takes the larger predecessor finish: maximum of nine and ten gives ES ten. The backward calculation subtracts E's four-day duration from its required finish of fourteen, giving LS ten. A and C take the earlier prerequisite arrival and would allow integration before D finishes. B mistakes E's late finish for its late start. Identifying the correct event at each end of an activity is as important as performing the subtraction correctly.

Question 4 - A

G finishes at five and H starts at five, so any postponement of G, with the rest of the original early placement unchanged, moves H's early start. The branch can nevertheless absorb eight days before affecting F's start at fourteen. B adds two values that refer to shared path flexibility. C confuses immediate interface sensitivity with project-level criticality. D reverses the distinction: G has no free float precisely because H responds immediately, although the final milestone need not move until the available branch flexibility is exhausted.

Question 5 - C

The earlier late-finish boundary creates a measurable conflict without changing the forward-pass work sequence. The professional response is to report the sixteen-day forecast, the fourteen-day requirement and the need to evaluate a feasible change. A treats an input requirement as evidence of acceleration. B draws a contractual conclusion unsupported by CPM arithmetic. D suppresses the requirement and the resulting signal without resolving the underlying commitment. A requirement may legitimately be revised through the appropriate decision process, but it should not be removed merely to improve the report.

Question 6 - B

A still finishes at three. B now finishes at five and D at eight, while C still finishes at nine. E must therefore wait until nine, finishes at thirteen, and F finishes at fifteen. A ignores the application branch and assumes that a local saving transfers fully to the project. C reasons from B's status after acceleration instead of recalculating the full network. D assumes that a changed controlling path necessarily causes delay. The scenario demonstrates diminishing benefit when another path becomes the controlling route.

Question 7 - D

An explicit review activity makes the work, accountability and acceptance condition visible and allows progress and remaining duration to be updated. A creates overlap without establishing that manufacture can proceed before review completion. B fixes a desired date while concealing whether the prerequisite is satisfied. C applies an unjustified universal prohibition: a documented lag can sometimes represent an interval appropriately, but identifiable managed review work benefits from explicit representation. Initial dates remain equivalent only if the calendar, duration and relationship assumptions are preserved.

Question 8 - A

The scheduler needs to understand what the software is flagging and whether the selected chain actually governs the chosen completion point. Calendars and imposed dates can complicate the relationship between float-based flags and longest-path analysis. B assumes consistent product behaviour that does not exist. C excludes work that can become controlling or affect an important interface. D changes the model arbitrarily and produces no meaningful delivery forecast. Review should preserve the model while investigating its settings and tracing its actual driving conditions.

Preparing for Chapter 6

The next stage develops the connected activity network into a structured schedule model that can be maintained and assured. Retain the reasoning established here: activities need credible boundaries, dates need an identifiable calculation basis, and completion forecasts need connected driving paths. Coding, data quality and the selection of schedule components will add useful organisation only when the underlying logic continues to represent the intended delivery method.

References and further reading

PMI definitions in this chapter are quoted from the third edition, with printed page numbers. The frameworks, worked calculations, diagrams and examination questions are original teaching material. Case accounts retain their publication dates and should not be read as statements about each project's current status.

Australian National Audit Office (ANAO) (2026) *Cyber Security Readiness for the 2026 Census*. Auditor-General Report No. 34 of 2025–26, 27 May, especially paras 2.102–2.107. Official audit.

Autorité de sûreté nucléaire (ASN) (2024a) ‘L'ASN autorise la mise en service du réacteur EPR de Flamanville’, 7 May. Archived on the successor authority's website. Official authorisation announcement.

Autorité de sûreté nucléaire (ASN) (2024b) *Principales étapes suivant la mise en service du réacteur EPR de Flamanville*. Explanatory note accompanying the May 2024 announcement, pp. 1–2. Official sequence.

Bianco, L., Caramia, M. and Giordani, S. (2022) ‘Project scheduling with generalized precedence relations: A new method to analyze criticalities and flexibilities’, *European Journal of Operational Research*, 298(2), pp. 451–462. doi:10.1016/j.ejor.2021.07.022.

Cohen, I. (2024) ‘Data-Driven Project Planning: An Integrated Network Learning, Process Mining, and Constraint Relaxation Approach in Favor of Scheduling Recurring Projects’, *IEEE Transactions on Engineering Management*, 71, pp. 7719–7729. doi:10.1109/TEM.2024.3382727.

Digital Transformation Agency (DTA) (n.d.) *Assessing delivery confidence of digital projects: Delivery management*. Australian Government. Official guidance.

Flughafen Berlin Brandenburg GmbH (FBB) (n.d.) *Berlin Brandenburg Airport*. Company history, especially ‘2020 – The year BER goes into operation’. Airport operator's history.

Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, especially pp. 27–45, 75–97 and 172–180. Official guide.

Government Accountability Office (GAO) (2026) *Information Technology: Census Bureau Needs to Better Manage Schedule for Modernization Program*. GAO-26-107629, 4 June, Table 9. Official report.

Infrastructure and Projects Authority (2022) *Project Routemap: Delivery Planning*. UK Government, pp. 20–21. Official guidance.

National Audit Office (NAO) (2025) *The Bank of England's Real-Time Gross Settlement system renewal programme*. HC 1546, 12 December, especially pp. 11 and 29–31. Official report.

National Authority for Tunnels (NAT) (2024) ‘Trial operation with passengers will begin at the stations line 3 phase3 part3 on Wednesday morning, May 15, 2024’, 12 May. Egyptian Ministry of Transport. Official announcement.

Oracle (n.d.) *P6 Professional Help: Settings tab – Project Details*. Critical-activity options and longest-path calculation. Official product documentation.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*, especially pp. 4–5. Official examination outline.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: Project Management Institute. Especially sections 3.2.1.3, 3.4.1–3.4.2, 3.4.4–3.4.9, relevant Section 4 components and glossary. Citations throughout use printed pages.

Roads and Transport Authority (RTA) (2020) ‘Al Tayer: Dubai Metro Route 2020 to start operation on 1/1/2021’, 19 December. Government of Dubai. Official pre-opening announcement.

Son, J., Han, B. G., Khwaja, N. and O'Brien, W. J. (2024) ‘Assessment of Schedule Quality Problems from the DOT Schedule Reviewers' Perspective: Case of TxDOT’, *Transportation Research Record*, 2678(10), pp. 622–633. doi:10.1177/03611981241234903.

Vazquez, A., Pozzana, I., Kalogridis, G. and Ellinas, C. (2023) ‘Activity networks determine project performance’, *Scientific Reports*, 13, article 509. doi:10.1038/s41598-022-27180-0.

CHAPTER 06

Building the Digital Schedule Model and Basis of Schedule

Making the schedule understandable, reproducible and controlled

A digital schedule should allow another competent person to understand how its dates were produced. An attractive chart cannot provide that assurance on its own. The activities may be incomplete, the calendar may differ from the working arrangements, or the displayed baseline may refer to the wrong version. Even a technically sound calculation becomes difficult to trust when its inputs, settings and approval status cannot be recovered. This chapter therefore treats the schedule as a controlled model supported by an explanation of its basis, rather than as a file that happens to contain dates.

The work connects scheduling knowledge with practical information management. Activities, calendars, dependencies and durations are assembled within a tool; their meaning and behaviour are checked; a calculated version is saved; and appropriate presentations are produced for the people making decisions. The basis of schedule explains the scope, evidence, assumptions and limitations behind that version. Approval establishes an authorised comparison point, while subsequent updates record what has happened and forecast what remains. These are related activities, but none should be mistaken for another: saving a file does not approve it, and approving a reference does not make the current forecast remain on time.

For PMI-SP preparation, the emphasis is on configuration, schedule development, baseline establishment, evidence-based updating and communication. For a Project Controls Professional working at Level 6, the further expectation is to justify the choices and limitations. The professional should be able to explain why a field is needed, how its value was established, what a software setting changes and which decision a particular report supports. No prior formal study of another project controls discipline is assumed. Resource optimisation, quantitative risk analysis and detailed performance control are introduced only where needed to understand the model; their full treatment follows in later chapters.

The chapter framework: six connected responsibilities

The original framework in Figure 6.1 begins with the intended decision and the rules for producing schedule information. It then moves through assembly, verification, documentation, authorisation and maintenance. Each responsibility has an identifiable result: an agreed purpose, a coherent model, a checked calculation, an explained basis, a recorded decision and a recoverable sequence of updates. The cycle repeats when the project changes. A model that was fit for an early option comparison may need additional detail and evidence before it can support a delivery commitment.

The digital schedule development and control framework

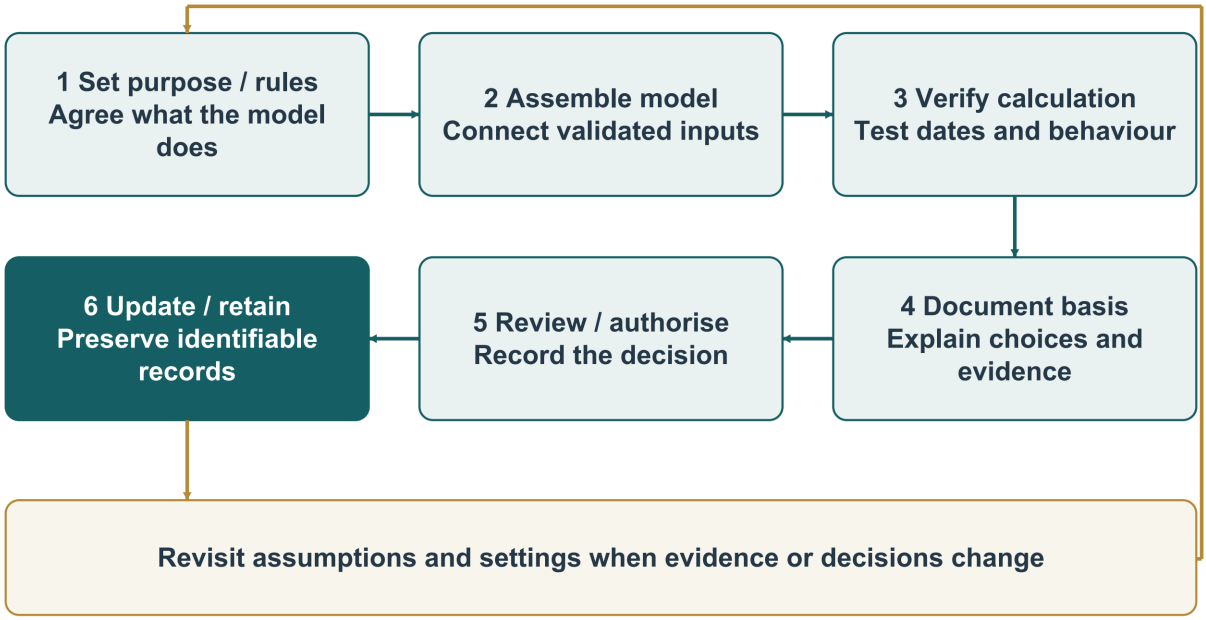


Figure 6.1. An original framework linking model development with evidence and control. The responsibilities are connected; producing a report does not replace checking the model or obtaining the appropriate decision.

6.1 Distinguishing the tool, model, instance and presentation

Scheduling Tool. 'A tool that provides schedule component names, definitions, structural relationships, and formats to support the application of a scheduling method.' (PMI, 2019, p. 190)

The tool supplies the mechanisms for storing information and calculating results. These may include calendars, relationship types, resource assignments, date constraints, progress fields and reporting layouts. The product also supplies defaults, and those defaults are themselves modelling choices. A scheduler who accepts an inherited configuration without checking it may unknowingly use a different working week, criticality rule or treatment of incomplete work. Tool competence therefore includes understanding the consequences of settings, as well as knowing where the relevant command is located (PMI, 2019, p. 28).

Schedule Model. 'A representation of the plan for executing the project's activities, including durations, dependencies, and other planning information, used to produce a project schedule along with other scheduling artifacts. See also schedule model analysis.' (PMI, 2019, p. 190)

The model combines project-specific information with the rules used to interpret it. It represents a delivery method: what is to be done, how the work is connected, which working periods are available and what conditions govern progress. Software can calculate an internally consistent result from poor inputs, so a successful calculation is not sufficient evidence that the represented plan is feasible. The delivery team contributes knowledge of the work, while the scheduler converts that knowledge into an explicit and testable structure. Both contributions are needed to establish a credible forecast.

Schedule Model Instance. 'A version of the schedule model that has been processed by a schedule tool and has reacted to inputs and adjustments made to the project-specific data within the scheduling tool (completed update cycle), which is saved for record and reference, such as data date version, target schedule models, and the baseline schedule model.' (PMI, 2019, p. 190)

An instance makes the model's condition at an identifiable point recoverable. The current working model may continue to change, but a retained instance allows the team to establish what was known and calculated when a report or decision was made. The component entry called Schedule Model Instance also describes the designation used to identify that version, such as an as-of date or revision number (PMI, 2019, p. 129). The saved object and its designation should be distinguished: a version code is useful only if it points to the correct retained content.

A presentation selects and displays information from an instance. A milestone report, a detailed Gantt chart and a resource profile can all describe the same underlying version while answering different questions. Filters, grouping, time scale and selected fields affect what the reader sees. A presentation that hides an activity has not removed it from the model, and a summary bar has not replaced the detailed dependencies beneath it. PMI distinguishes the project-specific model from its resulting presentations precisely because these different uses of the word 'schedule' can otherwise create confusion (PMI, 2019, pp. 30-31).

One model instance supports several presentations

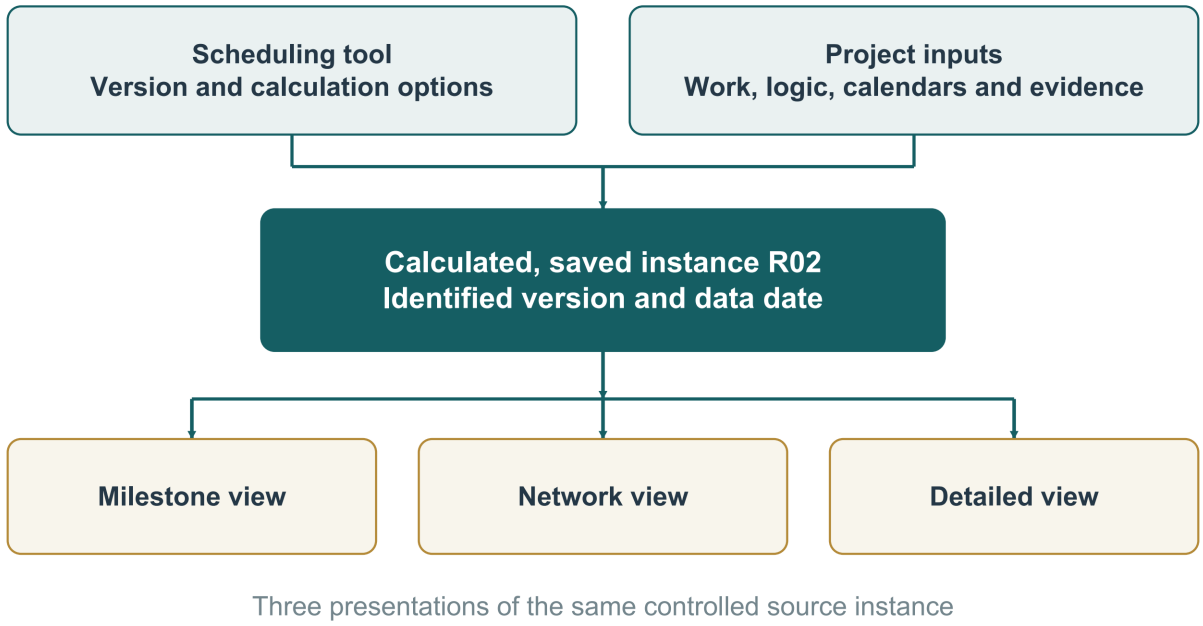


Figure 6.2. The tool processes project information to create a model instance. Different presentations can be generated from that same instance, provided their source and reporting cut-off remain identifiable.

Keep identity, revision and approval status separate

> **Schedule Model ID.** 'A short, unique numeric or text identification assigned to each schedule model to differentiate that schedule model from others. Also known as project identifier.' (PMI, 2019, p. 129)

The model identifier answers which model is being discussed; the instance designation answers which version; the data date answers up to what point progress is represented; and the approval status answers what use has been authorised. Combining all four in one informal filename can make them difficult to manage. A sensible naming convention helps, but the authoritative record should also retain these attributes within the controlled information system. A file named 'final' may still contain unreviewed assumptions, and a recently modified file may contain an old status position.

Table 6.1 | Distinguishing identity, revision and approval

Information item	Question it answers	Independent illustration
Model ID	Which project model is this?	SM-EX06
Instance designation	Which retained calculation is this?	R02
Data date or cut-off	Through which boundary is progress represented?	End of working period 5
Approval status	What use has been authorised?	Issued for review
Presentation identity	Which selection of that information is displayed?	Milestone view from R02

These distinctions support a simple but important discipline: every report should be traceable to the instance from which it was generated. The report should identify its purpose and comparison basis as well as its date. If a stakeholder receives a milestone summary after the detailed model has changed, the team should be able to identify whether the summary remains valid, requires replacement or represents a deliberately retained historical position. This is a matter of information reliability, not merely document appearance.

The UK's Programme and project data standard, published in December 2025 as version 1.0 for a twelve-month internal government trial, provides a recent example. It distinguishes milestone baseline, forecast and actual dates, alongside identifiers, metadata and validation rules. These distinctions show why similar-looking date columns need explicit meanings (Government Project Delivery, 2025, pp. 39 and 59-63). Its field structure is separate from PMI's component catalogue. In particular, retaining an original baseline field does not prevent authorised rebaselining when original and revised references remain separately identifiable.

6.2 Reading the scheduling component catalogue intelligently

Section 4 of the PMI standard provides a structured catalogue of potential scheduling components. It is more useful as a guide to meaning and behaviour than as a list of columns to display. A scheduling product may use a different label, allow a value to be entered where another product calculates it, or respond differently to a particular setting. Reading the component's full entry helps establish whether the proposed use is appropriate. A familiar field name should start the enquiry rather than end it (PMI, 2019, pp. 93-95).

Examine all eight attributes of an entry

The catalogue describes eight possible attributes. Together they explain what a component represents, how it is populated and what other information influences it. Consider a remaining-duration field: its name alone cannot establish the unit, the person responsible for the estimate, the calculation behaviour or the way it interacts with resource assignments. Similarly, a baseline field may display a date without making clear which baseline version has been assigned for comparison. Professional use requires attention to the entry as a whole and to the actual tool's implementation.

Table 6.2 | The eight facets of a schedule component

Catalogue attribute	What the learner should establish	Practical consequence
Component name	The concept represented, including alternative product labels	Map by meaning, not by a similar heading alone
Required, conditional or optional use	Why the component is needed in this model	Select fields to meet the project's requirements
Manual or calculated	Whether the value is entered, derived or tool-dependent	Identify who supplies evidence and what must be recalculated
Data format	Whether the field holds text, dates, numbers or another structure	Preserve identifiers, units and date interpretation during exchange
Behaviour	How the component acts or influences other results	Test the effect of settings and changes
Good practices	How the component can be used appropriately	Apply judgement to the delivery context
Conditional note or associated component	Dependencies on other fields or processes	Check the linked information before accepting the value
Definition	The component's stated use and function	Establish a common meaning before reporting it

The eight attributes follow PMI (2019), sections 4.1.1-4.1.8, pp. 94-95. The practical consequences are teaching interpretations.

Manual does not mean unreliable, and calculated does not mean correct. A manually entered actual finish can be well supported by an accepted completion record. A calculated early finish can be wrong because the calendar or predecessor is wrong. The distinction indicates how the value is produced, not its quality. Some attributes depend on the tool or on the selected activity type, so the project should identify which data are authoritative inputs and which are derived outputs. An import that overwrites a calculated result with a fixed value may change the nature of the model even if the displayed date initially remains the same.

Understand required groups and scoring without confusing them

The standard distinguishes core-required components (CRC) from resource-required (RRC), EVM-required (ERC) and risk-required (KRC) groups. The latter groups are conditional on the project's requirements and methods. Optional components (O) should serve a defined analytical or communication purpose. Non-scored components (NS) still require responsible use: a date constraint can substantially alter a calculation even when it does not contribute a point to the conformance score. The score is therefore not a measure of whether every modelling choice has been justified (PMI, 2019, pp. 93-97).

Catalogue entries and conformance scoring positions

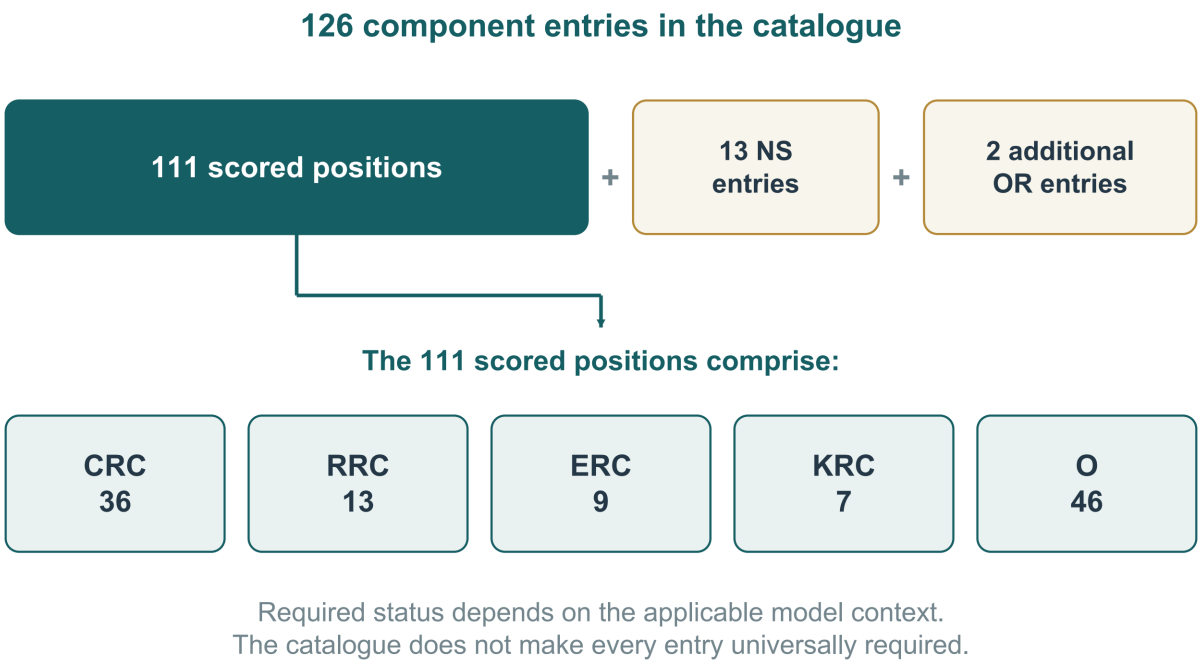


Figure 6.3. The catalogue contains 126 distinct entries, while the scoring structure contains 111 positions. Thirteen entries are non-scored and two additional entries arise because the activity and project physical/duration percentage alternatives are listed separately but each pair occupies one scoring position.

The scoring positions comprise 36 core, 13 resource, nine EVM, seven risk and 46 optional components. These numbers describe the standard's assessment structure; they do not mean that every project must activate every available method or that 111 populated fields establish a sound plan. All applicable required components must be properly used before a conformance score is recorded; assessment can still identify gaps in an incomplete model. Detailed scoring and maturity interpretation follow in the assurance chapter. Here, the purpose is to distinguish the catalogue's 126 detailed entries from the 111 scored positions (PMI, 2019, p. 140 and Appendix X3, p. 157).

The percentage-complete alternatives deserve particular attention. Table 4-1 provides an activity physical-percentage or duration-percentage option and a corresponding project-level pair. The alternatives do not make the measures interchangeable. Physical progress concerns the agreed measure of output, while duration progress concerns time consumed relative to total duration. Work percentage introduces another basis involving effort. The chosen measure should be named and explained; an unqualified '60 per cent complete' can conceal materially different meanings. A worked comparison later in this chapter demonstrates why.

Navigate by the information needed for the decision

The catalogue is grouped into twelve categories and then described alphabetically in its detailed entries. The following map shows how those categories contribute to a working model. It provides a route through the entire catalogue without implying that every specialist field should be used immediately. For example, a resource-constrained plan needs information that a preliminary logic-only option comparison does not yet contain. The earlier comparison should disclose that limitation rather than populate resource fields with unsupported values.

Table 6.3 | Navigating the schedule component catalogue

Catalogue category	Role in the model	Example of a review question
Calendar	Defines available working periods	Which working pattern governs this activity?
Constraint	Represents a justified date boundary or scheduling preference	Is this a real requirement or an artificial date fix?
Duration	Distinguishes original, actual, remaining and total time	Is the remaining estimate supported by the work still required?
Earned value	Connects authorised scope, budgets and measured performance	Are progress rules and time-phased budgets consistent?
Finish date	Distinguishes actual, early, late and resource-adjusted finishes	Is the displayed finish observed, calculated or required?
Float	Describes calculated flexibility	Which completion or interface requirement is protected?
Percent complete	Expresses progress on a stated basis	Is this physical, duration or work progress?
Relationship	Connects the relevant predecessor and successor events	Does the link represent the actual prerequisite?
Resource	Describes assignments, availability, quantities and capability	Is the delivery method feasible with the available resources?
Schedule risk	Supports uncertainty and risk analysis	What evidence supports the inputs and activity mappings?
Start date	Distinguishes actual, early, late and resource-adjusted starts	Is the start consistent with status and prerequisites?
Miscellaneous	Provides identity, structure, status and model context	Can the activity, model instance and comparison record be traced?

Category map based on PMI (2019), Table 4-1, p. 97. Specialist calculations are developed in their relevant chapters; the model's purpose determines which are needed.

An effective field-selection decision therefore begins with the question being asked. If the team needs to explain why a milestone moved, it needs the current and comparison instances, relevant dates, changed assumptions and connected drivers. Adding an unrelated optional field does not improve that explanation. If the team needs to demonstrate resource feasibility, omitting availability and assignment information leaves a material gap. Catalogue knowledge supports these decisions by making the meaning and dependencies of the available information explicit.

Use the full component reference with the model

Book Appendix B, *Complete Schedule Component Reference*, accompanies this chapter and Chapter 12. It contains all 126 source entries, their formal definitions and printed-page references, together with their use classifications, input or calculation origins, data formats, behaviours and applicable notes. Use the catalogue when specifying a field, checking an import or challenging an assessment. The source's component classifications and the assessment scoring categories are not interchangeable; the appendix identifies the documented differences rather than forcing them into an apparently consistent table.

6.3 Assembling and configuring a coherent digital model

The digital build should follow the delivery structure rather than the order in which information happens to arrive. Establish the model identity, scope structure, working calendars and agreed conventions before importing large activity lists. Assemble activities and milestones with stable identifiers, connect the relevant events, and assign the information needed for the chosen analysis. Then calculate and examine the result. Where resource or risk information is incomplete, describe what the present model can support and what further analysis is required before a stronger conclusion is drawn.

Use stable identifiers and meaningful relationships between data

An activity identifier should remain a reliable way of recognising the activity across updates and systems. Its description may become clearer, its forecast may move and its responsibility code may change, but uncontrolled renumbering can break progress history and cross-references. When work is genuinely split or replaced, record how the new activities relate to the earlier scope. A deleted row should not silently remove completed work, an unresolved obligation or the evidence of an earlier forecast. The information structure should preserve the distinction between a change to the work and a change to its presentation.

Codes add useful dimensions for selection and reporting, such as work package, location, discipline, contractor or responsible team. They do not replace the activity's logical relationships. Grouping all activities by location can produce a useful view while concealing dependencies that cross location boundaries. Equally, a WBS hierarchy explains how work contributes to scope but does not automatically establish the delivery sequence. The planner should check both structural completeness and logical connectivity. Resource, cost and risk references can then be attached through controlled identifiers rather than through ambiguous text matching.

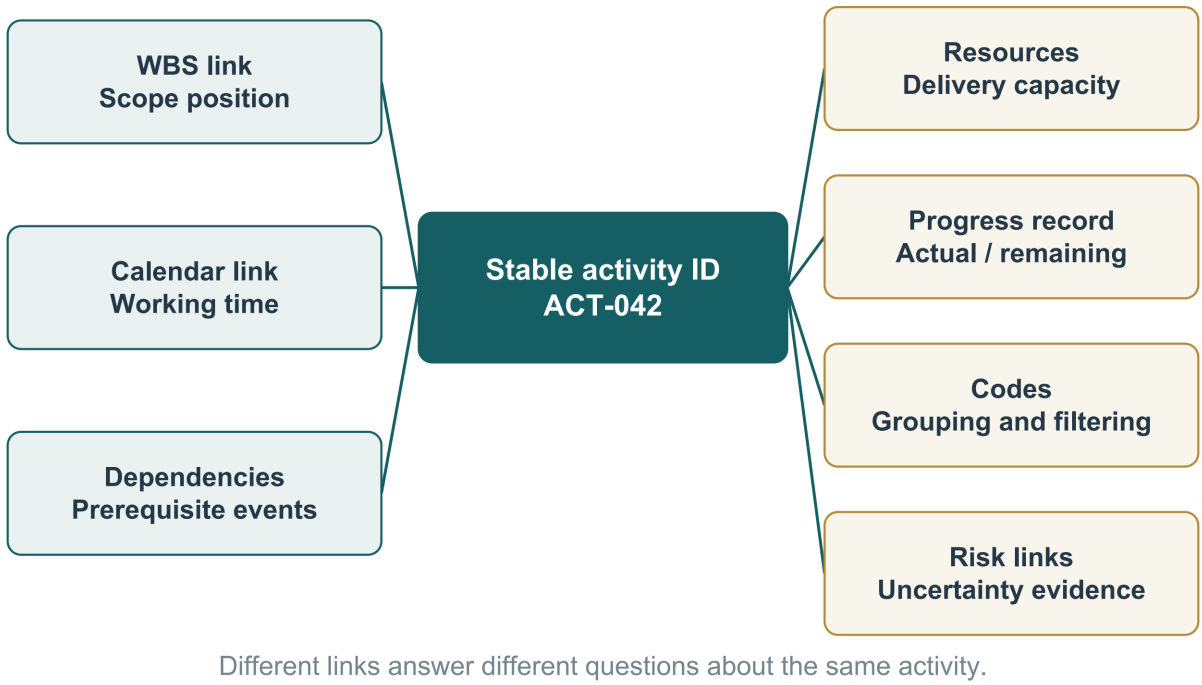


Figure 6.4. An original view of schedule information around a stable activity identity. Each connection has a distinct purpose; a code, dependency, resource assignment and progress record are not interchangeable.

A small formatting error can become a substantive modelling error during exchange. An identifier such as 0012 can lose its leading zeros when interpreted as a number. A date such as 03/04 can be read as different months in different locales. A four-day duration can be converted incorrectly when the receiving system assumes different hours per day or applies another calendar. Specify field types, units and the date convention, and test representative records before accepting a full import. Preserve the original source and the mapping so that any discrepancy can be investigated.

Configure the calculation before relying on its results

The configuration record should cover the scheduling method, software version, time units, calendar references, calculation direction or boundary assumptions, criticality rules and treatment of incomplete work. Where relevant, it should also identify resource-levelling settings, external links and the selected baseline for comparison. Some settings reside at project level, others at application or user level. Two people opening the same exported activity list may therefore obtain different results unless the calculation environment has also been preserved.

Defaults should be tested with a small understood network. A known FS chain can reveal an unexpected calendar exception; a merge can test which prerequisite governs; and a controlled duration change can demonstrate whether the forecast responds. The purpose is not to recreate the software's entire algorithm. It is to establish that the project has selected and understood the behaviours that materially affect its dates. If a tool upgrade or import changes those behaviours, the difference should be explained before the new result becomes the basis of a report.

Table 6.4 | Documenting model configuration decisions

Build decision	Evidence to retain	Consequence if the decision is unclear
Calendar and time units	Working periods, exceptions and unit conversion conventions	The same stated duration can produce a different date
Activity and relationship types	Delivery rationale and applicable calculation behaviour	Dates can appear plausible while prerequisites are bypassed
Status and remaining-work treatment	Cut-off convention, actual evidence and calculation settings	Work can be placed inconsistently around the reporting boundary
Resource treatment	Assignments, availability and whether levelling was applied	A logic-based forecast can be mistaken for a feasible resource plan
Comparison selection	Exact reference or baseline instance and its status	Variance can be measured against the wrong record
External data and links	Source versions, owners and refresh arrangements	A model can combine information from incompatible reporting periods

This comparison is an original configuration-review model. It supports the standard's discussion of tool behaviour and model development rather than prescribing a particular product interface.

Build progressively and reconcile the result

A practical build proceeds in controlled increments: establish a small coherent structure, calculate it, inspect the outcome and then add the next body of information. This makes it easier to identify which change caused an unexpected result. Reconcile activity and milestone counts against the agreed scope, check that required fields are populated with meaningful values, and confirm that relationships refer to existing activities. Review long or unusual durations with their owners. A large imported model should receive these checks before its detailed appearance creates an impression of maturity that the underlying evidence does not support.

The result should be understandable without relying on the memory of its original author. A successor scheduler should be able to locate the current model, identify its assumptions, calculate a consistent result and explain the significant milestones. This does not require excessive documentation of every routine action. It requires enough controlled information to distinguish deliberate planning choices from accidental settings and to recover the reasoning behind important decisions.

6.4 Verifying the calculation and preserving reproducibility

Verification examines whether the model has been assembled and processed as intended. Validation asks whether it adequately represents the delivery plan for its intended purpose. These are useful distinctions in professional practice, even though organisations may use the terms differently. A missing calendar assignment is an implementation problem; an assigned calendar that assumes unavailable night working is a delivery problem. Both can move the forecast, and neither will necessarily be exposed by inspecting a printed bar chart.

Separate data checks, calculation checks and delivery review

Data checks examine completeness, consistency and validity of the stored information. Examples include duplicate identifiers, relationships to missing activities, incompatible units and actual dates beyond the reporting cut-off. Calculation checks examine whether the tool produces the expected result from those inputs. Delivery review then examines whether the scope, sequence, durations and assumed resources are credible. These layers complement one another. Passing a data check does not establish feasibility, while an experienced delivery manager's confidence does not remove the need to check how the software has interpreted the plan.

A useful calculation check has a predicted result. If a critical predecessor is extended by one working day in a simple unconstrained FS chain, the downstream response should be explainable. If the expected movement does not occur, investigate whether another date boundary, calendar, relationship type or progress rule is controlling the result. The purpose is to understand the difference, not to force a preferred date by adjusting settings until the warning disappears. Preserve the reference version before conducting these experiments, and distinguish test changes from changes accepted into the current plan.

Reproduce the result from an identified set of inputs

Reproducibility means that a competent reviewer can recover the relevant inputs and calculation conditions and explain the same material outcome. The objective is not necessarily an identical binary file: applications may store user preferences or timestamps differently. The important agreement concerns scope, relationships, calendars, status, material dates and the reasoning behind them. Where a different tool or software version produces a different result, the difference should be reconciled rather than dismissed as an inevitable technical detail.

A reproducible schedule calculation and retained record

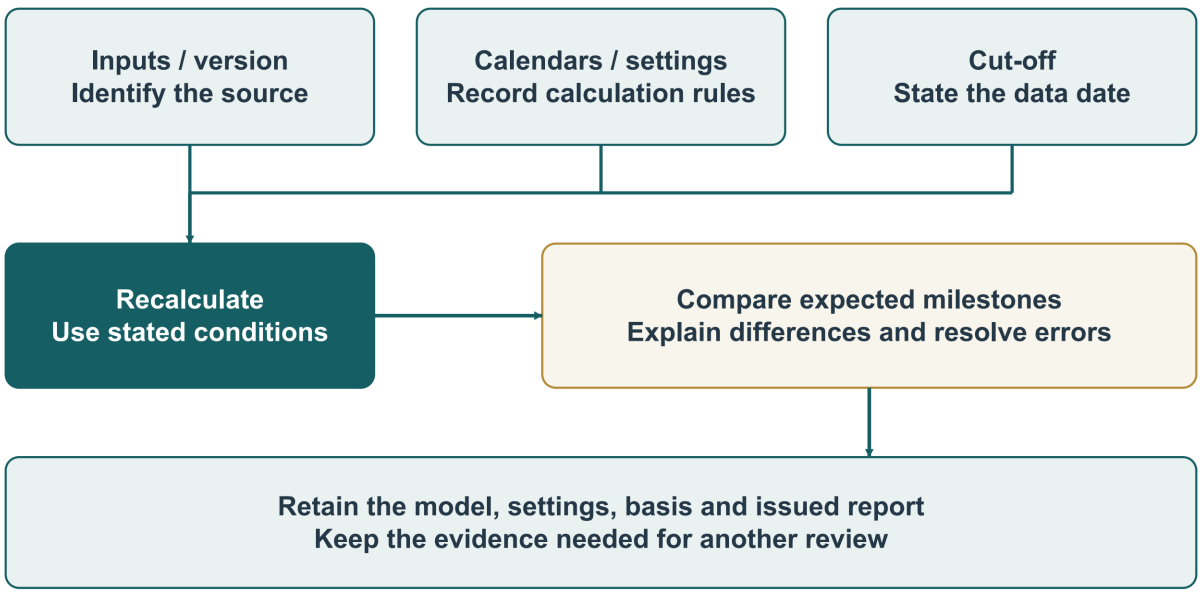


Figure 6.5. An original reproducibility process. Retained inputs and settings support recalculation, while comparison of significant outputs establishes whether the recovered model represents the same planning position.

The retained record should include the model instance in a suitable native or recoverable form, its calendar and relevant external information, the calculation settings, the associated basis of schedule and

the issued reports. The exact package depends on the system architecture: some organisations retain a controlled database snapshot, while others use a native file with supporting records. A PDF is valuable evidence of what was communicated, but it normally does not preserve the full model required to recalculate the forecast. Conversely, a native file without the issued report may not show what the decision-maker actually saw.

GAO's Schedule Assessment Guide supports this connection between the model and its explanatory record. Its basis-document guidance includes model organisation, logic, calculation parameters, software settings, calendars and justified exceptions (GAO, 2015, pp. 137-138). These are schedule-specific reasons for retaining the configuration as well as the activity data. The particular settings remain product-dependent; a named option in one application should not be assumed to have the same effect in another.

Check exchanges at both structural and semantic levels

An export can be syntactically successful while losing planning meaning. A relationship may survive but use a different lag calendar; a date may survive but change from calculated output to imposed input; or an activity may remain while its resource assignment is omitted. Compare more than the final completion date. Inspect counts and identities, representative calendars, relationship types, constraints, actual dates, remaining durations and selected milestone results. The final date could coincidentally match even when the internal model differs materially.

A useful exchange test begins with a small sample that includes the features most likely to cause difficulty. Include a calendar exception, a milestone, an in-progress activity and any important relationship or constraint type. Import it into a controlled receiving environment and compare the results with the source. Record supported mappings and known limitations, then apply the agreed treatment to the wider exchange. Where information cannot be transferred reliably, retain a clear reconciliation record and identify which source governs the disputed field. Open exchange formats can support interoperability, but the name of a format alone does not guarantee equivalent scheduling behaviour.

Huymajer et al. (2024) demonstrate this issue in a specific technical setting. Their IFC-based process represents tunnelling execution information, including labour, equipment and materials, and was evaluated with real data from the Zentrum am Berg research tunnel. The study shows how execution data can be exchanged and connected to geometry. Its application here is that interoperability requires agreed meanings and mappings. It does not demonstrate equivalent calculations across every scheduling product or a general reduction in project duration.

Release a checked instance rather than a moving working file

Reports should be generated from the reviewed instance after its calculation and reconciliation are complete. Continuing to edit the same file while preparing different reports can create an inconsistent pack: the milestone page may represent one forecast while the detailed appendix represents another. A controlled release point avoids that ambiguity. Record the instance, cut-off, comparison selection and report settings, then issue the relevant views together. If a material error is discovered afterwards, correct it transparently, preserve the superseded issue and explain the effect on the information already communicated.

6.5 Writing a basis of schedule that explains the model

The basis of schedule records the reasoning needed to understand and judge a particular schedule. It connects the numerical model to scope, evidence, assumptions, delivery methods and responsibilities. It should explain why the model has its present form and what conclusions it can support. A generic description of the software or a copied project narrative adds little unless it clarifies an actual modelling decision. The most useful content allows a reviewer to trace a significant date back to the work, conditions and evidence that produced it.

Distinguish the management plan from the model's basis

The schedule management plan establishes the rules for developing, maintaining, controlling and communicating schedule information. The basis of schedule explains how those rules and the available evidence have been applied to the particular model or issue. The first may specify that durations require owner review and source references; the second identifies the evidence and assumptions used for the current durations. They should be consistent and cross-referenced, but repeated pages of policy should not obscure the explanation of the actual plan. PMI's model-development discussion similarly connects the schedule to its management plan and requires the basis of duration and cost assumptions to remain current as the model changes (PMI, 2019, pp. 29 and 62).

The original framework in Figure 6.6 organises the basis into four connected layers. Scope and interfaces establish what the model covers. Method and configuration explain how it works. Evidence and uncertainty show the strength and limits of the inputs. Responsibility and history establish who reviewed the assumptions and what decisions changed the record. These are organising questions for a coherent narrative, not a prescribed form. A short, specific explanation with clear references can be more useful than a long document filled with repeated statements.

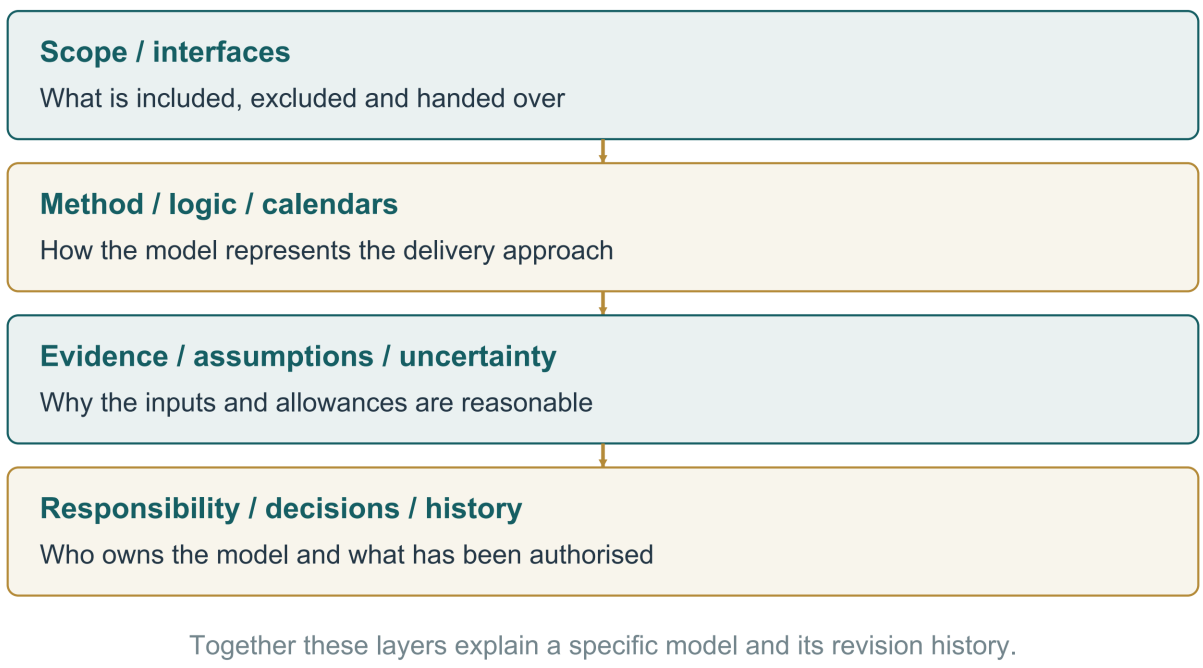


Figure 6.6. An original framework for the basis of schedule. The layers link the represented work to its calculation, supporting evidence and decision history.

Explain boundaries, interfaces and the delivery method

Begin by identifying the model, instance, purpose and maturity. Describe the included scope, relevant breakdown structure, completion conditions and any exclusions. An exclusion should explain its effect: if a supplier's internal manufacturing detail is outside the model, the receiving milestone and update arrangement still need to be understood. Clarify the interface rather than imply that excluded detail removes the underlying dependency. Distinguish confirmed requirements from assumptions about work that has not yet been fully defined.

Then explain the scheduling method and the important delivery logic. Identify major phases, interface milestones, approval gates and any unusual overlaps or constraints. Routine FS links do not each require a paragraph, but a critical partial-release assumption may require a clear explanation and an evidence reference. State the working calendars, significant exceptions, duration-estimating approach and assumed resource arrangements. Describe how long-term planning packages will be elaborated without losing their relationship to the existing scope and comparison record. Detail should be proportionate to the decisions the model is expected to support.

Make assumptions testable and uncertainty visible

> **Assumption.** 'A factor in the planning process considered to be true, real, or certain, without proof or demonstration.' (PMI, 2019, p. 176)

A useful assumption is specific enough to be checked. 'Resources will be available' leaves the reviewer unable to judge the dependency. A stronger explanation identifies the type and capacity of the resource, the period in which it is needed, the evidence currently available and the owner of the confirmation. The basis should also identify the consequence if the assumption fails. This does not require a full quantitative risk analysis at every early stage; it requires candour about the conditions under which the present forecast is credible.

Duration estimates should distinguish productive time, explicit waiting periods and any allowances for uncertainty. Where the project has adopted contingency or buffers, explain their purpose, location, ownership and relationship to the underlying estimates. Do not conceal the same exposure in both inflated durations and an additional allowance without recognising the overlap. At this stage, an emerging contingency rationale may identify unresolved exposure and the planned analysis, while the later risk chapter develops probability-based decisions in detail. A precise deterministic finish should not be presented as a confidence statement merely because the software displays an exact date.

Connect statements to evidence and decisions

Evidence references should allow the reader to locate the relevant source and understand its currency. A duration based on an estimator's current production assessment is different from a duration copied from an old project with different access conditions. A supplier's preliminary indication is different from an accepted commitment. Record these distinctions where they affect important milestones. The basis should not imply that every source has equal reliability or that a reference number alone resolves conflicting information.

Celik, Petri and Barati (2023) address the provenance of BIM information through a framework demonstrated in a bridge scenario and a blockchain test-network experiment. Their work records features such as version, issuing discipline and responsibility. The relevant scheduling lesson is to preserve where an input came from and how it changed. The study does not establish that stored data are inherently correct, prove project-wide schedule savings or imply that a scheduling team must adopt blockchain technology.

For example, an independent planning narrative might explain that installation uses a five-day working calendar, assumes an accepted design release by a stated boundary, and uses a duration derived from a reviewed quantity and crew productivity. It should then identify the unresolved access confirmation and the effect of a later release. This connects scope, logic, duration and uncertainty in a way that a list of dates cannot. When the access position changes, the model and its basis should be revised together so that the narrative continues to describe the calculation actually being issued.

The basis also records significant review findings, decisions and limitations. Identify who prepared and reviewed the model, the date of the review, the use authorised and any actions still open. Maintain a concise account of material changes between issues, including revised methods, scope, calendars or estimation assumptions. This makes the document a useful explanation of the current planning position while preserving the ability to understand earlier decisions. It should remain closely connected to the model, rather than becoming a separate report updated only when someone requests an audit.

A documented US example: regular updating without a sufficient basis

GAO's 2025 review of the US Department of Veterans Affairs' appointment-systems modernisation examined a May 2024 project schedule. It found weekly progress recording, a trained scheduler and baseline dates for most activities and milestones, but no schedule basis document explaining the approach, custom fields, assumptions and exceptional features. Reporting also lacked explanations of variances and logic changes (GAO, 2025, pp. 27-28). This concerns the modernisation project, not patients' appointment times. It demonstrates that useful control practices can coexist with a material documentation gap; the report does not establish that the missing basis caused a quantified delay.

6.6 Reviewing, approving and protecting the baseline

> **Baseline Schedule Model.** 'A baseline schedule model is an instance of the scheduling components at the time the project plan was approved by the project stakeholders (the latest approved schedule model) and is used for comparison to other schedule model instances.' (PMI, 2019, p. 108)

Baseline approval is a decision about a sufficiently developed and reviewed plan. The tool's capture function stores information, but the authority to use that information as the approved reference comes from the project's agreed process. PMI places approval after review of the calculated completion, milestones, critical paths, float and resource requirements, with iteration where changes are necessary (PMI, 2019, pp. 64-65). The level of evidence should match the commitment. Resource feasibility and uncertainty need proportionate consideration before dates are relied upon as an approved delivery baseline.

Separate review, agreement and authorisation

Technical review examines the model and its supporting basis. Agreement establishes whether the relevant delivery parties understand the scope, interfaces and assumptions. Authorisation records the decision of those empowered to approve the reference and any conditions attached to it. These responsibilities may involve some of the same people, but they answer different questions. A scheduler can confirm that the calculation is correct without having authority to accept a commercial milestone, and a sponsor's desire for a date does not establish the technical means to achieve it.

A provisional comparison snapshot can be useful while a plan is being developed. It allows the team to observe the effects of refinements without implying that all required approval has occurred. Its status should remain explicit. The independent worked example later in the chapter uses such a provisional reference for teaching the mechanics of an update. In a real project, any unresolved resource, risk or

assurance actions would be considered through the approval process before the plan became the authorised baseline.

England's HS2 reset provides a current example of this distinction. The NAO's June 2026 report describes the consolidation of estimates from 21 projects and further work to validate assumptions, test underlying information, resolve inconsistencies and examine integration. The estimates announced in May still contained substantial uncertainty; an initial baseline was targeted for autumn 2026 and a final version for spring 2027 (NAO, 2026, p. 23, paras 2.6-2.8). These were the audit's reported intentions, not completed approvals. A named revision or published estimate does not, on its own, demonstrate that assurance and authorisation are complete.

Schedule Baseline. 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and performance measurement baseline.' (PMI, 2019, p. 189)

The approved baseline should remain recoverable with its associated basis and approval record. A current forecast can move away from it as progress, remaining work or conditions change. That difference is useful management information. Replacing the baseline automatically with each update would remove the reference needed to explain performance. If a baseline change is legitimately authorised, retain the original and intervening approved versions, identify the reason and effective date, and make clear which comparison each report uses.

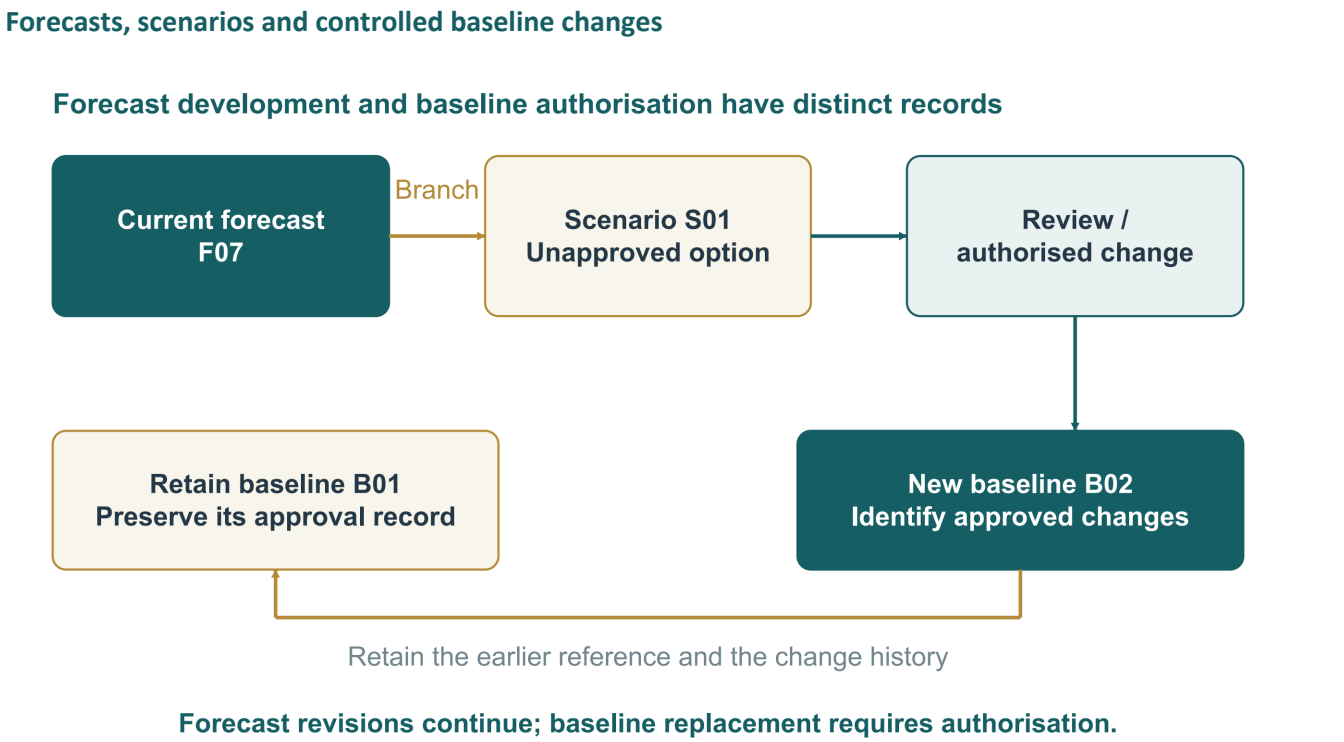


Figure 6.7. Original baseline-control model. Scenario analysis informs a decision; only an authorised change establishes a revised baseline. Previous approved records remain recoverable while the current forecast continues to evolve.

Understand the target model and the comparison question

Target Schedule Model. 'A target schedule model is an instance of the scheduling components used for comparison to other schedule models. A target schedule model may be selected from any available schedule model instance, for example, last update period.' (PMI, 2019, p. 134)

In this component definition, target does not necessarily mean a desired future date. It is a selected comparison instance. Comparing the current forecast with the original baseline answers how the position has changed from the original approved plan. Comparing it with the previous update answers what has changed during the latest reporting period. Comparing it with an authorised revised baseline addresses performance against the current approved reference. These questions are all useful, but their results should not be labelled as though they used the same starting point.

Table 6.5 | Baseline, target and comparison records

Record	Main purpose	Authority and preservation
Working model	Develop and test the present plan	Controlled editing; not every save is an issued instance
Current forecast instance	Show actual status and expected remaining delivery	Retain the reviewed cut-off and supporting evidence
Provisional reference	Compare developing options or teaching calculations	Label its limited status; it is not automatically approved
Approved baseline	Provide the authorised performance reference	Preserve approval and change only through the agreed process
Target instance	Supply the selected comparison point	Identify the exact version and the question being compared
Scenario	Explore an alternative assumption or response	Keep proposed changes distinct until the relevant decision is made

Integrate the baseline with scope and cost where required

A schedule baseline becomes more useful when its activity and work-package structure can be reconciled with authorised scope and, where applicable, time-phased budgets. An integrated performance measurement baseline requires consistent scope, schedule, budget and responsibility arrangements. Capturing dates alone does not create that integration. The team needs agreed progress rules and traceable links between the scheduled work and the control accounts or work packages against which performance will be assessed. Detailed earned-value calculations follow later; the principle here is that incompatible scope or timing assumptions produce misleading comparisons.

> **Change Control.** 'A process whereby modifications to documents, deliverables, or baselines associated with the project are identified, documented, approved, or rejected.' (PMI, 2019, p. 177)

A change decision should state what has changed and why, the options considered, the resulting effects and the records that must be updated. Correcting inaccurate status is not the same as authorising additional scope, and revising a forecast is not necessarily a baseline change. A major approved change may justify a revised baseline, but it should not erase the explanation of earlier performance. Preserve the relationship between the new reference and the earlier record so that the organisation can understand both the present plan and how it arrived there.

ANAO's 2024-25 Major Projects Report illustrates the importance of the selected comparison. For LAND 200 Tranche 2, it explained that an updated agreement redefined milestones, allowing final operational capability to be achieved against a new baseline. More broadly, it noted that rebaselining removed previously reported slippage from the comparison (ANAO, 2025, paras 4.22 and 4.25). An authorised rebaseline can be legitimate; the lesson is that performance against the revised reference does not, by

itself, answer whether the original commitment was achieved. The report does not establish how the project's native schedule files were retained.

6.7 Completing a first controlled update

Data Date (DD). 'A point in time when the status of the project is recorded.' (PMI, 2019, p. 179)

An update joins observed progress to an estimate of the remaining work. The data date separates the reporting position from the future forecast, but its exact treatment must be consistent with the tool and the agreed reporting convention. Record when the cut-off occurs, which evidence is included and how incomplete work is placed from that boundary. The date on which a report is prepared may be later than the data date. Those dates should not be silently substituted for one another, because doing so changes what the report appears to know.

PMI's maintenance guidance calls for gathering status, updating the model with actuals and remaining work, comparing the result with a retained reference, incorporating approved changes and communicating the outcome (PMI, 2019, pp. 67-69). A useful first update applies those principles to a small example. Detailed treatment of progress rules, out-of-sequence work and performance analysis follows in the schedule-control chapter. The purpose here is to establish a disciplined cycle and the distinction between evidence, calculation and decision.

Establish a provisional reference

Consider an independent digital-service release package with five activities. Each working period represents one working day. A confirms the requirements in two periods. B configures the platform in four periods and C prepares the operating guide in three; both follow A. D verifies the release in two periods after B and C, and E approves handover in one period after D. All relationships are FS with zero lag. The example uses one working-time scale, time-zero boundaries, fixed activity durations and sufficient assumed resources, with no imposed date constraints. A start milestone precedes A and a finish milestone follows E.

The initial calculation places A at zero to two, B at two to six, C at two to five, D at six to eight and E at eight to nine. Save this calculated instance as PR01, explicitly labelled a provisional reference for the example. Its finish at nine can be used to explain later movement, but PR01 is not described as an approved operational baseline. This distinction allows the mechanics of comparison to be taught without implying that the separate resource, risk and approval requirements have already been satisfied.

Record progress at boundary five and estimate what remains

At the reporting boundary five, accepted evidence shows that A started at zero and finished at two, while C started at two and finished at five. Completion at the boundary is included in this example's cut-off convention. B started at two and is still in progress. It has consumed three working periods, and its owner now estimates three further working periods to complete the remaining configuration. D and E have not started. The three-period remaining estimate is an input supported by the assessment of unfinished work; it is not obtained by subtracting elapsed time from the original four-period estimate.

Table 6.6 | Updating the illustrative model at boundary five

Activity	PR01 reference interval	Evidence at boundary 5	Remaining working periods	Updated finish
A: requirements	0 to 2	Actual start 0; actual finish 2	0	2, actual
B: configuration	2 to 6	Actual start 2; still in progress	3	8, forecast
C: operating guide	2 to 5	Actual start 2; actual finish 5	0	5, actual
D: verification	6 to 8	Not started	2	10, forecast
E: handover approval	8 to 9	Not started	1	11, forecast

The updated calculation places B's remaining work from five to eight. C is already complete, so D waits for B and occupies eight to ten. E then occupies ten to eleven. The current forecast finish is eleven, compared with nine in PR01, giving a movement of plus two working periods. The remaining driving sequence is B, D and E, requiring six periods from the reporting boundary. The observed actual dates remain recorded, and PR01 remains available for comparison.

Reference and updated positions for a small release package

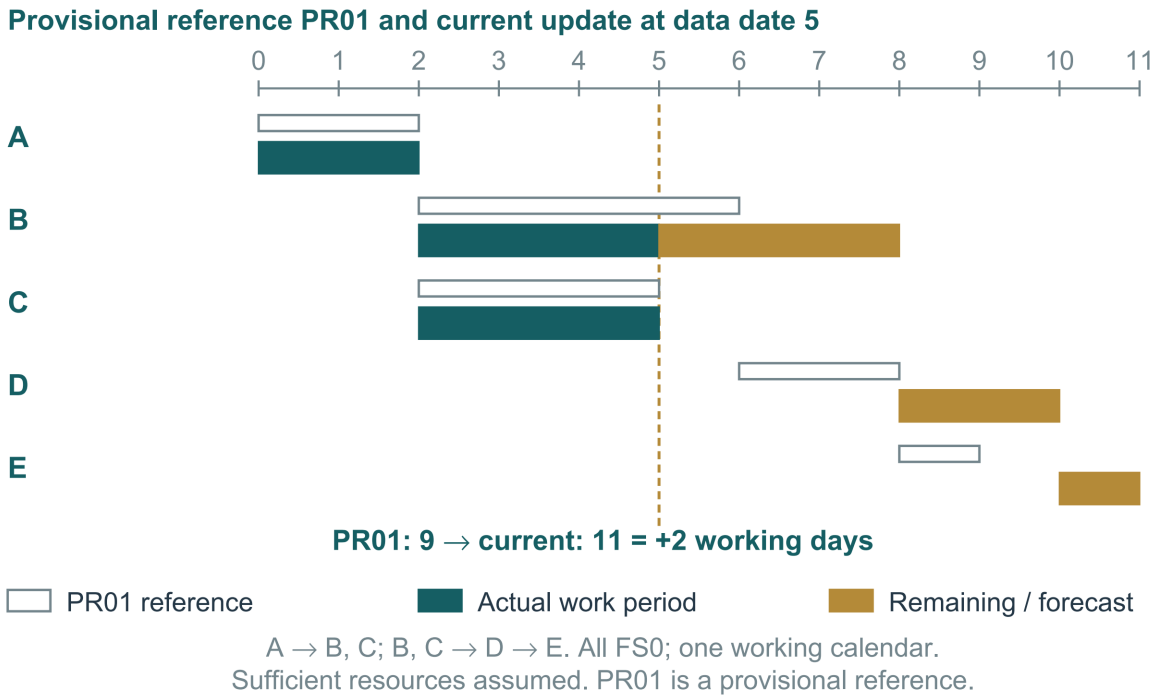


Figure 6.8. The original teaching example compares PR01 with the update at boundary five. Actual progress is retained; the remaining forecast moves completion from nine to eleven. PR01 is a provisional comparison reference, not an approved operational baseline.

The plus-two result is a finish-date variance against the named reference, with positive values meaning later in this example. It is not the earned-value schedule variance expressed as earned value minus

planned value. Reports should state the measure, sign convention, units and comparison instance. If a later report compares the same forecast of eleven with a previous update that also forecast eleven, it will show no period-on-period movement while still remaining two periods later than PR01. Both statements can be correct because they answer different questions.

Explain why percentage-complete values differ

> **Activity Duration Percent Complete.** 'The calculated percentage that the activity actual duration is of the activity total duration for a schedule activity that has work in progress.' (PMI, 2019, p. 176)

For B, actual duration is three and current total duration is three actual plus three remaining, giving 50 per cent. Dividing by the original duration of four would give 75 per cent, but that is not the definition's denominator. Suppose the same activity has four accepted, equally weighted configuration units out of ten; physical progress is then 40 per cent under that agreed quantity rule. Suppose also that 18 work-hours have been recorded and 12 remain; a work-based calculation using actual work divided by actual plus remaining work gives 60 per cent. That last formula is the convention selected for this illustration and must be checked against the actual product's work-percentage field.

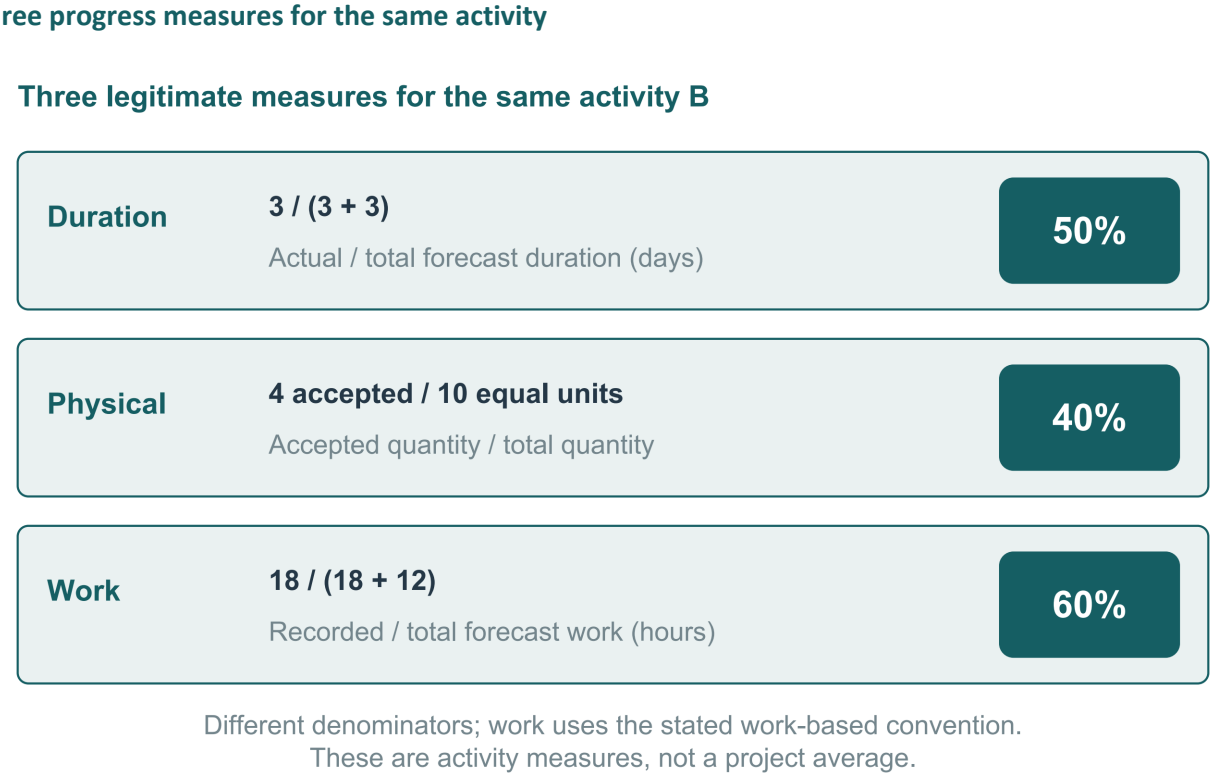


Figure 6.9. Duration, physical and work progress use different denominators. Their values need not agree. The work-based formula shown is an explicitly selected convention; the field's implementation must be checked in the scheduling tool.

These figures describe different aspects of progress rather than competing answers to one question. Time can be consumed without an equivalent proportion of accepted output, and effort can be spent on difficult work whose completion credit is recognised later. Remaining work-hours also do not automatically translate into remaining duration without knowing the resource allocation and working pattern. Nor should the project percentage be obtained by averaging unrelated activity percentages without a defensible weighting rule. Name the measure, retain its evidence and use it for the decision it can support.

Issue a concise explanation with the updated instance

A useful briefing for the example would state that the forecast finish is eleven, two working periods later than PR01, because configuration has three periods remaining at the reporting boundary. The guide is complete; verification and approval remain dependent on configuration. The team should evaluate any recovery option against the remaining work and acceptance requirements before adopting it. This explanation connects the changed input to the changed result, identifies the driving sequence and preserves the comparison basis. It is more informative than reporting that the project is a single percentage complete.

Before issue, check that actual dates are consistent with the cut-off, unfinished activities have credible remaining estimates and the reported views come from the same calculated instance. Save the reviewed update and its basis, retain the progress evidence and record any material assumptions still requiring confirmation. These steps establish the recurring cycle: observe, estimate, calculate, compare, explain and retain. They allow later analysis to distinguish a genuine change in delivery from a change in data, settings or reporting convention.

Sheik, Veelaert and Deruyter (2023) demonstrate an IFC workflow that creates progress information, adds planned data, incorporates actual observations and produces reports. Tested on several models, it illustrates how a structured exchange can support updating. It still depends on supplied observations: the model does not independently know that an activity has met its completion criteria. This reinforces the distinction between automating information transfer and establishing the evidence on which progress is accepted.

6.8 Integrating digital information without losing scheduling meaning

Digital project environments can connect schedules with models, quantities, locations, documents and operational information. This can improve the visibility of sequence and interfaces, but a connection is useful only when its meaning is understood. A three-dimensional object does not necessarily correspond to one schedule activity. One activity may deliver many objects, while an object may pass through design, manufacture, installation, inspection and acceptance activities. The mapping needs enough structure to represent the relevant lifecycle events without duplicating scope or crediting the same output more than once.

Locate the scheduling tool within the project information system

A project management information system (PMIS) brings together the information, processes and supporting applications used to manage the project. The scheduling application is one contributor: cost records, document control, risk information, resource data, approvals and reporting may reside elsewhere. Integration therefore requires agreed identifiers, ownership, cut-off dates, interfaces and reconciliation rules. A shared dashboard can still contain incompatible scope or reporting periods if those controls are absent. For example, an activity marked complete from an installation feed may still await the accepted test record held in document control. Define which evidence supports each field, which system controls it, and who resolves a disagreement before publishing the forecast. A PMIS can support these decisions and retain their history; the software does not acquire the project's approval authority.

Use visual integration to support an explainable model

A four-dimensional presentation links time information to a spatial model, allowing the team to examine the proposed sequence visually. It can reveal practical issues such as overlapping access requirements or an installation sequence that is difficult to understand in a conventional chart. The visual presentation still depends on the schedule dates, object selection and mapping rules. An appealing animation cannot demonstrate that relationships are complete, resources are available or the shown version is authorised. The professional should be able to trace a visible state back to the activity, model instance and information version that produced it.

Alhady et al. (2024) demonstrate a BIM and extended-reality workflow using the El-Merghani bridge. The authors explicitly used a hypothetical Primavera P6 schedule for the four-dimensional model. The study is therefore useful for understanding how geometry, scheduling and visual communication can be connected, while preserving the distinction between an illustrative sequence and observed construction performance. It should not be cited as evidence that the represented dates were achieved or that simulated benefits became realised project savings.

The following official international examples show different types of digital information relevant to that task. They range from project configuration and model-to-programme links to city information and laboratory evidence. They do not all describe scheduling software, and none is presented as an independent demonstration of reduced project delay. The questions in the final column are the chapter's professional interpretation of what a scheduler should establish.

Table 6.7 | Lessons from official digital integration examples

Official example	What the publication documents	Question for the scheduler
UAE: Dubai Digital Twin Platform, July 2026	A launch announcement describes combined spatial and operational information for planning, infrastructure and scenario analysis	Which dated and accepted information supports this activity or assumption?
France: Grand Paris Express BIM charter, version 2, March 2021	Configuration versions, coding and a shared reference model that need not be a single file	Which information configuration and object identifiers underpin this schedule instance?
Germany: Karlsruhe-Basel BIM-Lab brochure, July 2025	Links between three-dimensional objects, programme activities and cost-plan or quantity items	Is each object-to-activity mapping complete, current and appropriate for the analysis?
Egypt: HBRC digital technical reports, August 2025	Digital processes for issuing technical and laboratory reports across 39 laboratories, covering 223 tests	Which report supports the relevant testing, acceptance or release condition?

Sources: Protocol Department - Dubai (2026); Société du Grand Paris (2021); DB InfraGO (2025); HBRC (2025). The French charter is expressly non-contractual. The UAE and Egyptian releases do not demonstrate direct integration with an approved construction schedule.

The French and German examples make configuration and mapping particularly visible. A shared reference does not have to be one file, but its components need a recoverable relationship. A programme link does not mean that all systems synchronise automatically, so the source and receiving versions remain important. The UAE example broadens the range of available information, while the Egyptian example reminds the reader that useful digital evidence includes formal reports as well as geometry.

Digitisation changes how information is exchanged; it does not remove the need to interpret its scope, status and relevance.

Retain professional responsibility for the forecast

Automated imports, progress recognition and generated narratives can reduce repetitive work, but their outputs still require checks against the delivery evidence and model rules. A detected installed object may not yet satisfy the project's accepted-completion condition. A generated explanation may attribute a milestone movement to the wrong activity if it uses a stale comparison. Establish which information is observed, inferred, calculated or authorised, and retain the route by which it entered the schedule. The responsibility for the issued forecast remains with the project's agreed review and approval arrangements.

The schedule should now be understandable as an information system as well as a network calculation. Its identity, configuration, input evidence, comparison records and decision status should be clear enough for another professional to examine. The basis explains the plan's reasoning, while retained instances preserve the history of what was known and forecast.

Knowledge check and examination practice

These original questions support the configuration, model-development, baseline, updating and communication capabilities described in the PMI-SP Examination Content Outline (PMI, 2012, pp. 3-6 and 9). They are not official examination questions. Select the single best answer. For the numerical example, use the common working-time scale and explicit boundary-five reporting convention established in this chapter.

Question 1 - Identifying an approved baseline

A scheduler has calculated a model and used the software's baseline-capture command. Resource and risk reviews remain open, and the authorised approver has not accepted the plan. What is the most appropriate description of the saved record?

A An approved baseline because the software created it.
B A final performance measurement baseline because dates exist.
C A captured reference whose provisional status must remain clear until the required review and approval occur.
D An invalid record that must be deleted because it is not approved.

Question 2 - Interpreting catalogue attributes

An actual finish is manually entered from an accepted completion record. An early finish is calculated using an incorrect calendar. Which statement is correct?

A The manual value can be well supported, while the calculated value requires correction to its inputs and recalculation.
B The calculated value must be more reliable because no person typed it.
C Both values should be replaced with the baseline finish.
D Manual fields cannot be used in a conforming schedule model.

Question 3 - Checking an exchanged model

A schedule is exported to another product. The imported file contains the same number of activities and shows the same final completion date. What should the receiving scheduler do before relying on it?

A Accept it because matching activity counts prove equivalence.
B Accept it because matching completion dates prove equivalent logic.
C Delete the source file to ensure there is only one version.
D Reconcile identifiers, calendars, logic, constraints, status and representative outputs, including any mapping limitations.

Question 4 - Improving the basis of schedule

A model contains custom fields, unusual lags and a significant access assumption. The basis document gives only the software name and a general project description. Which improvement would add the most value?

A Add screenshots of every menu without explaining the modelling choices.
B Explain the fields, logic, settings and assumption evidence, including their effects and review responsibilities.
C Remove the unusual features from the narrative so the document is easier to approve.
D State that all dates are certain because the model calculates successfully.

Question 5 - Updating the forecast

At boundary five in the worked example, B has three working periods remaining. C is complete. D requires two periods after B and C, and E requires one after D. PR01 finished at nine. What is the updated finish and movement against PR01?

A Finish nine; no movement, because the reference remains stored.
B Finish eight; one period earlier, because B has three periods remaining.
C Finish eleven; two periods later, with the reference retained.
D Finish ten; one period later, because E is an approval rather than productive work.

Question 6 - Distinguishing progress measures

B has actual duration three and remaining duration three. Four of ten equally weighted units have been accepted. What are duration percent complete and physical progress under the stated rules?

A Duration 50 per cent; physical 40 per cent.
B Duration 75 per cent; physical 40 per cent.
C Duration 50 per cent; physical 50 per cent.
D Both must be 60 per cent because the work-based percentage is 60.

Question 7 - Naming the comparison

The current finish is eleven, the previous update also forecast eleven, and the original reference finish is nine. What should the report say?

A There is no variance against any reference because the current finish has not changed.
B The original reference should be overwritten with eleven to avoid inconsistent results.
C The schedule is two periods late against the previous update.
D There is no period-on-period movement, but the forecast remains two periods later than the original reference.

Question 8 - Interpreting a four-dimensional presentation

A stakeholder sees a detailed animation of a proposed construction sequence. The animation uses a hypothetical schedule and an older design configuration. What is the best professional response?

A Treat the animation as evidence that the sequence is approved and achievable.
B Identify its illustrative status, underlying schedule and design versions, and the reviews needed before it supports a delivery decision.
C Assume the animation automatically updates whenever design information changes.
D Use its displayed dates as actual progress because the objects are visible.

Answer explanations

Question 1 - C

The capture function preserves information; approval is an authorised project decision. The record can be useful for comparison while its provisional status and open reviews remain explicit. A confuses software functionality with governance. B additionally assumes that date capture establishes an integrated performance measurement baseline, which also requires consistent scope, budget and performance arrangements. D discards a potentially useful development record without justification. The appropriate action is to preserve and label it correctly while the necessary review proceeds.

Question 2 - A

Quality depends on evidence, meaning and correct processing. The actual finish is supported by a completion record, while the early finish inherits the wrong calendar assumption. B gives calculated data unwarranted authority. C replaces distinct observations and forecasts with a comparison value, destroying their meaning. D contradicts the catalogue's recognition of manual as well as calculated components. Correct the calendar through the appropriate process, recalculate and assess the effects; do not edit the forecast merely to make it resemble the baseline.

Question 3 - D

Matching counts and a final date are useful checks but do not demonstrate equivalent internal models. Those matches can occur even if an activity changed identity, a constraint replaced logic or a calendar difference happened to cancel another change; A and B therefore draw unjustified conclusions. C removes the source needed for reconciliation. The receiving scheduler should examine structural and semantic consistency, identify unsupported mappings and retain the source. Any material difference should be explained before the exchanged model is accepted for its intended use.

Question 4 - B

The basis should explain the actual model's reasoning and the information needed to judge it. Custom-field meanings, justified lags, access evidence and responsibilities make the calculation understandable and reviewable. A adds volume without explaining consequences. C hides matters that could materially affect delivery. D confuses successful arithmetic with certainty about the future. A useful basis makes limitations specific enough to investigate and connects important assumptions to evidence and decisions.

Question 5 - C

B finishes at five plus three, or eight. D then occupies eight to ten, and E ten to eleven. Compared with PR01's finish of nine, the movement is plus two working periods. A confuses preservation of the reference with preservation of the forecast. B stops the calculation at B and omits its successors. D omits the stated duration of approval even though that work is a required part of the network. The change is reported against the named reference without overwriting it.

Question 6 - A

Duration percent complete uses actual duration divided by current total duration: three divided by six equals 50 per cent. Physical progress uses the agreed accepted-output rule: four divided by ten equals 40 per cent. B divides actual duration by the original four-period estimate rather than the current total. C assumes time consumed implies the same proportion of accepted output. D assumes the work-based percentage governs every progress measure. Each value needs its own clear denominator and evidence.

Question 7 - D

The current and previous forecasts agree, so there is no period-on-period movement. The current forecast remains two periods later than the original reference, so that comparison still shows a difference. A fails to distinguish the selected targets. B destroys the original comparison record. C attributes the two-period difference to the wrong reference. A report should identify each comparison explicitly, because one can remain unchanged while another still indicates a material departure from the original plan.

Question 8 - B

The animation may be useful for discussing an option, but its evidential status depends on the schedule assumptions, design configuration, mapping and review. A treats visual detail as approval and feasibility. C assumes automatic synchronisation without evidence. D confuses a representation of proposed work with observed completion. The professional response is to explain what the presentation can support, identify its source versions and establish the additional checks needed for the decision being considered.

Preparing for Chapter 7

A coherent digital model can still assume more resource capacity than the organisation possesses. Chapter 7 tests that assumption by examining assignments, availability, loading and alternative delivery arrangements. Retain the controlled model, its basis and its comparison records while resource analysis changes the forecast. The same principles continue to apply: explain the inputs, understand the calculation, justify the decision and preserve the history.

References and further reading

Formal PMI definitions are quoted from the third edition with printed page references. Frameworks, figures, numerical examples and questions are original teaching material. Official cases and research findings retain their stated dates and evidence limitations.

Alhady, A., Alanany, M., Khodair, Y., Salem, S. and El Maghraby, Y. (2024) 'Integrating building information modelling (BIM) and extended reality (XR) in the transportation infrastructure industry', *Advances in Bridge Engineering*, 5, 22. doi:10.1186/s43251-024-00132-6.

Australian National Audit Office (ANAO) (2025) *2024-25 Major Projects Report*. Auditor-General Report No. 16 of 2025-26, 17 December, especially paras 4.22 and 4.25. Reporting position: 30 June 2025. Official report.

Celik, Y., Petri, I. and Barati, M. (2023) 'Blockchain supported BIM data provenance for construction projects', *Computers in Industry*, 144, 103768. doi:10.1016/j.compind.2022.103768.

DB InfraGO AG (2025) *BIM-Lab Karlsruhe: Digitales Planen und Bauen im Bahnprojekt Karlsruhe-Basel*. July 2025 imprint; especially 'Wie BIM den Arbeitsalltag verändert hat' and 'Aus 3D wird 5D'. Official project brochure.

Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, especially pp. 135-139. Official guide.

Government Accountability Office (GAO) (2025) *Veterans Health: Improvements Needed to Achieve Successful Appointment Scheduling Modernization*. GAO-25-106851, 22 May; publicly released 23 June. The schedule examined was dated May 2024; see pp. 27-28. Official report.

Government Project Delivery (2025) *Programme and project data standard*. Version 1.0, 11 December; approved for a twelve-month internal government trial. Especially Table 6 and sections 4-5. Official standard and status.

Housing and Building National Research Center (HBRC) (2025) 'HBRC discusses leading digital transformation in Egyptian infrastructure' [descriptive English translation of the Arabic title], 27 August. Chairman's statement on digital technical and laboratory reports. Official centre release.

Huymajer, M., Melnyk, O., Wenighofer, R., Huemer, C. and Galler, R. (2024) 'Building Information Modeling in the execution phase of conventional tunneling projects', *Tunnelling and Underground Space Technology*, 146, 105539. doi:10.1016/j.tust.2023.105539.

National Audit Office (NAO) (2026) *High Speed Two reset*. 29 June, especially p. 23, paras 2.6-2.8. Official report.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*, especially pp. 3-6 and 9. Official examination outline.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: Project Management Institute. Especially sections 2.3-2.5, 3.2.1.6-3.2.1.8, 3.3 and 4.1-4.3, Table 5-1, Appendix X3 and the glossary. Citations use printed pages.

Protocol Department - Dubai (2026) 'Hamdan bin Mohammed witnesses launch of Dubai Digital Twin Platform', 2 July. Official launch announcement.

Sheik, N.A., Veelaert, P. and Deruyter, G. (2023) 'Exchanging Progress Information Using IFC-Based BIM for Automated Progress Monitoring', *Buildings*, 13(9), 2390. doi:10.3390/buildings13092390.

Société du Grand Paris (2021) *Charte BIM de la Société du Grand Paris: Stratégie de déploiement et objectifs de la démarche BIM*. Version 2, 24 March, document UMQO_02_HPH_PGR_000005_2; especially pp. 8, 16 and 30. Official project-owner charter.

CHAPTER 07

Testing Resource Feasibility and Optimising the Schedule

Turning a logical sequence into a deliverable plan

A schedule can contain complete scope, credible dependencies and correctly calculated dates while still requiring the same people or equipment in two places at once. The calculation has established what the logic permits, but it has not necessarily established what the organisation can deliver. Resource analysis closes that gap by connecting the work to the capacity, capabilities and working arrangements needed to perform it. The question is not simply how many resources the project needs in total. It is which resources are needed, where, when, for how long and under what conditions.

This chapter develops the resource information within the digital model and tests its consequences for completion, cost and delivery risk. It explains resource libraries, assignments, calendars, quantities and productivity before using an independent worked example to expose an overallocation. It then compares smoothing and levelling, examines time-phased costs, introduces critical-chain buffers and evaluates alternative delivery arrangements. A short update shows how changed remaining resource requirements affect the forecast. The examples use transparent assumptions so that learners can distinguish what the arithmetic proves from what still needs professional judgement.

For PMI-SP preparation, the central capabilities are to establish resource requirements, identify availability, develop a resource-constrained schedule and evaluate alternatives. At Project Controls Professional Level 6, the scheduler should also be able to challenge capacity claims, recognise conflicting commitments and explain the effects on affordability, safety, quality and environmental constraints. A shorter schedule is useful only when the proposed delivery method is credible. Uncertainty is introduced here from first principles as a condition affecting resource decisions and developed more fully in Chapter 8.

The chapter framework: demand, capacity and a justified decision

The original framework in Figure 7.1 connects six responsibilities. Define the required capability, assign it to the work, compare time-phased demand with available capacity, resolve conflicts, evaluate the consequences and maintain the agreed position. The process is iterative because a change to crew size can alter duration, a changed duration can create a new conflict, and a different delivery date can change cost or access conditions. Resource analysis therefore belongs within schedule development and control, rather than being a separate calculation performed after the dates have already been promised.

Resource feasibility and optimisation framework

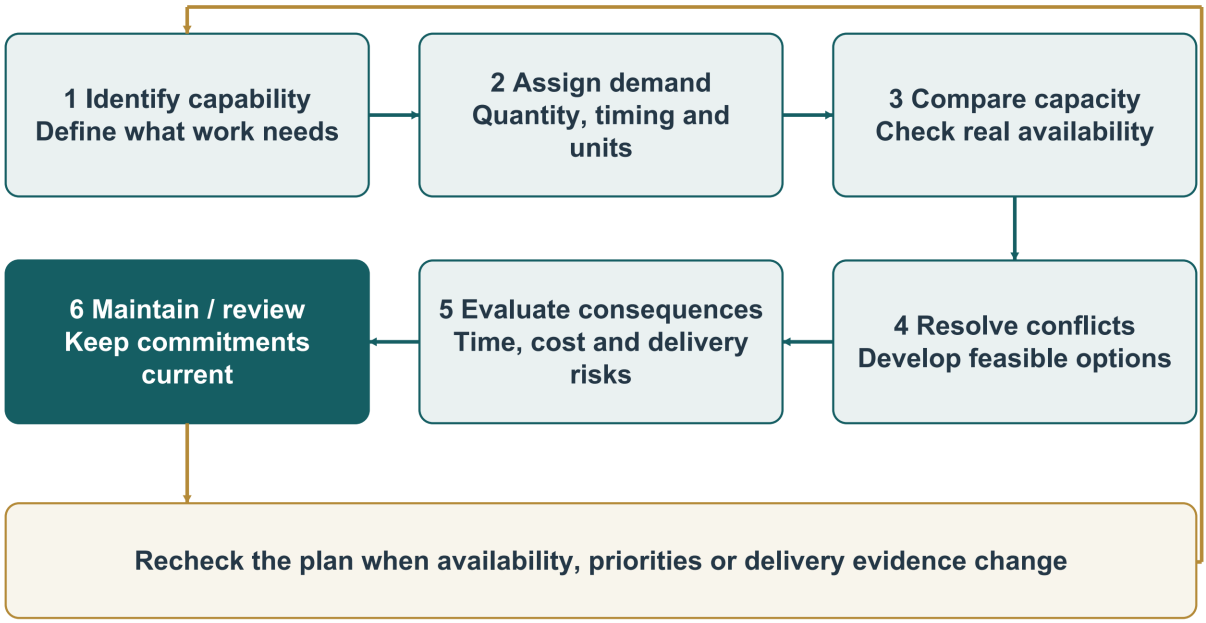


Figure 7.1. An original framework for testing resource feasibility. The result is a justified delivery arrangement with explicit assumptions, rather than a resource chart considered in isolation.

7.1 Defining the resources and capabilities required

> **Resource.** 'Skilled human resources (specific disciplines either individually or in crews or teams), equipment, services, supplies, commodities, budgets, or funds.' (PMI, 2019, p. 188)

Resources extend beyond headcount. A test may require a qualified specialist, a calibrated instrument, an available test bay, an accepted procedure and a material sample. Adding more general labour does not substitute for any missing element in that combination. The resource analysis should identify the conditions that enable the activity to proceed, including the capability and capacity of the limiting resource. PMI's resource-planning guidance explicitly recognises human resources, machines, materials and locations, together with availability, calendars and skill sets (PMI, 2019, pp. 52 and 61).

Organise a resource breakdown structure and dictionary

A resource breakdown structure organises resources into a meaningful hierarchy, commonly by category and type. It helps the team identify the range of capabilities needed and report demand at suitable levels. A top-level labour category might divide into engineering, installation and testing; equipment into lifting, access and specialist tools; and materials into the relevant supply groups. The hierarchy should reflect the project and the decisions it supports. It is distinct from the work breakdown structure, which organises scope, although assignments connect resources to the scheduled work (PMI, 2026, p. 24).

> **Resource Library.** 'A documented tabulation containing the complete list, including resource attributes, of all resources that can be assigned to project activities. Also known as resource dictionary.' (PMI, 2019, p. 189)

The library turns the hierarchy into usable information. Each entry needs a stable identity, a clear description, an appropriate classification, units, availability and relevant attributes. The Resource ID distinguishes the resource; the Resource Description explains the role or item; and the Resource Type supports classification. A type should not imply that everyone in the category is interchangeable.

Individuals may have different competences, authorisations, familiarity with the asset or ability to work independently. Record the distinctions that materially affect the activity rather than treating a generic label as evidence of capability.

Resource hierarchy and dictionary information

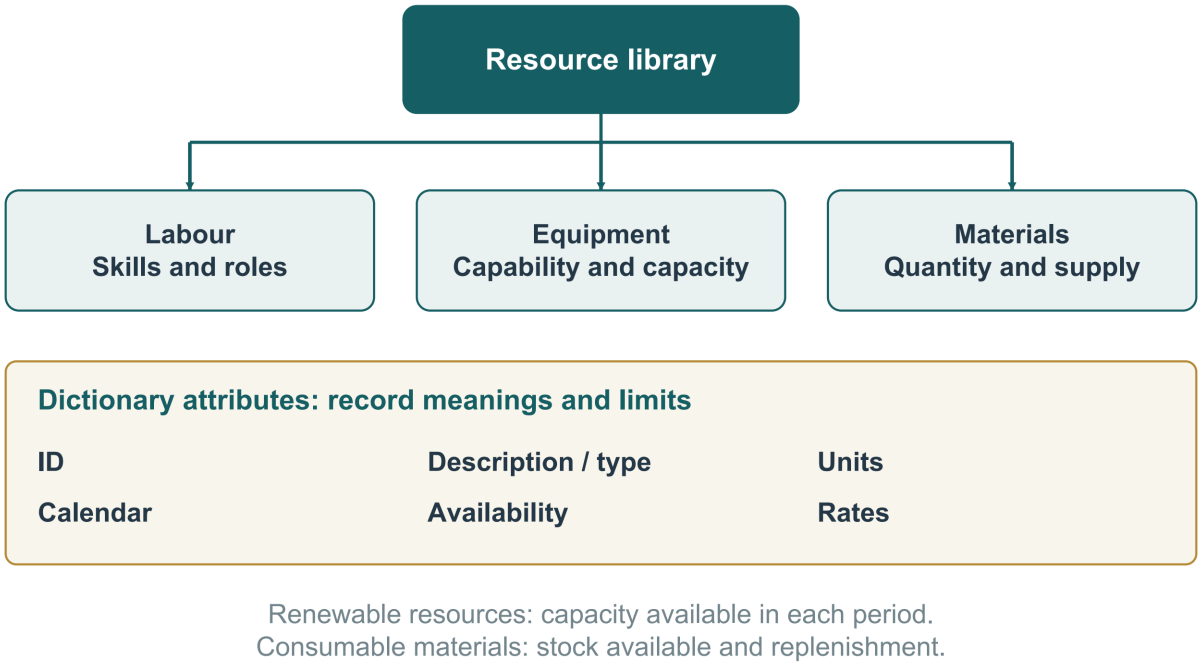


Figure 7.2. An original resource-information structure. The hierarchy supports grouping, while the dictionary establishes what each assignable resource represents and the conditions governing its use.

> **Resource Type.** 'A unique designation that differentiates a resource by skills, capabilities, or other attributes.' (PMI, 2019, p. 189)

The source catalogue describes one classification type for an individual resource, but that should not be read as a claim that a person can possess only one skill (PMI, 2019, p. 128). A person with several capabilities remains one person with limited availability. Recording that individual under several skill categories must not create several independent pools of capacity. Where the model uses generic roles during early planning, document the assumption about substitutability and confirm the actual allocation before relying on it for near-term execution.

Recent research helps explain why this distinction matters. Snauwaert and Vanhoucke (2025) examined scheduling formulations in which skill proficiency affects eligibility, substitution, duration, cost or other aspects of resource use. Their computational experiments show how different capability assumptions lead to different scheduling problems. They do not establish a universal productivity advantage for a particular qualification or grade. The practical implication is to record the competence and authorisation actually required by the work, and to support any assumed productivity difference with evidence from the relevant delivery environment.

Match quantities to meaningful units

Table 7.1 | Resource quantities and their units

Resource information	Appropriate example	Important distinction
Labour capacity	Two qualified technicians available per working day	A headcount limit differs from total person-days of effort
Equipment capacity	One inspected lifting unit in an agreed operating window	Availability also depends on access, setup and operating conditions
Consumable quantity	Forty accepted components available before assembly	Stock is consumed; it is not a reusable daily capacity
Specialist service	An inspection team available for a defined period	The booking must match the required competence and acceptance role
Facility or location	One test bay with a compatible operating calendar	The location can constrain work even when labour is available

Renewable capacity, such as a crew or a machine, becomes available again after an assignment ends. A consumable material is used up and requires a stock and replenishment interpretation. These different resource behaviours should not be forced into one undifferentiated total. Even within labour, a person-day, a crew-day and an hour are different units. An eight-person-day requirement may mean two people for four days or four people for two days only where the delivery method permits that substitution. The library should identify the unit and the assumed crew composition clearly enough to prevent accidental conversion.

7.2 Connecting effort, duration, productivity and availability

> **Effort.** 'The number of labor units required to complete a schedule activity or work breakdown structure component, often expressed in hours, days, or weeks. See also duration.' (PMI, 2019, p. 180)

Effort measures the labour input; duration measures the working time occupied by the activity. Their relationship depends on the delivery method, productive capacity and working calendar. Under a simple constant-productivity assumption, duration can be estimated as required effort divided by productive labour capacity per working day. The assumption matters: coordination, access, minimum crew requirements, learning and fixed process time can prevent the arithmetic from scaling proportionately. The planner should establish the delivery mechanism before selecting a formula.

Use the effort calculation as an explicit model

Suppose a divisible task requires sixteen person-hours of productive effort. Two suitably qualified people can each contribute four productive hours per working day, giving eight person-hours per day and a two-day duration. This is a transparent estimate under the stated assumptions. It does not establish that four people could complete the task in one day. The work may have limited work fronts, require sequential decisions or need supervision that becomes a bottleneck. Distinguish attendance time from productive time and avoid hiding the same allowance in both the effort estimate and an unexplained productivity reduction.

Effort, productive capacity and duration

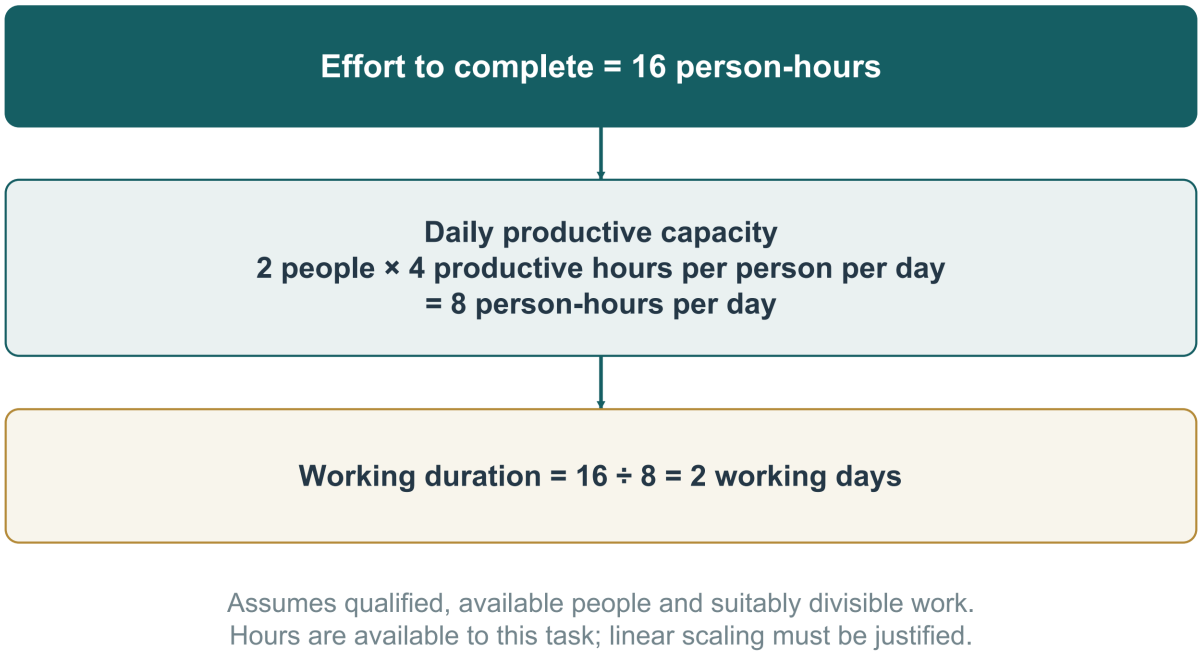


Figure 7.3. An original effort-duration illustration. Sixteen person-hours divided by eight productive person-hours per day gives two working days; the result depends on the stated method and capacity assumptions.

> **Resource Assignment.** 'The linkage of one or more resources to a schedule activity and identification of the amount of each resource that is needed to accomplish the work on that schedule activity.' (PMI, 2019, p. 188)

An assignment should establish more than the name of the responsible team. It should identify the relevant resource, quantity or intensity, timing and basis of the requirement. Two technicians assigned throughout a four-day activity represent eight technician-person-days. A specialist required only for the final inspection has a different assignment pattern. Uniform loading may be a useful approximation for early planning, but it can conceal peaks or late mobilisation requirements. Use sufficient detail to support the capacity decision without manufacturing precision that the underlying estimate cannot justify.

> **Resource Availability.** 'The dates and number of work periods, in calendar units, that a given resource is available according to the appropriate resource calendar.' (PMI, 2019, p. 188)
>
> **Resource Calendar.** 'A calendar that identifies the working days and shifts upon which each specific resource is available.' (PMI, 2019, p. 188)

Availability is not the same as uncommitted capacity. A resource may be employed and working throughout a week while already assigned to another project. The source catalogue specifically notes that the availability value does not itself reflect existing assignments (PMI, 2019, p. 127). Check both the working calendar and the allocation across relevant activities and projects. A locally feasible schedule can remain organisationally infeasible when several teams have independently assumed access to the same specialist, equipment or facility.

The United States Government Accountability Office's study of naval shipbuilding and repair illustrates the difference between an asset inventory and usable capacity. Its analysis considers dry-dock suitability, competing commercial and government work, location and workforce demand over time. A dock's

existence does not make it suitable and available for every maintenance requirement; similarly, a forecast workforce peak may require earlier retention and development of skills. This is an example of matching a dated requirement to usable capability, rather than treating all facilities or workers as interchangeable (GAO, 2025, pp. 25 and 28-30).

Identify the resource that governs the duration

Some resources directly govern an activity's rate or duration; others support it without being the limiting factor. PMI calls attention to driving resources because their allocation can affect duration during levelling (PMI, 2019, p. 112). For example, an approved test procedure may require one qualified operator and a fixed two-hour equipment cycle. Adding observers will not shorten that cycle. Conversely, additional trained installers may increase output where work fronts and materials are available. The scheduling tool's activity and assignment settings must represent the chosen relationship; different settings can hold duration, effort or units constant when another value changes.

> **Resource Lag.** 'The number of calendar units a resource is to wait after the activity start date before beginning work on the schedule activity.' (PMI, 2019, p. 188)

A resource lag describes delayed participation within an activity, not a relationship delay between two activities. It may represent a stable arrangement in which a specialist joins after an initial stage. The standard advises using it for an unchanging interval (PMI, 2019, p. 128). If the specialist's participation depends on a separately managed release or uncertain predecessor output, an explicit activity or milestone may make the condition clearer. A resource lag should not conceal work whose ownership, progress or uncertainty needs to be visible.

Keep actual, remaining and total quantities distinct

At activity level, actual resource quantity records the resource used to the reporting cut-off, remaining quantity estimates what is still required, and the current total brings the two together on a consistent basis. Project-level actual, remaining and total quantities aggregate the relevant assignments across activities. These totals should retain the resource identity or compatible classification and unit. Summing crane-hours and tonnes produces no useful resource measure, while summing labour effort does not reveal the maximum number of people needed at the same time (PMI, 2019, pp. 105-106 and 125-126).

The current total is not necessarily the original estimate. Additional effort may be needed because of rework, revised scope or lower productivity. Equally, a method improvement may reduce what remains. Record the evidence and assumptions behind the revised remaining quantity rather than forcing it to equal the original estimate less actual consumption. The short update later in this chapter demonstrates how a changed remaining quantity affects duration, the resource-constrained sequence and the cost forecast.

7.3 Exposing demand and bottlenecks in a worked schedule

Resource loading places the estimated demand against time. The resulting profile can show a conflict even when the network logic is correct. A histogram usually displays demand or usage for each period; a cumulative curve shows the quantity accumulated over time. Neither should be interpreted without its units, calendar, reporting interval and capacity reference. A monthly average may conceal an infeasible daily peak, and a low project-wide average may coexist with an overloaded specialist who governs completion.

Establish the independent example

Consider a small equipment-readiness package. A prepares the test specification. B and C calibrate two separate units after the specification is ready. D tests the integrated arrangement after both calibrations. E prepares a training pack after A, and F releases the package when D and E are complete. All durations and costs are invented teaching values. Each time unit is one working day, measured from boundary zero; all relationships are FS with zero lag, one common calendar applies, and activities are not interrupted once started. A start milestone precedes A and a finish milestone follows F.

Table 7.2 | The resource-feasibility worked example

ID	Activity and predecessors	Duration: working days	Assignment throughout activity
A	Prepare test specification; start boundary	2	One planner
B	Calibrate unit 1; after A	4	Two technicians
C	Calibrate unit 2; after A	3	Two technicians
D	Test integrated arrangement; after B and C	2	Two technicians
E	Prepare training pack; after A	5	One writer
F	Release package; after D and E	1	One manager

The technical sequence alone places A at zero to two, B at two to six, C at two to five and D at six to eight. E occupies two to seven, allowing F to occupy eight to nine. The logic-only finish is therefore nine. The planner, writer and manager are available as required, but the organisation can supply only two qualified technicians at a time. Each of B, C and D requires a fixed two-person crew; one person cannot perform the activity alone under the assumed method. The technicians are interchangeable within that crew, and no other technician assignments exist in this example.

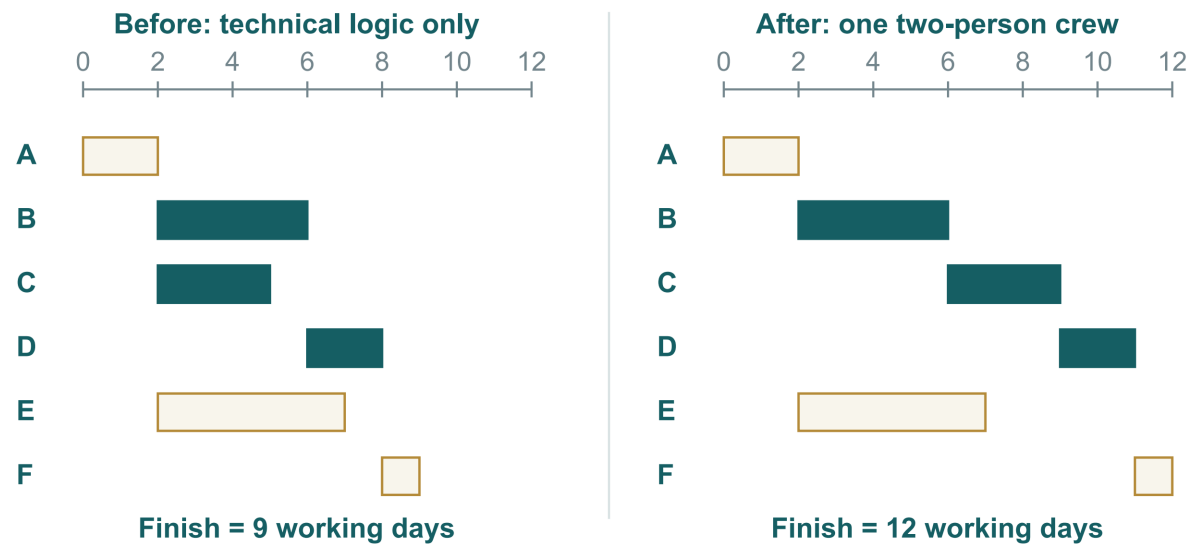


Figure 7.4. The original teaching example contrasts the nine-day logic-only calculation with a twelve-day sequence using the available two-person technician crew. Moving C does not change the technical prerequisites for integrated testing.

Compare demand with the available capacity

Between boundaries two and five, B and C each require two technicians. The combined demand is four against a capacity of two. The file may still display a nine-day finish if resource assignments have been entered without enforcing the availability limit. Assignment and feasibility are different stages. The conflict cannot be resolved by changing the display scale or by reporting that the average technician requirement is below two over a longer interval. The same two people cannot undertake both fixed-crew tasks simultaneously under the stated assumptions.

The total technician effort is eight person-days for B, six for C and four for D, giving eighteen person-days. Total effort alone does not identify the conflict; the timing of that effort does. With two technicians available, the three activities occupy nine crew working days. They cannot begin before A finishes at two, and F needs a further day after D. These observations establish a lower bound of twelve days for the whole package under the stated resource and method assumptions. A feasible schedule that reaches twelve will therefore be optimal for this small example.

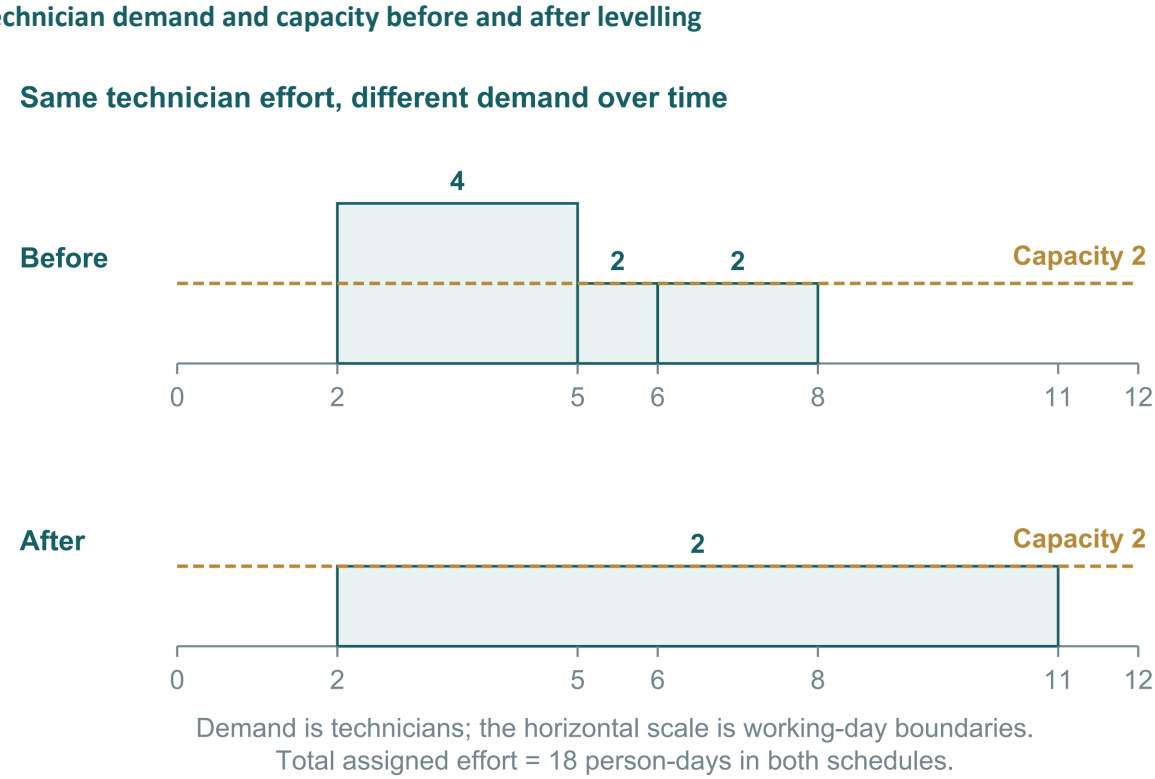


Figure 7.5. The original demand profile exceeds the two-technician limit. The revised sequence uses the same eighteen technician-person-days over a longer interval without exceeding capacity.

Resolve the conflict and trace the new controlling sequence

Retain B at two to six, then schedule C from six to nine. D can now occupy nine to eleven, and F eleven to twelve; E remains two to seven. The resource limit is respected throughout. Scheduling C before B would also finish the calibration work at nine and the package at twelve. Both sequences achieve the lower bound, although a real project might prefer one because of access, risk, supplier readiness or the value of obtaining a particular result earlier. The arithmetic establishes equal completion under this model, not equal desirability in every respect.

The controlling sequence now reflects the resource order as well as the technical logic. B and C did not originally have a technical dependency on one another, but they compete for the same indivisible crew. Preserve that distinction when recording the solution. A documented resource sequence or resource-driven relationship can make the chosen order reproducible, but it should not be misrepresented as a permanent physical prerequisite. If another qualified crew becomes available, the reason for sequencing B and C may disappear and should be reviewed accordingly.

Activity Resource-Leveled Start Date and Activity Resource-Leveled Finish Date identify the resulting positions after resource limitations have been considered. The corresponding project fields describe the first and last scheduled boundaries of the resource-limited model. Here the project start remains zero, while its finish moves from nine to twelve; C moves to six to nine and D to nine to eleven. Product implementations and the stored distinction between original calculated dates and levelled dates vary. Preserve both the comparison and the settings that produced the revised position (PMI, 2019, pp. 105-106 and 125).

Plan the release of capacity

The resource profile should show how capacity ramps up, reaches its peak and ramps down, as well as whether its highest point exceeds availability. PMI explicitly includes these stages in resource planning (2019, p. 52). Mobilisation may require recruitment, induction, qualification, equipment and access before the crew becomes productive. The falling side of the profile also requires a decision: a team cannot be released solely because its main production activity has finished if testing, defect correction, records or handover still need its competence. Compare the proposed release date with credible remaining demand and agreed commitments to other projects. Record who can authorise release, any notice or remobilisation conditions and the residual capacity retained. This makes the staffing profile an executable deployment plan rather than a curve that assumes people appear and disappear without consequences.

7.4 Distinguishing smoothing from levelling

> **Resource Leveling.** 'A resource-optimization technique in which adjustments are made to the project schedule to optimize the allocation of resources and which may affect critical path.' (PMI, 2019, p. 188)

Resource levelling adjusts the schedule to address the resource situation. The resulting changes may affect activity timing, the controlling sequence and project completion. Resource smoothing seeks to adjust demand within the available scheduling flexibility while preserving the required schedule boundaries; it may be unable to remove every conflict without a further change to the plan. The distinction concerns what the adjustment is allowed to change, rather than whether it is performed manually or through software. PMI's current lexicon distinguishes these techniques, while the scheduling standard develops levelling and its consequences in detail (PMI, 2026, p. 24; PMI, 2019, pp. 83-84).

> **Resource-Limited Schedule.** 'A project schedule whose schedule activity, scheduled start dates, and scheduled finish dates reflect expected resource availability. Also known as resource-constrained schedule. See also resource leveling.' (PMI, 2019, p. 189)

The main worked example requires a changed completion date if only two technicians are available. C originally has one day of total float in the logic-only network, but moving it from two to six is a four-day start shift. The existing flexibility cannot absorb the conflict. Calling the adjustment smoothing would obscure its effect: the resource-feasible finish moves from nine to twelve. If the nine-day finish must be preserved, the team needs a different feasible arrangement, such as additional qualified capacity or a substantiated change to the method.

A separate example where smoothing is sufficient

Consider two independent preparation jobs P and Q, lasting three and two working days respectively. Both may start at zero, each needs two technicians throughout, and only two technicians are available. A separate activity R takes six days, uses another resource and also starts at zero. All three must finish before the same completion milestone. The logic-only dates put P at zero to three, Q at zero to two and R at zero to six. Completion is six, governed by R. P has three days of total float and Q four.

Move Q to three to five, after P. The technician demand never exceeds two, and completion remains six because R still governs the milestone. Q uses three of its four days of flexibility and retains one. This is a successful smoothing adjustment under the stated assumptions. It does not prove that every resource conflict can be resolved without changing completion. The amount and location of available float, the resource requirements and the independent controlling work determine whether such an option exists.

Smoothing within the available scheduling flexibility

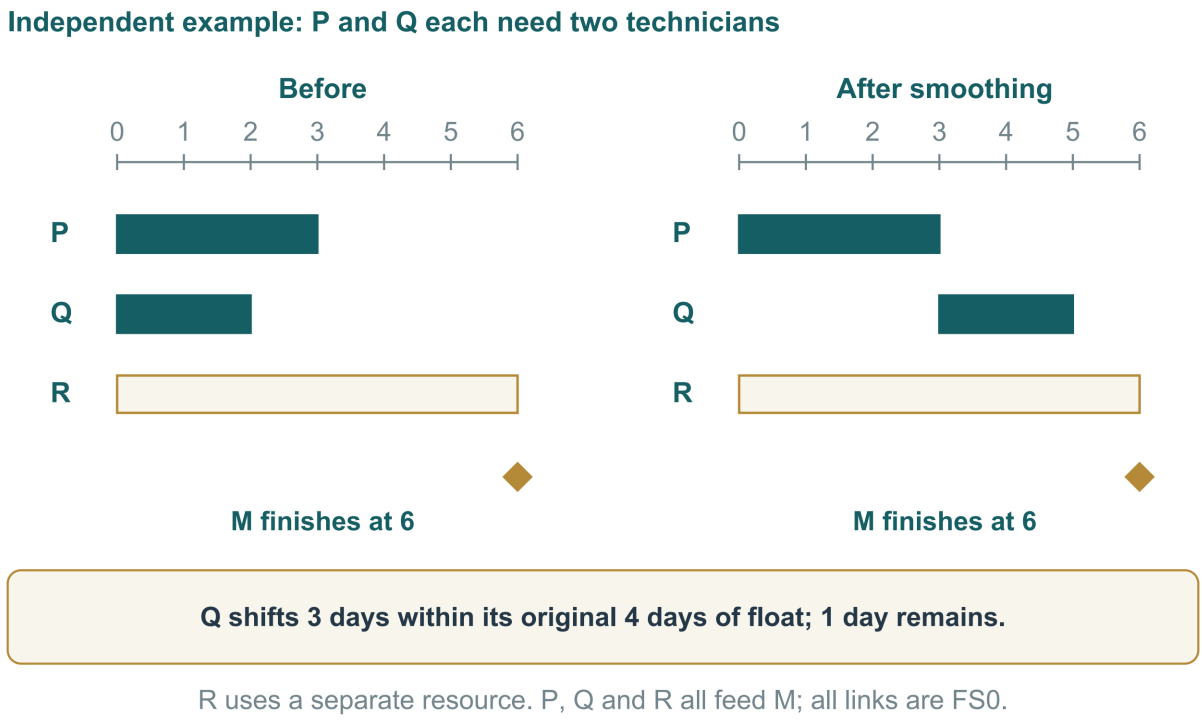


Figure 7.6. A separate original example: moving Q within its available float removes the technician conflict while the independent six-day activity R continues to govern completion.

Table 7.3 | Comparing resource smoothing and levelling

Decision	Smoothing emphasis	Levelling emphasis
Main boundary	Adjust resource demand within available schedule flexibility	Respect the selected resource limits, allowing schedule effects where necessary
Project finish	Preserve the relevant completion boundary	May move if the available capacity cannot support the earlier date
Unresolved conflict	May remain when float is insufficient	Requires a feasible sequence, changed capacity or an explicit unresolved limitation
Professional check	Confirm the change remains within the intended limits	Recheck dates, controlling sequence, float, cost and delivery assumptions

Comparison synthesises PMI's treatment of the techniques. A software command's name does not establish which constraints its selected settings actually enforce.

Review priorities and algorithmic choices

A scheduling tool may prioritise activities by float, dates, assigned priority or another rule when several activities compete for capacity. It may allow splitting, consider only selected resources or use a particular planning horizon. These settings can produce different results from the same activity list. Record the choices that materially affect the solution and inspect the result with the delivery team. A feasible output is not automatically the shortest, cheapest or most robust option; conversely, a shorter output may depend on an unacceptable assumption about interruption or resource substitution.

The twelve-day solution in the main example is provably optimal because a simple resource-capacity lower bound matches a feasible schedule. Most substantial project models do not admit such an easy proof. They involve several resource types, calendars, skills and competing objectives. A heuristic offers a practical way of finding a useful solution, but it should not be presented as a proof of global optimality. Compare meaningful alternatives, test sensitive assumptions and disclose the limits of the search rather than claiming that a software result is 'the optimum' without supporting evidence.

GAO's schedule guidance reinforces the need to review automatically levelled results and the resource assumptions behind them (GAO, 2015, pp. 52-62). A coarse resource category can conceal the very specialist shortage the analysis is intended to expose. Retain the chosen order through controlled settings or a documented model representation, and test that it can be reproduced. Avoid locking dates with arbitrary constraints merely to preserve the appearance of a levelled chart; doing so can prevent the model from responding properly to subsequent changes.

Research on multi-skilled scheduling reinforces this need for judgement. Vermeire and Vanhoucke (2025) combined activity, skill and resource priority rules and evaluated the resulting schedules computationally. Some results improved on previously best-known benchmark solutions, but a best-known solution is not necessarily a proven optimum. The professional lesson is to compare suitable priority and assignment choices, document their assumptions and test their outcomes. A software-generated date gains credibility from the model and evidence behind it, rather than from the fact that an algorithm produced it.

7.5 Connecting resource choices to time-phased cost

> **Resource Rate.** 'The unit cost rate assigned to a specific resource, including known rate escalations.' (PMI, 2019, p. 189)

A resource quantity becomes a cost estimate only when its unit and rate basis are understood. A technician-person-day, a machine operating hour and a fixed mobilisation charge have different cost behaviours. Rates may vary by period, location, shift or commercial arrangement. Distinguish productive assignment cost from paid standby, minimum hire periods, travel, setup and indirect costs. A schedule that spreads the same effort over more days may leave one direct-cost calculation unchanged while increasing supervision, facility or project-running costs.

Cost the worked example under explicit assumptions

For this teaching calculation, the planner costs £400 per assigned day, each technician £300 per assigned person-day, the writer £250 per assigned day and the manager £450 per assigned day. The rates are invented and constant. Only assigned working time is charged; there are no standby, minimum-hire, travel or other charges unless explicitly introduced. Project indirect cost is £200 for each working day from start to completion. These assumptions make the comparison transparent, but a real estimate would use the actual commercial and employment arrangements.

Table 7.4 | Direct resource cost in the worked example

Activity	Assigned quantity and rate	Direct cost
A	2 planner-days at £400	£800
B	8 technician-person-days at £300	£2,400
C	6 technician-person-days at £300	£1,800
D	4 technician-person-days at £300	£1,200
E	5 writer-days at £250	£1,250
F	1 manager-day at £450	£450
Total	Quantities retain their resource-specific units	£7,900

The two-technician levelled plan finishes at twelve, giving indirect cost of twelve multiplied by £200, or £2,400. Its total is therefore £10,300. The same direct quantities appear in the nine-day logic-only calculation, but that original position is infeasible with the available two-person crew. A lower cost derived from an infeasible sequence should not be presented as a deliverable offer. First establish a credible capacity arrangement, then compare the resulting cost and timing.

Examine an additional-crew option

Suppose a second qualified two-person crew can be ready by boundary two for a fixed mobilisation charge of £900. It performs C in parallel with B, restoring the original nine-day completion. Activity durations, productive effort and daily rates remain unchanged, and the mobilisation charge is the only additional crew cost. This restores parallel capacity rather than shortening the individual calibration activities. The resulting total is £7,900 direct activity cost plus £1,800 indirect cost plus £900 mobilisation, or £10,600. Compared with the two-technician plan, it saves three working days at an additional £300 under these assumptions.

Readiness by boundary two is a condition to verify, not a benefit created by the cost calculation. If recruitment, induction, equipment or access takes longer, the revised model must include that effect. The decision also depends on the value of earlier completion and the consequences elsewhere of obtaining the second crew. A specialist borrowed from another project may improve this forecast while delaying a higher-priority commitment. The organisation needs the combined effect before authorising the transfer.

Time-phase the quantities and budgets

In the levelled plan, A occurs before boundary two; B occupies two to six; C six to nine; D nine to eleven; E two to seven; and F eleven to twelve. Grouping the direct costs into three four-day reporting intervals gives £2,500 in zero to four, £3,150 in four to eight and £2,250 in eight to twelve. The cumulative totals are £2,500, £5,650 and £7,900. The profile explains when the planned work consumes resources. It differs from a payment forecast, which also depends on invoicing, milestones, credit terms and other commercial arrangements.

Time-phased planned direct cost for the levelled example

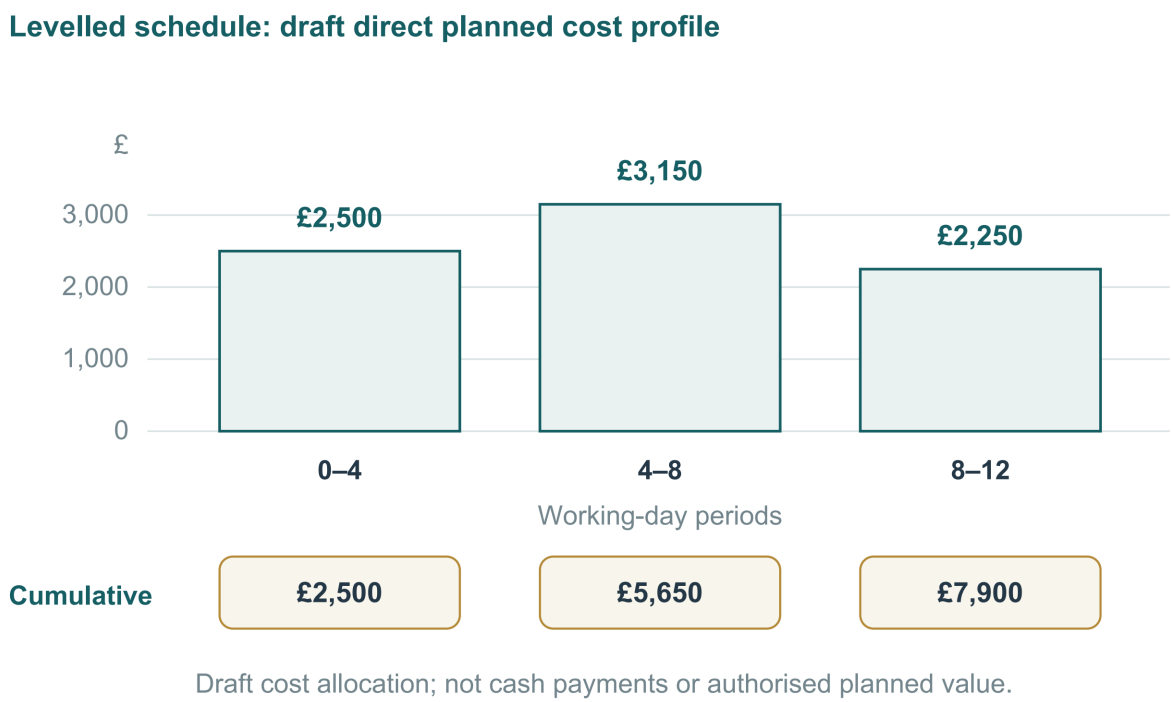


Figure 7.7. Original direct-cost profile for the twelve-day plan. The three interval totals sum to £7,900. This illustrative planning profile is not a cash-payment forecast or an authorised earned-value baseline.

Where earned value is required, scheduled activities should connect consistently to work packages and control accounts, with authorised scope, agreed progress rules and time-phased budgets. Avoid counting the same effort at both detailed and summary levels. Resource-based cost estimates support that integration, but drawing a cumulative curve does not establish an approved performance measurement baseline. Confirm responsibility and approval through the arrangements developed in Chapter 6. Subsequent performance analysis can then compare like with like rather than mixing an activity forecast with an unrelated budget structure.

England's New Hospital Programme illustrates the wider timing issue. The NAO's January 2026 review describes assessment of delivery timetables, annual funding limits and construction-industry capacity, including the consequences of investment waves and later supply-chain pressure (NAO, 2026, p. 39 and pp. 44-47). These are programme-level considerations, not evidence that a particular levelling algorithm was used. The scheduling lesson is to test the timing of both capacity and expenditure: moving work away from one peak may simply transfer the pressure to a later period already occupied by other commitments.

7.6 Applying critical-chain principles and buffer management

Critical Chain Approach. 'A schedule method that allows the project team to place buffers on any project schedule path to account for limited resources and project uncertainties.' (PMI, 2019, p. 178)

Critical-chain scheduling considers activity dependencies, resource contention and uncertainty together. Its starting point is a credible resource arrangement, rather than a logic-only network with unresolved conflicts. It also places management attention on the protection available around the controlling sequence and on readiness to begin work when needed. The scheduling standard describes reducing hidden individual allowances, making protection explicit through buffers and monitoring their

consumption during delivery (PMI, 2019, pp. 18-20). These principles require a coherent implementation; adding a row called 'buffer' to an otherwise unchanged model does not establish the whole approach.

Distinguish the resource-dependent sequence from its protection

The main worked example demonstrates why resource dependencies matter: with only one technician crew, B and C must be sequenced even though their technical prerequisites permit parallel work. A critical-chain approach would consider that resource dependence when establishing the controlling sequence and the treatment of uncertainty. The activity estimates, resource assumptions and protection need to be developed consistently. A twelve-day deterministic result is not automatically a risk-informed commitment, and the original nine-day logic-only result is not made feasible by placing a buffer after it.

Critical-chain buffers and resource readiness

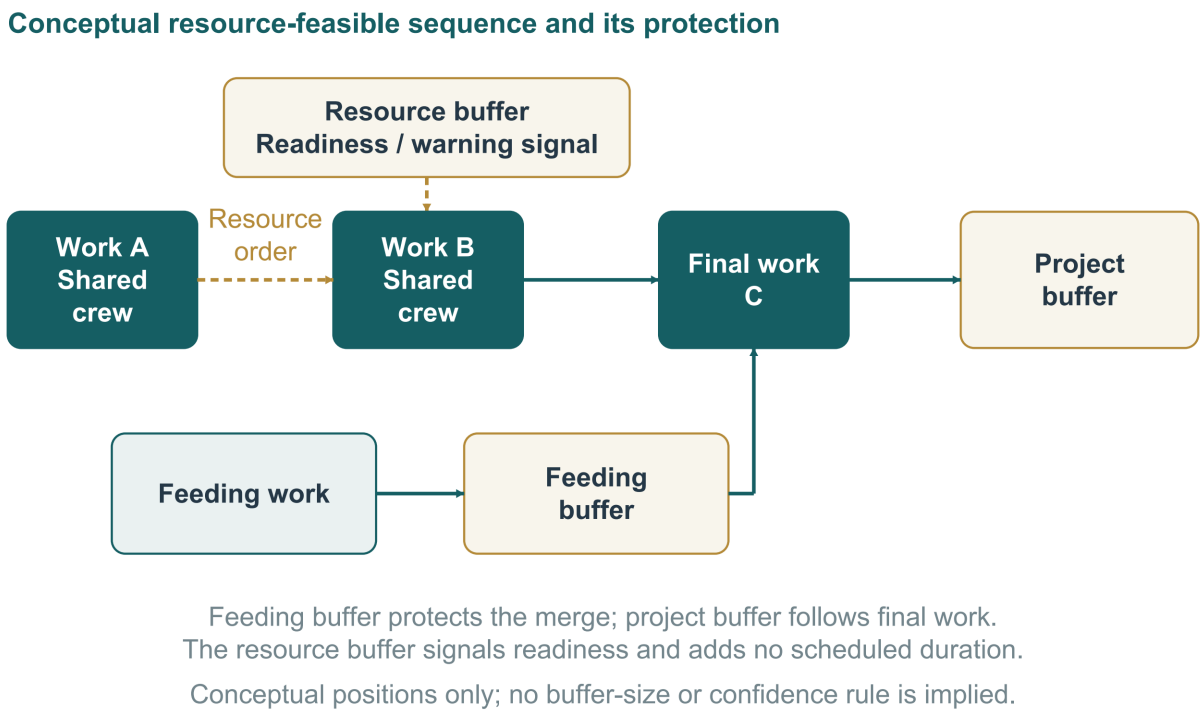


Figure 7.8. Original conceptual illustration of feeding, project and resource buffers. Time buffers protect specified points in the plan; a resource buffer is a readiness signal and does not add a block of safety time.

Table 7.5 | Distinguishing buffers and scheduling flexibility

Buffer or flexibility	Role	Important distinction
Project buffer	Protects the delivery commitment after the final activity of the controlling sequence	Explicit time protection, with an agreed sizing and control basis
Feeding buffer	Protects a critical-chain merge from variation in a feeding sequence	Its placement can affect resource timing and must be checked
Resource buffer	Warns that a resource will be needed and supports readiness	A management signal, not additional elapsed safety time
CPM float	Expresses calculated flexibility relative to network dates or constraints	A model outcome; it is not automatically an approved contingency allowance

Feeding buffers are located where other sequences join the critical chain, while the project buffer lies between the final work and the protected delivery date. Resource buffers operate differently: they alert people to upcoming resource requirements so that the resource can be ready when needed (PMI, 2019, p. 20). A named backup crew may be part of a separate response arrangement, but it should not be confused with the standard's description of a resource buffer. Clear terminology prevents a schedule from appearing protected when the necessary readiness arrangements have not been made.

Size protection deliberately and avoid double counting

The standard describes traditional critical-chain practice that aggregates allowances formerly distributed within activity estimates. This does not justify arbitrarily halving every duration or promising that buffers never affect the final date. Some time is intrinsic to the work: a required test, curing period or acceptance process does not disappear because an aggressive estimate is desired. Establish what each estimate contains, distinguish necessary work from uncertainty allowance, and document how the selected protection relates to the delivery commitment. Do not retain hidden protection in every activity and add another full allowance without recognising the duplication.

Buffer sizing should reflect the uncertainties, correlations, resource constraints and consequences relevant to the project. Statistical analysis can inform the choice, but the resulting protection depends on the quality of its inputs and the way resources are represented. Rules of thumb may provide an initial discussion point; they do not establish a universal confidence level. The next chapter develops schedule-risk analysis in detail. Here the key requirement is to make the basis visible and to test whether inserting a buffer changes the resource arrangement on which the plan relies.

Peng and colleagues (2025) examined critical-chain scheduling using resource flows and explicit sequencing relationships. Their research addresses an important modelling difficulty: inserting feeding buffers can move activities and introduce fresh resource conflicts. The study evaluates a particular heuristic through computational comparisons; it does not establish that every critical-chain implementation will outperform every alternative. Its useful implication for practice is more specific. After placing buffers, check the resource profile and dependencies again, so the apparent protection has not made the underlying delivery arrangement infeasible.

Monitor consumption in the context of progress

For a separate buffer-monitoring illustration, suppose the planned activity sequence finishes at twelve and a three-day project buffer protects a delivery date of fifteen. If the latest forecast for the sequence becomes thirteen, one of the three days has been consumed, or about 33 per cent. This is a measure against that stated buffer, not a percentage probability of delay. The same consumption may require different responses early and late in delivery, depending on remaining work, emerging risks and the trend. Any trigger levels should be agreed and justified for the project rather than copied as universal traffic-light thresholds.

A buffer supports decisions, not concealment. The team still needs to explain why work has taken longer, whether the resource arrangement remains credible and which response is feasible. Repeatedly revising the protected date or silently enlarging the buffer would remove the information needed to understand deterioration. Maintain the reference, report the current forecast and use the agreed decision process to change the plan where justified. Buffer management complements the disciplined recordkeeping established in the previous chapter.

Protect throughput as well as the buffer

Critical-chain scheduling also involves a way of organising execution. PMI links it to the theory of constraints and describes a non-multitasking approach intended to protect throughput (2019, p. 19). The concern is that a scarce specialist can appear fully occupied while several dependent work streams wait for an unfinished output. Repeatedly starting another assignment may increase work in progress without releasing anything that the next team can use. The practical response is to agree the priority of ready work, protect access to the limiting resource and help that resource complete an appropriate unit of work before switching unnecessarily. A buffer alone does not create this discipline.

Consider one specialist with two ready reviews each requiring two working days of effort. Alternating between them daily completes the first review at the end of day three and the second at the end of day four. Completing one before starting the other releases the first result at day two and the second at day four. This original example assumes no switching overhead: its benefit is earlier release of one usable result, not an automatic reduction of the final finish. Downstream dependencies determine whether the earlier result improves overall delivery. PMI's prescription should therefore be applied to the work system being managed; emergencies, genuine waiting periods, safety duties and different skill demands may justify changing assignments. The planner should control harmful switching rather than assume every concurrent responsibility is inefficient.

7.7 Choosing responsible optimisation options

Crashing. 'A schedule compression technique used to shorten the schedule duration for the least incremental cost by adding resources. See also fast tracking and schedule compression.' (PMI, 2019, p. 178)

Adding resources can shorten a resource-driven activity or remove a conflict between activities, but these are different mechanisms. In the worked example, the second crew restores parallel calibration without changing either activity's duration. In another project, a larger crew might shorten a divisible installation activity. Both proposals require evidence that the capability, work fronts and supporting resources are available. Focus on the work that governs completion and recalculate the whole network, because the controlling sequence may change as an option is applied.

Fast tracking overlaps work that would otherwise proceed sequentially. It can reduce elapsed time where partial release and the actual delivery method permit overlap, but may increase coordination and rework

exposure. It is not achieved simply by changing an FS relationship to SS or inserting a negative lag. Establish what output becomes available, what can start on that basis and what still governs final acceptance. The chosen overlap should remain understandable to the people responsible for delivering and checking the work.

Test feasibility before ranking apparent benefits

The original decision process in Figure 7.9 first tests whether an option can meet the relevant capability, access, quality and safe-working conditions. Options that fail those conditions require redesign before their attractive dates are compared. The remaining alternatives can then be assessed for completion, cost, resource commitments, uncertainty and wider effects. A weighted score should not allow an unacceptable working arrangement to be compensated for by a shorter duration. Constraints and trade-offs need to be distinguished explicitly.

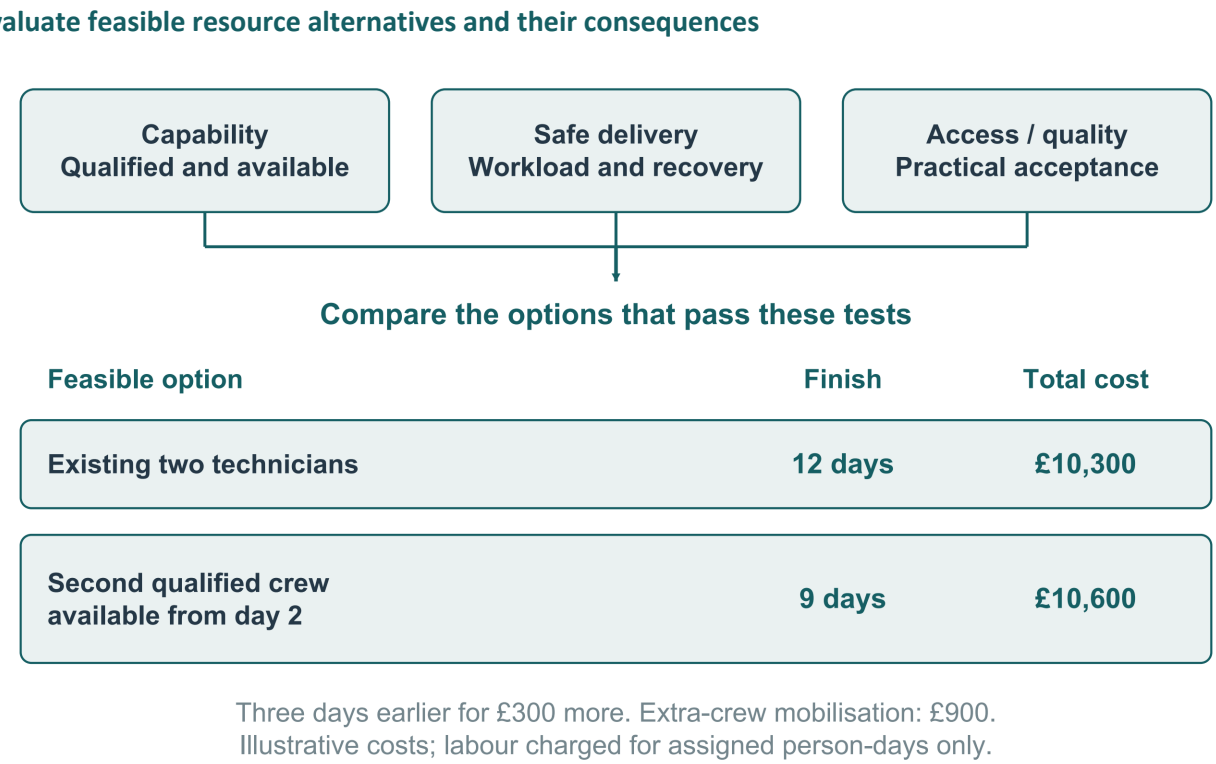


Figure 7.9. Original decision comparison for the worked example. Under the stated cost and availability assumptions, the additional crew saves three days for £300 more. The option remains conditional on confirmed readiness and an acceptable delivery arrangement.

The comparison also needs the correct organisational boundary. A scarce specialist, crane or test facility may serve several projects. Allocating it to the activity with the least local float may not produce the best overall outcome if another project has a more important commitment or costly mobilisation window. Agree priorities with the relevant decision-makers, model the significant interfaces and make the consequences visible. Where confirmation is still outstanding, identify the owner, required decision date and effect of non-availability rather than presenting an unresolved assumption as a confirmed allocation.

Torba and colleagues (2024) studied an industrial scheduling problem arising from SNCF rolling-stock heavy maintenance, where multiple projects share skilled operators and machines. Their computational experiments included twenty-seven large industrial instances and considered different performance objectives. The research shows why the final completion date alone may be an incomplete objective when several commitments compete for constrained capacity. These are computational results using industrial

data, not measured savings from an operational rollout. The scheduling implication is to make both the shared-resource constraints and the organisation's priority objective explicit before comparing alternatives.

Examine shifts, fatigue, quality and supporting conditions

Extended hours are not simply extra productive capacity. A changed shift pattern affects recovery, supervision, handovers, transport, inspection and access to supporting services. The UK's Office of Rail and Road advises assessment of actual working patterns when overtime, sickness or on-call work changes the planned arrangement, and examination of proposed changes where possible before they begin. Its guidance also recognises staff feedback and the limits of software estimates (ORR, 2024, paras 7.10-7.17). This is rail guidance; its practical lesson is to review the real working arrangement rather than infer acceptability from a calendar calculation alone.

Environmental and community conditions can also constrain a proposed recovery method. Extra deliveries may need approved routes and unloading capacity; a night shift may depend on lighting, noise arrangements and inspection availability; additional equipment may increase energy or fuel demand. Evaluate these effects using the project's actual requirements and evidence. A proposal that transfers work off site may improve access and reduce local congestion while introducing transport, interface and supplier-capacity dependencies. The schedule should represent those changes instead of treating the method as an unexplained duration reduction.

Australia's Antarctic programme provides a documented resource-and-funding choice. ANAO described six alternatives for the 2024-25 season, varying shipping days and station capacity. The budget-fitting recommendation excluded the Denman Marine Voyage, while the selected option retained it and recognised the need for about A$10 million of additional funding (ANAO, 2025, pp. 50-52). The case concerns an explicit option decision, not a CPM calculation or a measured optimisation saving. It shows why retaining desired scope can require a different authorised package of resources and funding.

Learn from different forms of resource constraint

Table 7.6 | Resource constraints in documented projects

Official case	Documented resource issue or arrangement	Scheduling interpretation
UAE: Al Khail Road, October 2024	RTA reported multiple contractors, a daily workforce of 5,000 and 650 machines and equipment items in its completed scheme	Acceleration needs coordinated capacity and work fronts; the reported outcome does not isolate a universal headcount-productivity relationship
France: Notre-Dame timber, 2025 account	ONF described specialist timber selection, processing, workshop assembly, transport and lifting	Check material suitability and the capacity of the whole preparation and logistics sequence
Germany: Riedbahn, December 2024	DB reported construction crews alongside replacement buses, recruited drivers and substantial ballast deliveries	Resource the enabling logistics and substitute operations as well as the engineering work
Egypt: Cairo Metro Line 4, March and September 2026	Official reports distinguished four operating tunnel-boring machines and two being prepared, then later reported six operating simultaneously	Distinguish equipment being mobilised from productive capacity already available

Sources: Government of Dubai Media Office/RTA (2024); ONF and Communes forestières France (2025); Deutsche Bahn (2024); State Information Service (2026a, 2026b). The final column presents teaching interpretations of the documented cases.

The UAE authority reported reducing construction time from eighteen to nine months, but its release does not establish the eighteen-month comparator as an approved baseline or isolate the effects of labour, contracting and equipment. The French account shows that apparently available timber still needs the right properties and specialist processing. The German report includes distinct construction and support roles, which must not be added as though they were one simultaneous crew. The Egyptian reports demonstrate a dated change in deployment; they do not prove that the extra machines started on the earlier forecast dates or shortened completion proportionately.

7.8 Maintaining a credible resource forecast

A resource plan requires updating as delivery proceeds. Actual consumption, remaining quantities, confirmed availability and emerging productivity can change the forecast even when the technical scope and logic remain stable. Keep the reporting cut-off consistent, retain actual records and obtain an evidence-based estimate of what remains. Resource owners should confirm future capacity, especially where the previous allocation depended on another project's release or a supplier's readiness. An unchanged availability field is not sufficient evidence that the original commitment still holds.

Update the levelled worked example

Return to the twelve-day plan using the existing two-technician crew. At boundary five, B has been in progress since two and has consumed three working days with two technicians, or six technician-person-days. Its owner now estimates two further days with the same crew, rather than the one day remaining in the reference plan. That is four remaining technician-person-days for B. No other assumption changes: E still finishes at seven, C still needs three days, D two and F one. The update preserves the actual work and the chosen B-then-C resource sequence.

B now finishes at seven, C occupies seven to ten, D ten to twelve and F twelve to thirteen. The current finish is thirteen, one day later than the retained levelled reference of twelve. Technician actual quantity is six; remaining quantity is four for B, six for C and four for D, giving fourteen remaining. The current forecast total is therefore twenty technician-person-days, compared with the original eighteen. These are quantities for the technician resource, not a sum of all project resource types.

At the unchanged £300 rate, the extra two technician-person-days add £600 to direct cost, taking it to £8,500. Thirteen working days of indirect cost add £2,600, giving a total forecast of £11,100. This is £800 more than the £10,300 levelled reference: £600 extra direct effort and £200 for the additional project day. No second-crew mobilisation is included in this update. The result depends on the stated charging assumptions and the absence of other changes; it should not be treated as a general formula for every delay cost.

Explain the decision needed, not merely the changed numbers

The update briefing should identify the reporting boundary, the increased remaining calibration effort, the resulting resource sequence and the effects on completion and cost. It should then identify any response requiring evaluation or authorisation. For example, obtaining another crew may now have a different benefit because of the mobilisation lead time and work already completed. Reusing the earlier option's three-day saving without recalculation would be unreliable. The relevant comparison is between feasible remaining-work alternatives at the present status position.

The same discipline applies to unresolved constraints. Maintain a clear record of the resource needed, the affected work, the evidence of availability, the responsible owner and the decision or confirmation still required. This is part of managing the plan, not a substitute for resolving the problem. If the team cannot secure the assumed capacity, show the consequence in the forecast and seek the appropriate decision. A credible resource plan remains connected to the organisation's actual commitments and delivery conditions throughout the project.

Knowledge check and examination practice

These original questions practise reasoning relevant to PMI-SP; they are not reproduced examination questions. They relate particularly to resource requirements, availability, assignments and schedule development in Domain 2, and resource updates and evaluation of alternatives in Domain 3 of the published examination content outline (PMI, 2012, pp. 4-6). Select the best answer using the information given. Where a question refers to the worked example, retain its common working calendar, fixed crews, non-interruptible activities and stated cost assumptions.

Question 1: available or uncommitted?

A specialist's resource calendar shows five working days next week. The scheduling system displays availability for all five days, but another project has already booked three. Your project requires four full days from this specialist during that week. What is the best next action?

A Accept the assignment because calendar availability exceeds your requirement.
B Reconcile the competing commitments with the resource owner and evaluate an authorised feasible arrangement.
C Replace the specialist's calendar with a seven-day calendar so the requirement fits.
D Change the activity's total effort to two days without consulting its owner.

Question 2: proving the resource-limited finish

In the main worked example, A takes two days before any technician work can start. B, C and D require eighteen technician-person-days in total, using fixed two-person crews. Only two technicians are available, and F needs one further day after the technician work. The documented B-then-C sequence is feasible. What is the earliest proven completion under these assumptions?

A Nine working days, because that is the logic-only critical path.
B Eleven working days, because the technician work ends then.
C Twelve working days, because the feasible sequence reaches the resource-based lower bound including F.
D Eighteen working days, because there are eighteen technician-person-days of effort.

Question 3: identifying smoothing

P takes three days and Q two; each needs the same two-technician crew. Independent activity R takes six days using a different resource. All three can begin at zero and must finish before milestone M. Moving Q from zero-to-two to three-to-five removes the overlap with P. Which interpretation is best?

A The change smooths the specified demand within Q's flexibility while M remains at six.
B The change must delay M because every resource adjustment extends completion.
C Q now requires five working days of effort because its finish is five.
D The change proves that every resource conflict can be resolved without moving completion.

Question 4: comparing the additional crew

The twelve-day resource-feasible option has £7,900 of direct cost and £200 of indirect cost per project working day. A confirmed additional crew permits nine-day completion with the same productive effort and rates, but adds £900 mobilisation. Assigned productive time is the only labour time charged. What is the correct comparison within this defined cost scope?

A The additional crew reduces total cost to £9,700.
B The additional crew leaves total cost unchanged at £10,300.
C The additional crew increases cost to £11,200 and saves no time.
D The additional crew costs £10,600, which is £300 more for three days saved.

Question 5: understanding the resource buffer

A critical-chain plan includes a resource buffer before a specialist is required. A colleague proposes treating that buffer as extra elapsed safety time and deleting the specialist's mobilisation checks. What should the scheduler explain?

A Resource buffers automatically provide extra staff whenever the chain is threatened.
B Resource buffers guarantee a specified probability of on-time completion.
C A resource buffer supports readiness and early warning; it neither adds time protection by itself nor replaces actions to secure the resource.
D Resource buffers and total float are interchangeable measures of approved contingency.

Question 6: updating quantities and completion

At boundary five in the levelled main example, B has consumed six technician-person-days. Its revised remaining requirement is four, while C still requires six and D four. The same two-technician crew performs B, then C, then D. B finishes at seven, E finishes at seven, and F needs one day after D and E. Which forecast is correct?

A Fourteen total technician-person-days and completion at twelve.
B Eighteen total technician-person-days and completion at thirteen.
C Twenty total technician-person-days and completion at twelve.
D Twenty total technician-person-days and completion at thirteen.

Question 7: interpreting optimisation results

A scheduling tool produces a resource-feasible twenty-four-day plan. A second priority setting gives twenty-three days. No lower-bound proof or exhaustive optimisation certificate is available. How should the scheduler describe the second result?

A It is the better feasible duration found in the tested alternatives, subject to validation of the common assumptions.
B It is a proven global optimum because it is shorter than the first result.
C It invalidates every resource assignment in the first result.
D It must be rejected because a resource-constrained schedule can have only one valid sequence.

Question 8: assessing an acceleration proposal

A manager proposes overlapping installation and commissioning and moving staff from another project to meet an earlier target. The staff count appears sufficient, but commissioning requires specific authorisation and depends on accepted installation outputs. What is the best first response?

A Remove the technical links and retain the target finish as a mandatory constraint.
B Establish which overlap is technically permissible, confirm capability and release of the shared staff, then recalculate a feasible option with its consequences.
C Assume all staff with the same job title are interchangeable and add them immediately.
D Reduce the project buffer until the finish matches the target without changing the delivery arrangement.

Answer explanations

Question 1: B

The working calendar describes potential working periods; it does not establish that they remain free of other commitments. The resource owner must help reconcile the competing demands, and the resulting option may involve reprioritisation, another qualified resource, a different sequence or a revised date. A accepts double booking as capacity. C changes the calendar without establishing an acceptable working arrangement and still fails to resolve ownership of the resource. D confuses the available allocation with the amount of work required: reducing the displayed effort does not remove the underlying work.

Question 2: C

Eighteen technician-person-days divided by a capacity of two technicians requires at least nine working days of technician work. That work cannot start before A finishes at two, and F adds one day after it: two plus nine plus one equals twelve. The documented sequence achieves twelve, so the lower bound proves the earliest finish for this specific example. A overlooks the technician conflict. B omits the final release activity. D treats total person-days as elapsed working days and ignores the two-person crew. The proof relies on the stated assumptions and does not establish a general rule for larger networks.

Question 3: A

Q initially has four days of flexibility relative to the six-day milestone. Moving its start by three days places it after P while leaving one day before M. R remains controlling, and the two-technician limit is respected. B incorrectly assumes that all resource adjustments extend the project. C confuses a finish coordinate with effort or duration; Q still takes two working days with the stated crew. D extends a valid result beyond its conditions. The main example shows the opposite situation: available float is insufficient to absorb the resource delay, so the finish moves.

Question 4: D

The twelve-day option costs £7,900 plus twelve times £200, or £10,300. The additional-crew option costs £7,900 plus nine times £200 plus £900, or £10,600. Its £600 saving in indirect cost partly offsets the £900 mobilisation, leaving a £300 increase for three days saved. A omits mobilisation. B assumes the indirect saving exactly equals the extra charge. C adds mobilisation to the original total without recognising the shorter period of indirect cost, and incorrectly removes the time benefit. Commercial benefits outside the specified scope would need separate evaluation before selecting the option.

Question 5: C

The resource buffer is a readiness mechanism: it prompts the actions needed to have a resource available at the required point. It is distinct from the time protection supplied by project or feeding buffers. A treats a warning as though it creates capacity. B assigns an unsupported probability to a management device; confidence would require a suitable analysis and defensible assumptions. D confuses deliberately managed protection with calculated network flexibility. Removing mobilisation checks weakens the very readiness that the resource buffer is intended to support.

Question 6: D

The current technician total is six actual plus fourteen remaining, or twenty person-days. The remaining fourteen comprises four for B, six for C and four for D. With B finishing at seven, C finishes at ten, D at twelve and F at thirteen. A reports remaining quantity as though it were total and retains an obsolete completion. B retains the original eighteen-person-day estimate despite the changed remaining requirement. C updates effort but fails to propagate the extra work through the constrained sequence. Keep the original estimate for comparison while reporting the revised total and finish transparently.

Question 7: A

Twenty-three days is an improvement over the first tested result if both schedules satisfy the same requirements and capacity assumptions. It is a best-tested feasible result, not a proven global optimum. B confuses improvement with mathematical proof. C wrongly assumes that another sequence makes the first assignment set invalid; both may be feasible. D overlooks the possibility of several valid schedules with different outcomes. The scheduler should validate the new sequence, record the settings and explain relevant cost, resource and delivery trade-offs before recommending it.

Question 8: B

The proposed acceleration combines technical overlap and additional capacity. Both require evidence: the overlap must preserve necessary acceptance conditions, and the staff must possess the required capability and be available through an agreed release. The revised model must then show the effect on dates, effort, quality, safety and other commitments. A removes the evidence of sequencing without changing the work. C assumes a shared job title establishes equivalent competence and availability. D consumes protection without resolving the underlying delivery conditions. A credible earlier date follows from a feasible method and resource arrangement.

Preparing for the next chapter

Resource feasibility is a necessary foundation for uncertainty analysis, but it does not remove uncertainty. The twelve-day worked plan assumes the crew remains available, the durations are achieved and the handovers occur as modelled. A different productivity outcome, absence, equipment failure or access restriction could change the result. Equally, the additional-crew option depends on the new team being ready when required. A deterministic date describes the outcome of specified assumptions; it does not establish a probability of meeting a commitment.

The next chapter develops schedule risk analysis, ranges, uncertainty, contingency and confidence in milestones. Its starting point is a model whose scope, dependencies, resource assumptions and data are sufficiently credible to analyse. Before introducing probability, distinguish an unresolved known capacity conflict from an uncertain future event. A schedule that requires four technicians when only two are committed first needs a feasible resource arrangement or an explicit alternative. Uncertainty analysis can then examine variation around that arrangement, including the possibility that its resource assumptions do not hold.

References and further reading

Page numbers for the PMI practice standard refer to its printed pagination. Formal definition quotations retain the source wording; the chapter's frameworks, worked examples, diagrams and questions are original teaching material. Interpretations of cases are distinguished from the outcomes reported by their official sources.

Australian National Audit Office (ANAO) (2025) *Australian Antarctic Program*. Auditor-General Report No. 6 of 2025-26, 19 November, pp. 50-52, especially Table 3.1. Official audit and report.

Deutsche Bahn (2024) 'Nach fünf Monaten Generalsanierung: DB nimmt Riedbahn zwischen Frankfurt/Main und Mannheim wieder in Betrieb', 14 December. Official account of the Riedbahn reopening and associated construction and support resources. Official press release.

Government of Dubai Media Office/Roads and Transport Authority (2024) 'RTA Achieves Completion of Al Khail Road Development Project Across Seven Key Locations', 21 October. Official completion account.

Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, especially pp. 52-62. Official guide.

Government Accountability Office (GAO) (2025) *Shipbuilding and Repair: Navy Needs a Strategic Approach for Private Sector Industrial Base Investments*. GAO-25-106286, 27 February, especially pp. 25 and 28-30. Official report.

National Audit Office (NAO) (2026) *Update on the New Hospital Programme*. HC 1594, 16 January, especially p. 39 and pp. 44-47. Official report.

Office national des forêts (ONF) and Communes forestières France (2025) *Notre-Dame de Paris renaît au cœur des forêts françaises*, especially pp. 7-8. Official publication and download.

Office of Rail and Road (ORR) (2024) *Managing rail staff fatigue*, revised guidance, 15 August, section 7, especially paragraphs 7.10-7.17. Official guidance.

Peng, W., Wang, Z., Xie, F. and Li, H. (2025) 'A heuristic approach for the critical chain project scheduling problem based on resource flows', *Computers & Operations Research*, 180, 107054. Publisher DOI.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*, especially pp. 4-6. Official outline.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. Third edition. Newtown Square, PA: PMI. Principal coverage: section 2.2.2, pp. 18-21; section 3.1.2.9, p. 52; section 3.2.1.4, p. 61; section 3.4.10, pp. 83-84; resource components, pp. 101, 105-106, 112 and 125-128; glossary, pp. 178, 180 and 188-189.

Project Management Institute (PMI) (2026) *PMI Lexicon of Project Management Terms*. Version 5.0, updated January, p. 24. Supplementary terminology for resource breakdown structure and resource smoothing. Official lexicon.

Snauwaert, J. and Vanhoucke, M. (2025) 'A solution framework for multi-skilled project scheduling problems with hierarchical skills', *Journal of Scheduling*, 28, pp. 289-310. Publisher DOI.

State Information Service, Egypt (2026a) 'Transport Minister inspects progress on first phase of Cairo Metro Line 4', 9 March. Official progress account.

State Information Service, Egypt (2026b) 'PM inspects first phase of Cairo Metro Line 4 project', 13 September. Official progress account.

Torba, R., Dauzère-Pérès, S., Yugma, C., Gallais, C. and Pouzet, J. (2024) 'Solving a real-life multi-skill resource-constrained multi-project scheduling problem', *Annals of Operations Research*, 338, pp. 69-114. Publisher DOI.

Vermeire, G. and Vanhoucke, M. (2025) 'A priority rule heuristic for the multi-skilled resource-constrained project scheduling problem', *Applied Soft Computing*, 171, 112776. Publisher DOI.

CHAPTER 08

Analysing Schedule Risk and Setting Credible Milestones

From a calculated date to a defensible commitment

A schedule calculation produces dates from the assumptions entered into a model. It does not, by itself, establish how likely those dates are to be achieved. Activity durations may vary, an approval may arrive late, several packages may depend on the same supplier, and a recovery proposal may introduce new resource or quality constraints. A credible milestone therefore requires more than an attractive bar chart or a correctly calculated critical path. It requires an explanation of the uncertainty that remains, the delivery arrangement being assessed and the evidence supporting the proposed commitment.

This chapter develops that explanation through schedule risk analysis. It distinguishes uncertain durations from discrete events and known issues, examines distributions and dependence, and uses a small original network to show how uncertainty propagates through parallel paths. Exact calculations establish a result that can then be checked against Monte Carlo simulation. The chapter explains completion probabilities, P50 and P80 dates, criticality and sensitivity before comparing responses, contingency and cost consequences. It concludes with the assurance and approval needed to establish a controlled baseline and, where applicable, integrate it with the performance measurement baseline.

The approach supports PMI-SP examination preparation and the professional judgement expected at Project Controls Professional Level 6. Learners should be able to question a probability estimate, recognise the limits of a simulation and explain the decision that follows from the analysis. No separate Risk Management module is assumed. The emphasis is on the risk information and reasoning necessary to build and defend a scheduling decision, rather than on treating software output as an independent source of certainty.

The chapter framework: evidence, uncertainty and an authorised decision

The original framework in Figure 8.1 connects six responsibilities. Define the decision and milestone, check the underlying schedule, map the uncertainty, calculate possible outcomes, compare feasible responses, and obtain an authorised decision supported by assurance. Each stage depends on the previous evidence, but the process is iterative. A proposed response may change the network, an assurance review may challenge the input ranges, and new information may alter the probability of a risk event. The analysis should therefore remain traceable to a particular schedule version, reporting position and set of assumptions.

Framework for schedule risk and milestone decisions

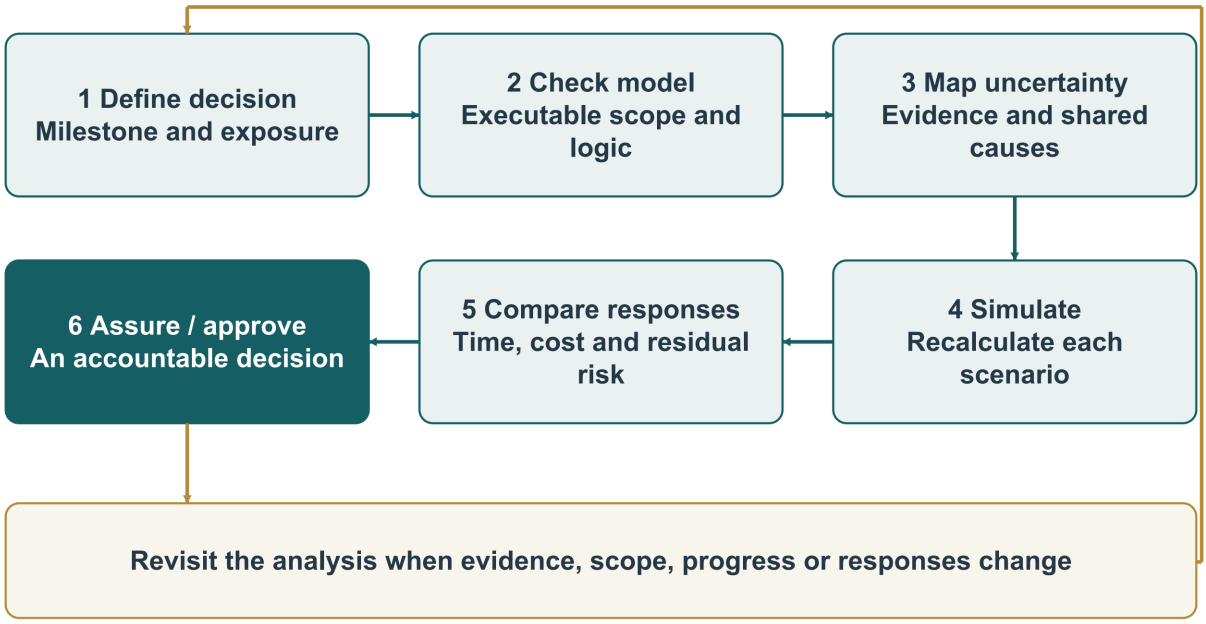


Figure 8.1. An original framework linking the scheduling decision to model quality, uncertainty analysis, response evaluation and authorised approval. A new set of assumptions requires a new assessment rather than a reused confidence label.

8.1 Recognising what is uncertain and what is already known

Schedule risk analysis is most useful when the team distinguishes different kinds of information before selecting a calculation. Routine variation in installation productivity is not the same as a possible late permit. A permit already refused is no longer merely an event that might occur. An assumption that a specialist will be available differs from a confirmed restriction on access. These distinctions affect how the information enters the schedule and who must act on it. They also prevent a register from becoming a list of concerns that has no clear connection to the work.

Table 8.1 | Distinguishing uncertainty, issues and known conditions

Information encountered	Scheduling treatment	Independent example
Duration uncertainty	Represent an evidence-based range or distribution for the relevant remaining work	Installation output varies even when the agreed crew and access are available
Discrete risk event	Represent whether an event occurs and the effect if it does	A clarification may arrive after the required release date
Known issue	Incorporate the established condition and estimate its remaining consequences	The clarification is already late at the reporting cut-off
Planning assumption	Identify the condition being relied upon and how it will be confirmed	An additional test team is expected to be released by another project
Constraint	Model a restriction on when or how the work can proceed	Testing is permitted only during an agreed access window

The table describes practical treatment rather than suggesting that the categories are permanently separate. An assumption may fail, a risk may occur and a restriction may be removed. What matters is the evidence at the reporting cut-off. If a delay has already happened, preserve the actual history and assess the remaining effect. Do not continue to sample a fifty-fifty chance of an event that is now known to have occurred. Conversely, do not enter an uncertain future event as an inevitable delay simply because it appears in the risk register.

Connect causes, events and consequences to the model

A useful risk statement identifies the condition that gives rise to uncertainty, the event or variation that matters and the schedule consequence. For example, an unresolved design interface may mean that a common engineering clearance is issued late, preventing two installation packages from starting. The schedule model should represent the affected release and successors. Describing the risk only as 'possible delay' does not explain where the effect enters, whether it affects both paths simultaneously or which response could change the outcome.

> **Risk ID.** 'A short, unique numeric or text identification assigned to each risk on the project's risk register.' (PMI, 2019, p. 129)

A stable Risk ID allows the same event to be traced between the register, affected activities, assumptions and response decisions. It does not mean that each mapped activity should receive an independent copy of the event. In the worked example, R-01 concerns one common clearance. Its occurrence is sampled once and applied through a shared gate. Sampling it independently for each successor would describe a different situation; adding the same delay to the gate and again to both activity estimates could count the exposure twice.

Mapping one risk to its common schedule effect

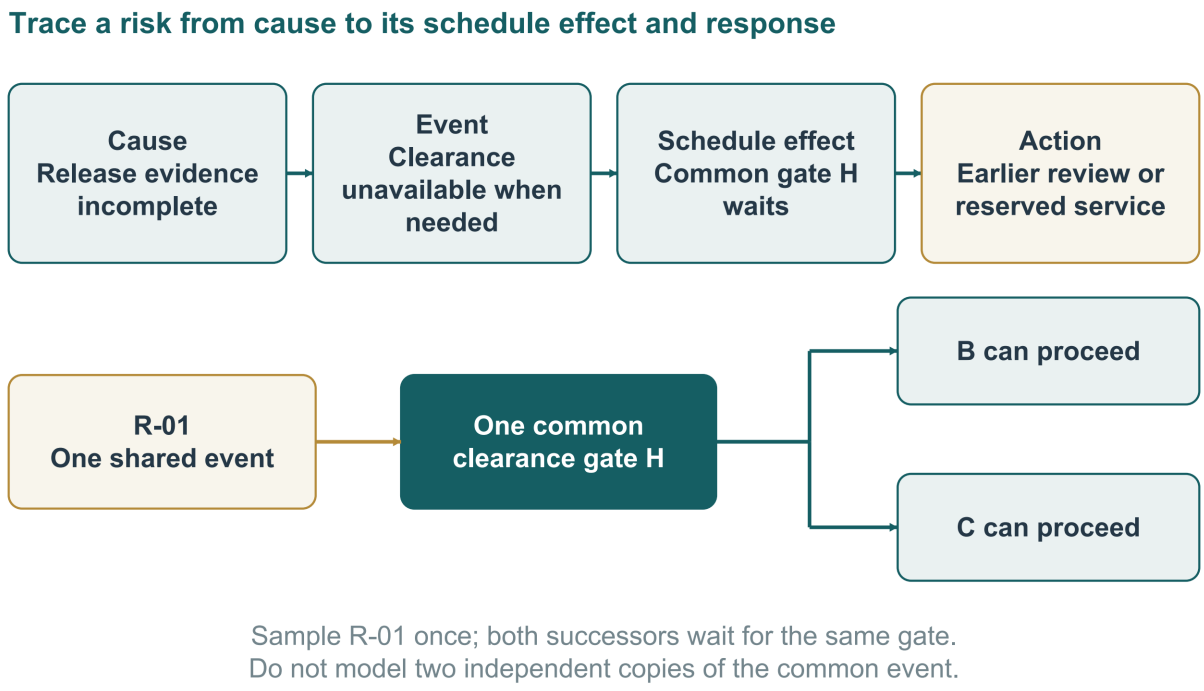


Figure 8.2. An original risk-to-schedule mapping. One common cause is represented once, with its consequences propagated through the relevant logic. The mapping also identifies where a response changes the assumed occurrence or impact.

The distinction applies to opportunities as well as threats. Earlier release of an accepted design or a validated alternative method may improve an outcome, but the benefit still needs a defined mechanism, owner and delivery conditions. It should not be introduced as an arbitrary negative delay to compensate for an uncomfortable result. Where an opportunity requires a decision, expenditure or approval, represent those conditions and distinguish an available option from an already authorised part of the plan.

8.2 Preparing a schedule that can support risk analysis

A simulation repeats the consequences of a model. If that model omits a major interface or assumes the same crew can work in two places at once, repetition will not make it credible. Before introducing uncertainty, check scope completeness, activity granularity, logic, calendars, access conditions and resources. Confirm that the completion milestone includes the actual acceptance or operational-readiness work required. A construction finish, an operating licence, trial operation and commercial service may be separate events. The analysis must identify which one is being assessed.

PMI places schedule risk assessment within the wider analysis of the schedule model and explains that simulation recalculates possible schedule instances from the selected inputs (PMI, 2019, pp. 83-85). This makes the modelling boundary important. The analysis should state its start position, data date, activity set and treatment of calendars, resources and relationships. Where only part of a programme is modelled, identify external dates supplied as assumptions and the uncertainty that has been excluded. A narrow analysis can still be useful, provided its confidence statement is not presented as a conclusion about the whole programme.

GAO's historical October 2024 review of NASA's Exploration Ground Systems illustrates the boundary question. It distinguished Mobile Launcher 2's September 2027 baseline turnover, based on 70% joint cost-and-schedule confidence, from a contractor's November 2026 risk-informed delivery date. Further verification, validation and integration followed delivery. GAO recommended analysis covering contractor delivery and subsequent work before integrated operations. These are historical audit findings, not current forecasts: the later recommendation record notes NASA's May 2026 termination notification. The lesson is to match the confidence claim to the precise milestone and to distinguish joint confidence from a schedule-only percentile (GAO, 2024, pp. 21-24).

Retain actual history and test the remaining work

For a project in progress, recorded actual starts and finishes form the established history. The model should analyse the work and decisions that remain. An activity already underway may need a revised remaining-duration range; that range should reflect what has been learnt, not simply reuse the original full-duration distribution. Check how the tool treats in-progress activities, partial resource assignments and external commitments. A reporting cut-off is a factual boundary, not a device for moving inconvenient actuals into the future.

The same discipline applies to resources. Sampling longer durations may create overlaps that were absent in the original resource-feasible schedule. The analyst must understand whether the risk tool preserves resource sequencing, relevels resources in each iteration or ignores capacity constraints. Each choice represents a different delivery policy. Retaining a known resource dependency may be appropriate where the crew order is fixed; dynamic reassignment may be appropriate where that flexibility exists and can be managed. Neither should be assumed merely because the software offers an option.

Make uncertain waiting and interfaces visible

Fixed lags and imposed dates can distort the transmission of uncertainty. If a lag represents uncertain curing, review or mobilisation work and the tool cannot assign uncertainty to it, an explicit activity may be needed. PMI makes that qualification in its schedule-risk guidance (PMI, 2019, p. 84). The change should preserve the real delivery meaning and relevant calendar. It should not create artificial work or remove a genuine minimum waiting period. A mandatory technical duration remains a requirement even if an optimistic estimate would produce a more convenient result.

Hard constraints require particular scrutiny because they may prevent a finish date from moving while negative float or another warning carries the consequence. The analyst should investigate the tool's calculation behaviour and report any imposed boundaries openly. A target date is a question to test against the forecast distribution. It should not be used to force every simulated result to the target and then be reported as evidence of confidence. Similarly, a response that depends on unavailable resources cannot be made feasible simply by narrowing its duration range.

8.3 Building evidence-based inputs and representing dependence

> **Probability Risk Distribution.** 'Defines the probability that particular attributes or ranges of attributes will be, or have been, observed.' (PMI, 2019, p. 120)

A distribution describes more than a low value and a high value. It expresses how probability is assigned between possible outcomes, including the relative likelihood of central values and extremes. The scheduler should establish the unit, the work being estimated, the assumed delivery method and the evidence supporting that assignment. Historical records, current productivity, supplier performance and structured expert judgement can all contribute, but each needs interpretation. A historical duration from different scope, resources or acceptance conditions is not automatically a suitable input for the present work.

Three estimates do not determine a unique distribution

Optimistic, most likely and pessimistic estimates are useful starting points when their meaning is agreed. Clarify whether the outer values are intended as practical bounds under stated conditions or as particular percentiles with further outcomes possible beyond them. The distinction matters. A bounded triangular distribution assigns no probability outside its specified limits; a range described as P10 to P90 leaves probability outside those values. Substituting one interpretation for the other can suppress or exaggerate the tail without changing the three numbers entered on screen.

Figure 8.3 compares two distributions with the same values of four, six and eight working days. In the discrete version, exactly four, six or eight days occur with probabilities of 25%, 50% and 25%. In the triangular version, duration can take values continuously between four and eight, with six as the mode. Both are symmetric and have a mean of six, but they do not assign the same probability to intervals or individual values. The worked example uses the discrete version deliberately so that every outcome can be checked without simulation software.

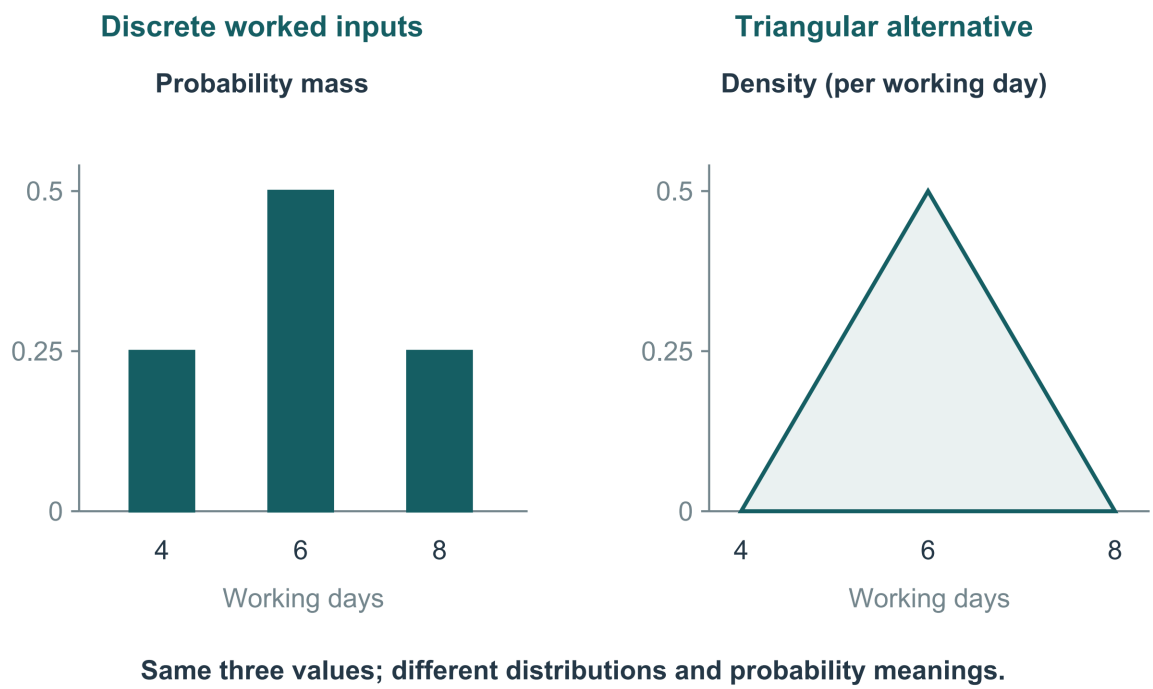


Figure 8.3. Original comparison of probability mass and probability density. The left-hand distribution is used in the worked example. The continuous density on the right is a different model; probability is represented by area over an interval rather than by the height at a single point.

A three-point weighted average is also not a complete risk model. For example, applying the familiar PERT weighting to four, six and twelve gives (4 + 4 × 6 + 12) / 6, or approximately 6.67 days. The mean of a triangular distribution using the same values is (4 + 6 + 12) / 3, or approximately 7.33 days. Neither arithmetic result establishes the project's completion probability, and neither addresses the interaction of parallel paths. The appropriate shape and parameter interpretation require evidence; they should not be selected solely to reproduce a preferred average.

Table 8.2 | Comparing duration distribution families

Distribution family	What it can represent	Main modelling check
Discrete	Identified outcomes with explicit probability masses	Outcomes and probabilities must be complete and sum to one
Triangular	A bounded continuous range with a specified mode	The bounds exclude all more extreme values
Beta-shaped	A flexible bounded shape, including specified PERT implementations	Document the parameterisation; three labels alone do not specify every version
Uniform	Equal probability density across a bounded interval	Lack of information does not automatically justify equal likelihood
Normal	Symmetric continuous variation around a mean	Check whether the tails permit physically impossible durations
Lognormal	Positive, right-skewed variation with a potentially long upper tail	Calibrate the parameters and tail against relevant evidence

Comparison of distribution choices discussed in PMI's risk-component catalogue (2019, p. 120). The explanatory checks are modelling considerations; no family is universally appropriate for every activity.

Separate routine variation from discrete events

When eliciting duration ranges, establish which conditions the estimate includes. If an activity's pessimistic duration already includes a particular approval failure, adding that same failure again as a separate event can double count it. A clear approach is to estimate routine duration variation conditional on the event being absent, then model the event's occurrence and consequences separately. Other approaches can be valid, but the total representation must be coherent. The register, estimate notes and model should tell the same story about what is included.

An event may have uncertainty in both occurrence and impact. A 20% chance of a three-day hold is different from an inevitable hold whose duration varies between zero and three days. Conditional impact ranges may be appropriate where the event could produce different consequences. The model should also distinguish mutually exclusive outcomes from independent events and identify any common-cause dependencies. A probability copied from a qualitative rating label needs particular care: a workshop category such as 'medium' is not, by itself, evidence for a precise numerical input.

Explain dependence through the delivery mechanism

Activities can depend on the same weather conditions, design maturity, supplier or specialist resource. Sampling their uncertainties independently may therefore create combinations that are implausible. Conversely, assigning a strong positive correlation to all durations merely because the project feels risky imposes an unsupported structure. Discuss the common cause, identify the affected activities and decide whether it is best represented through explicit events, shared drivers or a justified statistical dependence model. Check that the chosen representation has not duplicated a cause already included elsewhere.

Dependence does not have one universal effect on every output. For activities in sequence, simultaneous high durations can increase the spread of their sum. At a parallel merge, the maximum of the incoming path durations governs the handover, and the effect can differ. Later in this chapter, a deliberately extreme comparison makes both branches move together while preserving their individual distributions.

Its purpose is to expose the role of the joint assumptions, not to recommend perfect correlation as a convenient way to improve a forecast.

Song and Vanhoucke (2025) connect a risk-interaction network to an activity network and evaluate control strategies computationally. Their study supports examining how one risk can influence another and revisiting priorities as information changes. Its experiments use fictitious projects and assume unlimited resources; they do not establish measured delivery benefits or resolve constrained-resource modelling. The practical implication is to investigate shared causes and triggering relationships rather than relying only on isolated risk scores. The paper's specialised sensitivity measure should also be distinguished from PMI's critical-path frequency index.

8.4 Following uncertainty through a complete worked example

The following independent example concerns preparation, two parallel technical packages and final acceptance. All durations are working days on one common calendar, measured from a start boundary of zero. Relationships are finish-to-start with no lag. The packages have separate dedicated crews, so no shared-resource conflict is introduced when their durations vary. Resources for preparation and acceptance are also assumed available. These are deliberately simplified teaching assumptions, not observations from a real project or claims about typical industry probabilities.

Table 8.3 | Logic and assumptions for the risk example

Element	Logic and purpose	Duration or event assumption
A	Prepare the common specification	Fixed at two working days
H	Obtain the common clearance after A	No hold with probability 80%; a three-day hold with probability 20%
B	Complete technical package B after H	Four, six or eight days with probabilities 25%, 50% and 25%
C	Complete technical package C after H	Four, six or eight days with probabilities 25%, 50% and 25%
D	Complete final acceptance after both B and C	Fixed at two working days

The occurrence of R-01 determines H once for the whole project. B and C are sampled independently of each other and of H in the principal example. Their duration ranges exclude the clearance hold. The completion time is therefore $\mathbf{T = 4 + H + max(B, C)}$: two days for A, the common hold, the longer parallel package and two days for D. Using the most likely package durations and no hold gives ten working days. Both parallel paths are critical in that deterministic calculation, but they need not remain equally long in a simulated outcome.

Network and assumptions for the worked risk example

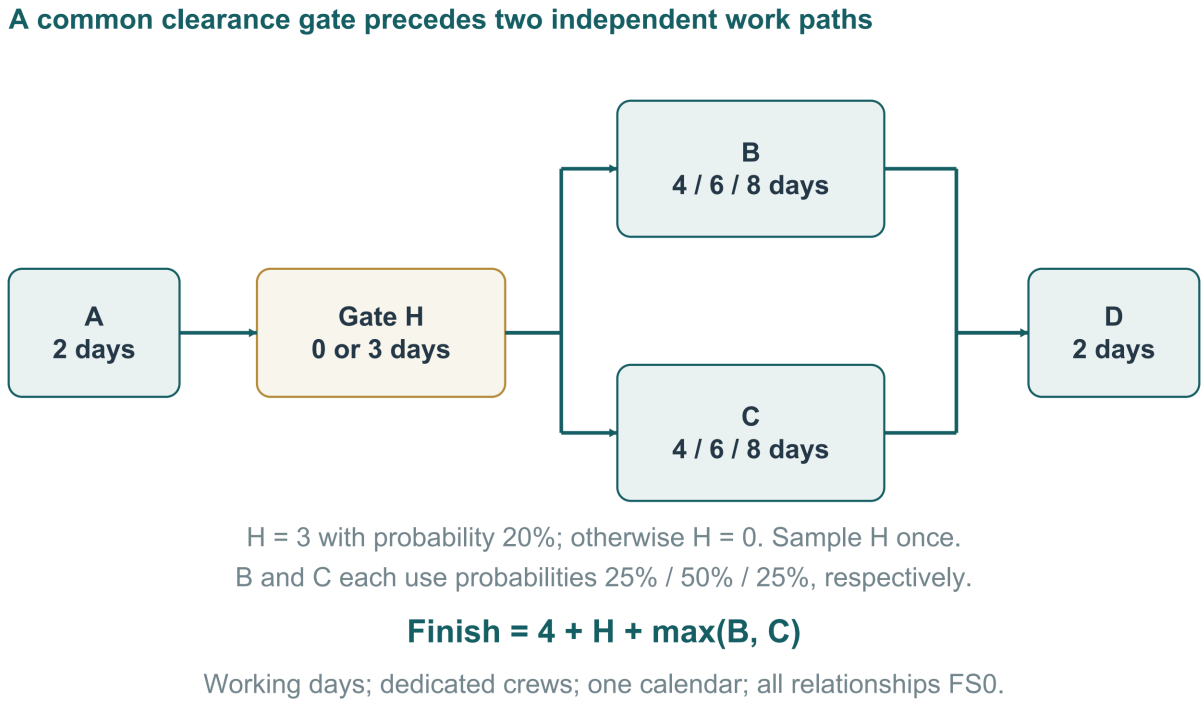


Figure 8.4. Original risk model with one shared clearance event and two separately resourced parallel packages. H is sampled once. The same event is not independently added to each package's duration.

Calculate the merge effect before adding the event

First set H to zero. Each package individually has a 75% chance of finishing within six days because its four-day and six-day outcomes have probabilities of 25% and 50%. Both must finish before acceptance can begin. Under the stated independence assumption, the chance that both take no more than six days is 0.75 × 0.75, or 56.25%. The handover is therefore less likely to be ready at that point than either individual package considered alone. This is the merge effect that a single-path calculation can miss.

The nine possible B-C combinations can be enumerated exactly. Their maximum is four days with probability 6.25%, six days with probability 50%, and eight days with probability 43.75%. The expected maximum is consequently 4 × 0.0625 + 6 × 0.50 + 8 × 0.4375 = 6.75 days. Adding the fixed preparation and acceptance gives an expected finish of 10.75 days. Each package's own mean is six, yet selecting six for both would give ten. The mean of the parallel maximum is not simply the maximum of the individual means.

Exact enumeration of the parallel merge

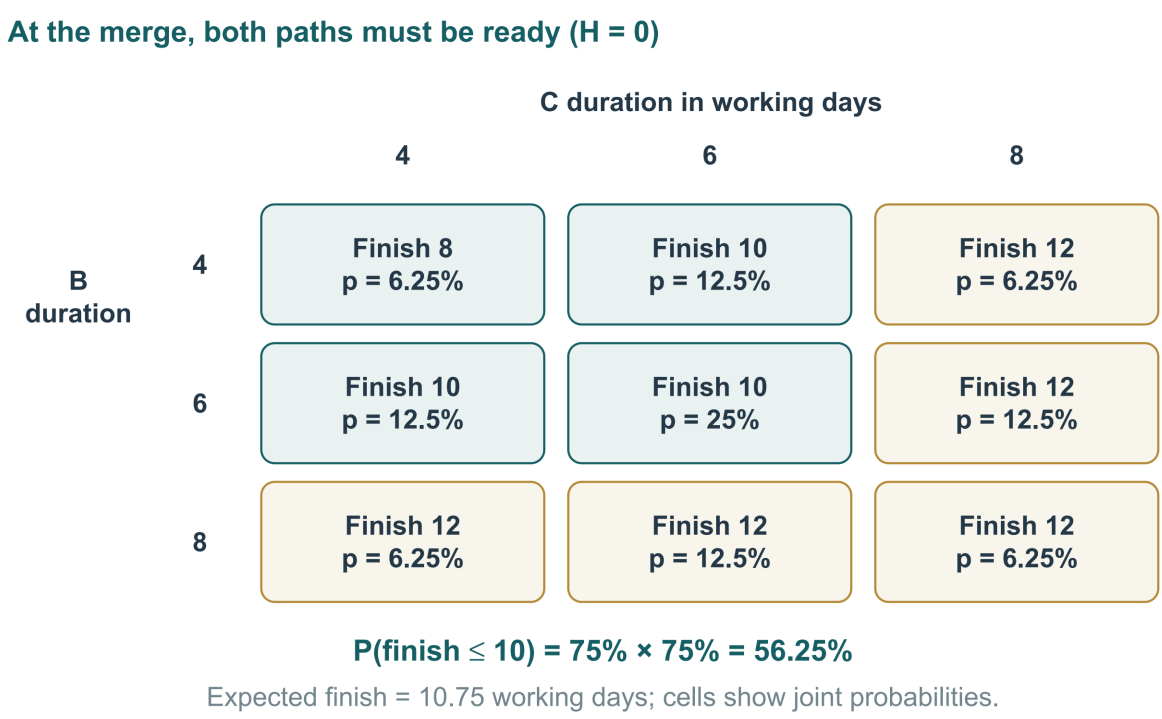


Figure 8.5. Original enumeration of the nine package combinations before the clearance event is added. Cell probabilities arise from the independent package distributions. The resulting expected finish is 10.75 working days, rather than the ten-day deterministic result.

Add the common event once

When the three-day hold occurs, it shifts both packages and the final finish by three days. It does not add six days merely because two packages are affected. The chance of finishing within ten days is 80% multiplied by the no-hold chance of 56.25%, giving **45%**. Even the fastest combination would finish at eleven if the hold occurred. The expected hold is 0.20 × 3 = 0.60 days, so the overall expected finish becomes 10.75 + 0.60 = **11.35 working days**.

Table 8.4 | The completion distribution with a common event

Finish boundary: working days	Probability of that finish	Probability of finishing by that boundary
8	5.00%	5.00%
10	40.00%	45.00%
11	1.25%	46.25%
12	35.00%	81.25%
13	10.00%	91.25%
15	8.75%	100.00%

The table is an exact result for this finite model, not a simulation estimate. Its final 100% means that all outcomes allowed by these assumptions finish by fifteen. It is not a guarantee that a real project could

never finish later. Omitted scope, a longer clearance hold, resource failure or a different relationship would change the model. The small example is valuable because the arithmetic is transparent; its deliberately bounded inputs should not be mistaken for evidence that real delivery uncertainty is equally bounded.

An Australian regulatory example reinforces the need to propagate impacts through the network. In a 2026 assessment commissioned by the Australian Energy Regulator for Marinus Link, EMCa explained that an impact on a contract milestone need not delay the overall critical path, and a cost exposure need not be a schedule delay. It considered a represented process linking risks to the master schedule reasonable for assurance, while emphasising support for workshop assumptions. This was an assessment of risk allowance expenditure, not proof of project delivery success or independent verification of every model result (EMCa, 2026, pp. 26-27).

Reproduce the calculation through Monte Carlo simulation

In each iteration, sample the package durations from their stated distributions and draw one occurrence outcome for the common event. Recalculate the network, store the finish and record which paths are critical. Repeat with new draws and assemble the frequency distribution. The calculation must preserve the specified joint assumptions, calendars and resource policy. In a larger model, it should also propagate the consequences through the whole network rather than merely add sampled durations along the original deterministic critical path.

For this chapter, a reproducible run of 100,000 iterations using random seed 20260922 produced a mean of 11.34705 working days, a 45.064% frequency of finishing by ten and an 81.280% frequency of finishing by twelve. A second run with seed 20260923 produced 11.356 days, 44.874% and 81.164%, respectively. Both runs returned P50 and P80 at twelve and P90 at thirteen. Their agreement with the exact enumeration checks the implementation of this example; it does not validate the probabilities as forecasts for an actual project.

There is no universal iteration count that makes every analysis reliable. Examine convergence of the outputs that matter, especially tail probabilities and decisions near a threshold. More iterations reduce sampling noise but cannot repair an omitted risk, an unsupported dependence assumption or an incorrect resource model. Preserve the input version, settings, sampling method and results so that another competent analyst can reproduce the reasoning. A repeatable calculation and a credible delivery model are related requirements, but they are not the same test.

8.5 Interpreting confidence, criticality and sensitivity

> **Activity Cumulative Probability Risk Distribution.** 'A table of dates and their associated cumulative probabilities of occurrence for schedule activity completion. Dates are derived using analytical techniques such as Monte Carlo calculations. When applied to the project end date, the value is equivalent to the project cumulative probability risk distribution.' (PMI, 2019, p. 100)

The cumulative distribution answers a decision-facing question: what probability does the model assign to completion by a stated boundary? A histogram shows the frequency of particular outcomes or intervals; the cumulative curve adds those probabilities as the date moves later. In the worked example, the project finish milestone has a cumulative probability of 45% at ten and 81.25% at twelve. An intermediate activity has its own distribution. The probability of completing one package should not be presented as the probability of completing the whole project.

Completion probabilities and percentile dates

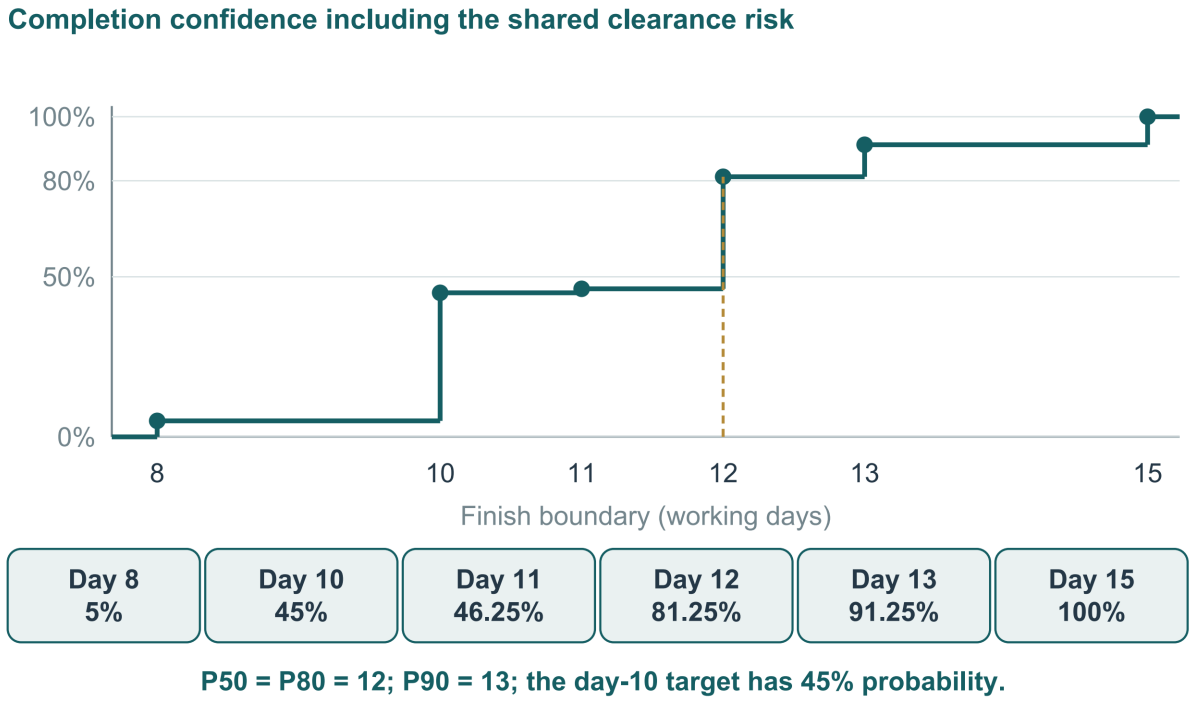


Figure 8.6. Original cumulative distribution for the worked example, including R-01. The curve is a staircase because the outcomes are discrete. P50 and P80 both occur at twelve; P90 occurs at thirteen.

Read a percentile in the correct direction

For this discrete example, a percentile is the earliest finish boundary whose cumulative probability reaches or exceeds the specified level. At eleven, only 46.25% of the outcomes have finished. At twelve, 81.25% have finished. P50 and P80 are therefore both twelve, while P90 is thirteen. The shared P50 and P80 value is a consequence of the large probability mass at twelve, not a contradiction or a claim that 50% and 80% mean the same thing. Interpolating a smooth line through this step would misrepresent the discrete model.

A P80 date is a modelled completion percentile, not an 80% statistical confidence interval around a parameter estimate and not an unconditional assurance of delivery. State the model version, milestone, reporting position and material assumptions alongside it. In a real dated schedule, convert working-time outcomes using the relevant calendars rather than adding the working-day count as calendar days. The selected confidence threshold also needs a governance basis. The use of an 80% threshold in this example is a teaching assumption; another decision may require a different tolerance.

Distinguish how often an activity is critical from its influence

> **Activity Risk Criticality Index.** 'The probability that the schedule activity will be on a critical path, calculated by dividing the number of times the activity is on a critical path during simulation by the number of iterations in that simulation.' (PMI, 2019, p. 106)

In the example, B is critical when its duration is at least as long as C's, and C is critical when its duration is at least as long as B's. Equal durations occur in 37.5% of the outcomes, and both paths are then counted. Each package consequently has a criticality index of 68.75%. These are not mutually exclusive shares, so they do not need to add to 100%. Confirm how a tool handles tied paths, constraints and resource dependencies before interpreting its displayed index.

Criticality and influence are different questions

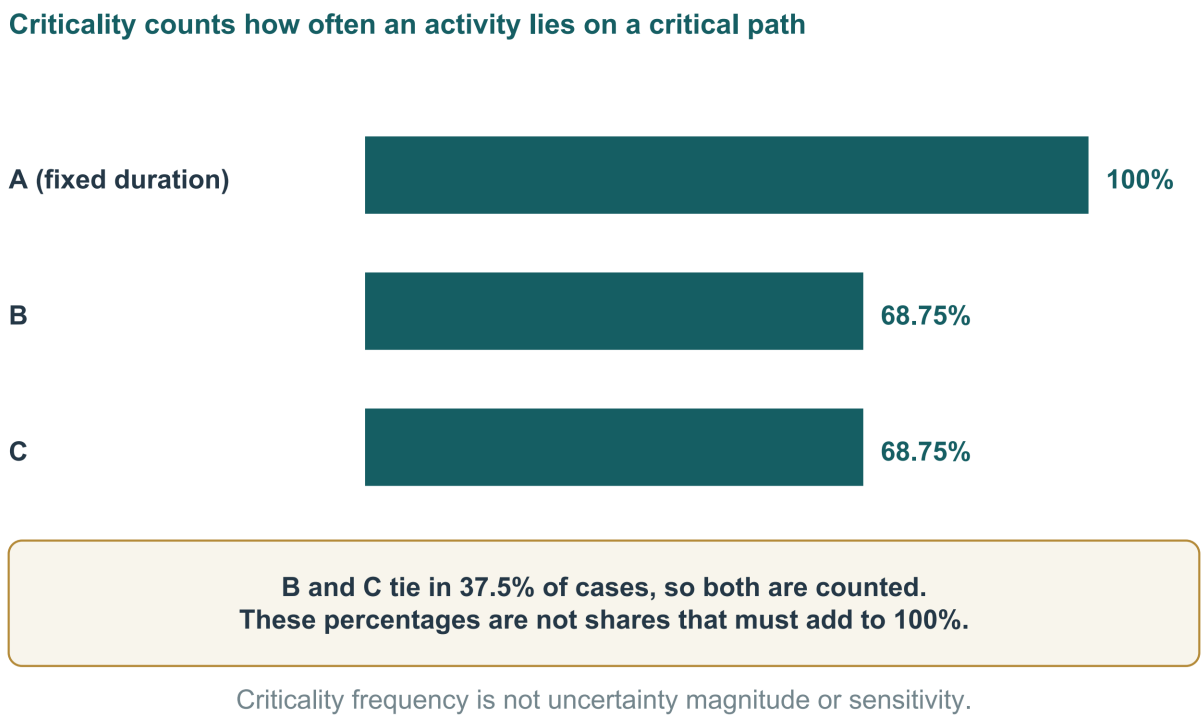


Figure 8.7. Original comparison of critical-path frequency and influence on uncertainty. The fixed preparation activity is always critical in this model, but its duration does not vary. The package indices count tied critical paths and therefore are not shares of a single total.

Criticality alone does not identify the best response. A fixed two-day preparation activity is on every path but contributes no duration variation under the stated assumptions. A less frequently critical package may have a severe tail, and a shared event may move the whole network. Sensitivity analysis explores how changes or variation in inputs are associated with changes in the result. Correlation-based rankings can help identify influential inputs, but dependence and interactions complicate their interpretation. A response comparison goes further by changing a defined delivery assumption and recalculating the consequences.

The original deterministic critical path should therefore be treated as a starting point. In one outcome B may take eight days while C takes four; in another the reverse occurs. Paths that are slightly shorter in a deterministic model can also become controlling when their uncertainty is considered. Review critical and near-critical work, common interfaces and risk drivers together. Monitoring only the activity with the highest criticality percentage can miss a practical intervention with greater benefit.

Hasan and Lu (2024) investigate subcritical paths and distinguish activity-duration variance from its effect on project-duration variance. Their published study develops specialised measures and tests an analytical procedure through a case and Monte Carlo simulations. Those variance-based measures are not interchangeable with PMI's activity criticality index. The useful teaching implication is to inspect uncertainty on paths beyond the original critical path and to ask how an activity's variation affects the whole network. The study should not be read as a universal ranking rule or evidence of a fixed percentage saving.

Test the effect of a different dependence assumption

Now make B and C perfectly positively dependent: both take four, both six or both eight, still with probabilities of 25%, 50% and 25%. Retain the same clearance event. Their individual distributions have not changed, but the parallel maximum now has a mean of six rather than 6.75. The overall expected finish becomes 10.60 days, and the chance of finishing by ten becomes 60%, compared with 45% under independence. P80 remains twelve. These are exact consequences of a deliberately extreme alternative joint model.

The comparison shows why dependence must be explained rather than treated as a generic 'risk increase' switch. Here it removes combinations in which one package is fast and the other slow, changing the maximum at the merge. It does not establish that positive correlation is beneficial in general, and it provides no evidence that perfect dependence is realistic. An analyst must not select the assumption merely because it improves the date. The appropriate joint behaviour should follow from the delivery mechanism and available evidence, with important alternatives tested openly.

8.6 Comparing responses, contingency and cost consequences

A response should identify what changes in the delivery arrangement and how that change affects the model. An early technical review might reduce the probability of an unresolved clearance. A reserved specialist service might shorten the hold if it occurs. Accepting a later commitment provides additional time protection but does not itself reduce the duration of the underlying work. A recovery action after a delay has happened addresses an established position; it must be evaluated against the remaining schedule rather than against the original untouched plan.

Vaseghi, Martens and Vanhoucke (2024) examine corrective actions that change activity-duration means or standard deviations and compare their selection computationally across different network structures. Their results show why both the activities selected and the way an intervention changes uncertainty matter. They do not establish that any particular action will produce a fixed benefit in a live project. For practice, explain the intervention's mechanism and resource requirements, change the appropriate inputs and recalculate the result. Changing a risk rating on a register without changing the delivery assumptions is not an equivalent intervention.

Compare two explicit response mechanisms

Consider two independent alternatives to the principal example. The first is an additional early review costing £600, assumed to reduce the probability of R-01 from 20% to 5% while leaving its three-day impact unchanged. The second reserves a support service for £300, assumed to reduce the hold from three days to one when it occurs, while leaving the occurrence probability at 20%. The fees are paid regardless of occurrence, and all execution costs are included within the stated cost assumptions. The alternatives are assessed separately, not in combination.

Both responses are assumed deliverable without extending A or creating another resource conflict. That assumption would need evidence in a real decision: availability, competence, lead time, approvals and the response's effectiveness must be checked. The numerical probabilities and fees here are invented for teaching. They should not be interpreted as market prices or as proof that a particular review achieves a specified reduction. The value of the comparison lies in showing how a stated change propagates through the model.

The review reduces expected completion to 10.90 days and raises the probability of finishing by twelve to 95.3125%. The reserved service produces an expected completion of 10.95 days and a 91.25% probability of finishing by twelve. Both retain P80 at twelve, although each reduces P90 from thirteen to twelve.

Looking only at P80 would therefore conceal meaningful changes in the distribution. Compare the chance of meeting the selected milestone, residual tail exposure and response conditions as well as the headline percentile.

Comparing response effects on confidence and expected cost

Compare responses at a shared commitment boundary

Option	P(finish by day 12)	Expected cost
Principal model	81.25%	£31,350
Earlier review	95.3125%	£31,500
Reserved service	91.25%	£31,250

All three options have P80 = 12 working days.

Illustrative cost = £20,000 + £1,000 × working days + response fee.
Fees: earlier review £600; reserved service £300.

Figure 8.8. Original comparison under the stated assumptions. Every option has P80 at twelve, but the probability of meeting that boundary and the expected cost differ. The displayed probabilities are exact for these illustrative assumptions.

Integrate costs using the same scenarios

Assume a fixed £20,000 of other project cost and a time-related cost of £1,000 per project working day until completion. Add the relevant response fee. Under the principal model, expected cost is £20,000 + £1,000 × 11.35 = **£31,350**. The review gives £20,000 + £600 + £1,000 × 10.90 = **£31,500**. The reserved service gives £20,000 + £300 + £1,000 × 10.95 = **£31,250**. These calculations exclude any benefits, penalties or other costs not specified in the example.

The reserved service has the lowest expected cost of these alternatives, while the review gives the highest chance of finishing by twelve. That is a decision trade-off, not a universal ranking of response types. An expected cost is not a guaranteed budget or a cost percentile. In this simple model, cost is directly linked to completion time, so the principal model's £32,000 cost threshold and twelve-day finish threshold are met by the same 81.25% of outcomes. In a larger project, independent cost drivers and responses can change that relationship. Separate P80 cost and schedule results do not automatically establish an 80% probability of meeting both simultaneously.

Set contingency without counting the exposure twice

If twelve is selected as the commitment relative to the ten-day deterministic planning point, the two-day difference is a proposed time allowance under this particular model. It is not the same as the event's expected delay of 0.60 days, the mean finish difference of 1.35 days or a mandatory industry percentage. Define where the allowance sits, what it protects and who may authorise its use. Do not add the full event delay, a percentile-based allowance and existing buffers together as though they were automatically independent provisions.

Retain a distinction between the underlying forecast and the protected commitment. Moving the promised date later can increase its modelled chance of achievement without improving the delivery process. A mitigation changes the assumptions or method that generate the forecast, while a contingency arrangement provides an agreed response or protection against residual exposure. The terms should be applied consistently with the organisation's controls. Where acceleration introduces overtime, additional interfaces or reduced review time, assess the resulting safety, quality, resource and rework consequences before treating the earlier date as a credible option.

Acebes and colleagues (2026) prioritise risks by comparing a model containing all risks with models in which each is removed separately, examining effects on duration and cost percentiles. Their experiments include fictitious networks and two real-project models. The approach highlights the importance of network position, but assumes unlimited resources and risks independent beyond precedence coupling. It is not evidence that individual contributions can simply be added into a contingency total. For a scheduling decision, compare clearly specified scenarios against the same outcome measure and retain the limits of the assumed interaction and resource model.

8.7 Learning from official international evidence

Real projects demonstrate why a milestone needs a clear boundary and an evidence-based decision. An official announcement may record an achieved approval, a revised forecast, a proposed stage plan or an actual ceremony. These are different kinds of evidence. The following comparison draws on official accounts from four countries. Its scheduling interpretations are teaching conclusions; the sources do not provide the internal probabilistic models or establish numerical confidence levels for the milestones discussed.

Table 8.5 | Schedule uncertainty in international evidence

Official case	What the dated evidence establishes	Scheduling interpretation
UAE: Barakah Unit 4	FANR reported in January 2024 that an operating licence had been received in November 2023 and testing was continuing. Commercial operation was announced on 5 September 2024	A completed licence and commercial readiness are different milestones; analyse the remaining acceptance conditions
France: EPR2	In January 2025, the Cour des comptes recommended deferring the final investment decision until financing was secured and detailed-design progress supported the first nuclear-concrete milestone	Identify maturity and funding assumptions before recommending a commitment; an audit recommendation is not evidence of a later approval
Germany: Stuttgart 21	DB's June 2026 account of its internal audit said the end-2026 target was unrealistic. Its revised plan placed the new main station in December 2031 within a wider staged programme	Challenge assumptions and interfaces; a revised stage plan is neither achieved delivery nor a probability interval
Egypt: Grand Egyptian Museum	A July 2025 official account attributed postponement of the planned 3 July inauguration to regional developments that could affect international participation. The Presidency recorded the ceremony on 1 November 2025	External conditions can govern an event milestone; distinguish inauguration from first visitor access or construction completion

Sources: FANR (2024); Abu Dhabi Media Office (2024); Cour des comptes (2025, pp. 9-10 and 13); Deutsche Bahn (2026); State Information Service (2025); Presidency of Egypt (2025). Each case is interpreted within the scope and date of its evidence.

The French finding describes the position considered in the January 2025 report; it should not be used to assert that the same financing condition remained unresolved at a later date. DB's account is the sponsor's published description of an internal audit, not an independently published external audit report. The UAE chronology does not establish that the interval between licensing and commercial operation was a delay. The Egyptian sources concern the formal inauguration. These distinctions help the scheduler avoid using a real case to support a claim that its evidence does not establish.

England's HS2 reset provides a further distinction between a published estimate and an assured baseline. In June 2026, the NAO described work to consolidate scope, schedule, cost and risk across twenty-one projects and the further checking needed before an assured baseline. The published expectation for initial Old Oak Common-Birmingham services was May 2036-October 2039. The NAO explicitly stated that it had not audited the calculations and evidence underpinning those schedule estimates. The reported range was therefore not a pair of verified percentile dates or evidence of completed baseline approval (NAO, 2026, pp. 21-23).

8.8 Assuring the milestone and authorising the baseline

Schedule Baseline. 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and performance measurement baseline.' (PMI, 2019, p. 189)

A confidence result is evidence for a decision; approval is an act of governance. PMI's schedule-development guidance requires review of end dates, milestones, critical paths, float and resource requirements, followed by adjustment and reanalysis where necessary. The formal approval process is established in the schedule management plan. Once agreed and approved, the retained baseline becomes the reference against which performance is assessed (PMI, 2019, pp. 64-65). A scheduler should therefore present a recommendation that connects the proposed date to the delivery method, remaining exposure and decisions needed to sustain it.

Apply an initial assurance gate

The original assurance gate below brings together the work developed across the chapter. It is a set of review questions, not a substitute for the organisation's approval authority. Reviewers should challenge the evidence and the consequences of unresolved findings. A model can be technically reproducible yet commercially unaffordable; a proposed response can improve the distribution yet depend on a resource that has not been secured. Material qualifications should remain visible in the recommendation rather than being removed from the presentation to create an appearance of certainty.

Table 8.6 | Assuring a schedule risk analysis

Review area	Question to resolve	Consequence for the decision
Scope and milestone	Does the model reach the actual acceptance or readiness event being promised?	Extend or qualify an incomplete analysis boundary
Logic and resources	Are dependencies, calendars and capacity feasible in the relevant scenarios?	Correct the model or evaluate an executable alternative
Inputs and dependence	Are ranges, event probabilities and joint assumptions supported and consistent?	Revise unsupported inputs and test important alternatives
Responses and protection	Are response owners, effectiveness, resources and contingency rules credible?	Make the necessary commitments explicit before relying on them
Cost and authority	Is the proposed arrangement affordable and within the relevant decision authority?	Obtain the authorised approval and retain its conditions

Assurance, approval and baseline control

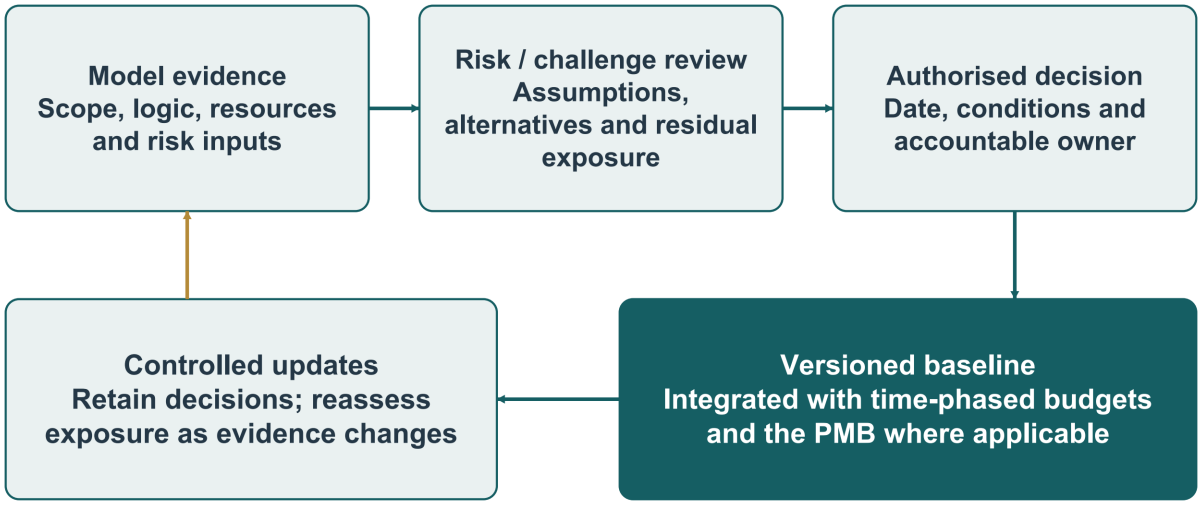


Figure 8.9. An original assurance-to-baseline workflow. Analysis informs the authorised decision. The accepted model, risk basis and integrated budget are retained together, while subsequent forecasts remain subject to controlled review.

The UK Government Functional Standard GovS 002 provides a relevant public-sector reference. Its 2025 edition connects evidence-based estimates and documented assumptions with baselining, confidence in forecasts and authorised risk decisions. It also addresses risk ownership, responses, residual exposure and contingency control. This supports a recommendation that states the evidence, remaining qualifications and authority needed for the proposed commitment. Its requirements apply within their stated government context; they do not make a selected percentile an automatic approval or prescribe P80 for every project (Government Project Delivery, 2025, clauses 4.1.3, 7.2, 7.5 and 7.6).

Integrate the schedule with the approved budget

Cost Baseline. 'The approved version of work package cost estimates and contingency reserve that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and schedule baseline.' (PMI, 2019, p. 178)

Performance Measurement Baseline. 'Integrated scope, schedule, and cost baselines used for comparison to manage, measure, and control project execution.' (PMI, 2026, p. 17)

For an integrated performance measurement baseline, the approved scope, dates and time-phased budget need to describe the same delivery arrangement. If a selected response introduces early review work, a reservation fee or a different sequence, reflect the authorised work and cost at the appropriate point. Do not leave the schedule showing the response while the budget still describes the unmitigated plan. Equally, the expected cost from a risk calculation is not automatically the authorised budget. Funding, cost confidence and reserve treatment require their own decision and a consistent connection to the schedule.

Keep the distinction between contingency within the approved cost baseline and management reserve under the applicable controls. PMI's current lexicon expressly excludes management reserves from the

cost baseline (PMI, 2026, p. 6). A schedule margin is also not automatically an activity that earns value merely through the passage of time. Planned value should remain connected to approved scope and the agreed performance-measurement method. Record how time protection, risk-response work and budget provisions are represented so that the same allowance is not spent or reported twice.

Retain the decision and refresh the forecast

The retained decision should identify the milestone and model version, analysis date, scope boundary, resource assumptions, material distributions and dependencies, selected response, confidence basis and remaining qualifications. It should also identify the approving authority and any conditions attached to approval. Preserve the accepted model instance and time-phased budget for comparison. A probabilistic report without its inputs and governing assumptions is difficult to reproduce; a baseline without an identifiable approval is difficult to control.

After approval, update actual progress and remaining work, review whether risks have occurred or been retired, and test whether responses remain available and effective. If the common clearance in the example has already been issued, its occurrence is no longer a future draw. If it has arrived late, preserve the actual delay and analyse what remains. A new forecast may justify escalation or a change request, but it does not automatically authorise replacement of the baseline. Maintain the distinction between what was approved, what is now forecast and what decision is required.

GAO's schedule guide similarly connects a credible network with risk analysis, milestone confidence and continuing review. Its treatment of merge effects, correlation, criticality and contingency reinforces the need to look beyond a single deterministic path and to revisit results as information changes. The practical result should be an executable, controlled plan supported by an understandable risk argument, rather than a probability curve detached from delivery decisions (GAO, 2015, pp. 99-120).

Knowledge check and examination practice

These original questions practise PMI-SP reasoning; they are not reproduced examination questions. They align particularly with Domain 2's treatment of critical and near-critical paths, quantitative schedule risk analysis, stakeholder agreement and the performance measurement baseline, together with Domain 3's ongoing analysis and authorised responses (PMI, 2012, pp. 4-7). Select the best answer. Numerical questions use the stated working-day boundaries and assumptions, not calendar dates or unmentioned resource constraints.

Question 1: an event has already occurred

At the reporting cut-off, the common clearance has arrived three working days late. The previous risk model assigned a 20% probability to that delay. What should the scheduler do next?

A Continue sampling a 20% chance of the same past event in every forecast iteration.
B Remove the actual delay because it was previously classified as a risk.
C Retain the established history and analyse the remaining work and any unresolved consequences.
D Replace the approved baseline automatically with the latest finish forecast.

Question 2: interpreting three-point estimates

An expert supplies durations of four, six and twelve days but has not explained whether the outer values are bounds or percentiles. The analyst proposes a triangular distribution immediately. What is the best response?

A Clarify the values' meaning, units, included risks and evidence before selecting the distribution.
B Assume every optimistic estimate means P10 and every pessimistic estimate means P90.
C Treat the weighted average as the complete project completion distribution.
D Select whichever shape produces the required target date.

Question 3: a parallel merge and a common event

In the worked example, each independent package has a 75% chance of taking no more than six days. Preparation and acceptance add four days in total. There is an independent 20% chance of a common three-day hold, and even the fastest held outcome finishes after ten. What is the probability of project completion by ten?

A 75%.
B 56.25%.
C 60%.
D 45%.

Question 4: reading discrete percentile dates

Completion occurs only at whole-working-day boundaries. Cumulative probability is 46.25% at eleven days and 81.25% at twelve. Using the earliest boundary whose cumulative probability reaches the selected level, which statement is correct?

A P50 is eleven and P80 is twelve.
B Both P50 and P80 are twelve.
C P50 must be halfway between eleven and twelve.
D The distribution is invalid because two percentiles cannot share one finish boundary.

Question 5: criticality totals

The two parallel packages each have a criticality index of 68.75%. The calculation counts both paths when they tie. A reviewer says their total exceeding 100% proves an error. Which explanation is best?

A The indices are membership frequencies, and tied critical paths can both count.
B Every criticality index must be rescaled so the project total equals 100%.
C Each package has a 68.75% probability of finishing late.
D Criticality measures the percentage of the project's total contingency allocated to each package.

Question 6: representing a shared risk

One late clearance event prevents both B and C from starting. Their duration estimates explicitly exclude that event. How should it be represented in the example's risk model?

A Draw two independent occurrences, one for each package.
B Add three days to both estimates in every iteration and also retain the probabilistic hold.
C Draw the common event once and propagate its effect through the shared gate and real dependencies.
D Ignore it because the two technical packages have separate crews.

Question 7: comparing a response

An assessed response leaves P80 at twelve working days but increases the modelled probability of finishing by twelve from 81.25% to 95.3125%. It also changes cost and depends on additional early review capacity. What is the best interpretation?

A The response has no schedule benefit because P80 did not move.
B The unchanged P80 proves the simulation failed.
C The response guarantees completion by twelve and can be approved without further review.
D The response improves the modelled chance of meeting that milestone, subject to its cost, feasibility and effectiveness assumptions being accepted.

Question 8: moving from analysis to a baseline

A team has produced a credible risk analysis and selected a candidate commitment date. What is required before that date becomes part of the approved baseline and integrated performance measurement arrangement?

A Save a screenshot of the cumulative curve and delete the prior model.
B Complete the relevant assurance and authorised approval, retaining the accepted model and consistent scope and time-phased budget.
C Replace the baseline whenever the simulation produces a different percentile.
D Add all management reserve to the planned-value profile so every allowance is measured as completed work.

Answer explanations

Question 1: C

The event is now part of known history. Retain its actual effect and assess the remaining work and any continuing uncertainty. A keeps treating an established fact as a future occurrence. B removes a real delay merely because it once appeared in the risk register. D confuses a changed forecast with authority to change the baseline. The updated analysis may support a response, escalation or change request, but that decision must follow the applicable controls. Other consequences may remain uncertain even though the original event's occurrence is known.

Question 2: A

Distribution selection depends on what the inputs represent and what they include. Bounds exclude more extreme outcomes in a bounded model; percentiles do not. Units, delivery assumptions and overlap with named risks also need clarification. B imposes a percentile interpretation without evidence. C confuses a summary statistic with a probability distribution and ignores the network. D selects an assumption to obtain a preferred answer. Expert judgement can be a legitimate input, but its meaning and supporting reasoning should be documented and challenged rather than inferred from three unexplained numbers.

Question 3: D

Both independent packages must fit within six days, giving 0.75 × 0.75 = 0.5625. The project must also avoid the common hold, with probability 0.80. The combined result is 0.5625 × 0.80 = 0.45, or 45%. A considers only one package. B includes the merge but omits the event. C multiplies 0.75 by 0.80 and still ignores the second package. The calculation depends on the stated independence and the fact that no held outcome meets ten; a different joint model would require a different calculation.

Question 4: B

The cumulative probability at eleven is below both 50% and 80%. At twelve it exceeds both, so twelve is the first boundary meeting either threshold. A incorrectly treats 46.25% as sufficient for P50. C inserts an interpolation that does not follow the stated discrete convention. D assumes every percentile needs a unique date, which is false when outcomes have probability mass at particular points. The resulting P80 date has 81.25% cumulative probability because the distribution jumps across 80%; it need not land on exactly 80%.

Question 5: A

An activity's index counts how often it belongs to a critical path. Those memberships are not mutually exclusive. Both packages count in the 37.5% of outcomes where they tie, and fixed activities can also belong to every path. B would change the meaning of the reported measure by forcing it into an allocation of a single total. C confuses critical-path membership with lateness against a target. D confuses an analytical frequency with a management allocation. Confirm the tool's tie and criticality conventions before interpreting the result.

Question 6: C

There is one shared clearance event, so it should be drawn once and its effects transmitted through the model's real dependencies. A invents separate occurrences and permits combinations inconsistent with the stated common event. B makes the delay certain inside the estimates and adds it again through the probabilistic hold. D overlooks a shared approval dependency simply because the crews are separate. Resource independence and risk-event independence are different questions. The model should preserve both the separate crew arrangement and the common clearance condition.

Question 7: D

The response improves the probability of meeting the selected boundary even though the same discrete percentile date is reported. The team should examine the distribution, cost, residual exposure and response conditions before recommending it. A ignores information beyond one percentile. B overlooks the fact that a step distribution can retain the same quantile after meaningful probability changes. C converts a conditional model result into a guarantee and bypasses feasibility and approval. The assumed early review must be deliverable and effective for its modelled benefit to support the decision.

Question 8: B

The analysis informs an authorised decision. Retaining the accepted model, scope and time-phased budget allows the resulting baseline to serve as a controlled performance reference. A preserves a presentation but discards the underlying basis and comparison history. C treats every forecast change as an approved rebaseline. D disregards the distinction between the cost baseline and management reserve and assumes that an allowance automatically represents scope earning value. The approved schedule and budget should describe the same delivery arrangement, including authorised response work and the agreed treatment of contingency.

Preparing for the next chapter

Risk analysis makes the limits of a plan more visible, but it does not prescribe one scheduling method for every project. Some work benefits from stable detailed logic, while other work requires progressive elaboration, short planning cycles or attention to flow through repeated locations. The next chapter examines adaptive, lean and location-based approaches. The discipline developed here still applies: define the milestone, represent dependencies and capacity honestly, make assumptions visible and explain what the available evidence supports. An adaptive plan can remain controlled without pretending that all future detail is already known.

References and further reading

PMI practice-standard references use printed page numbers. Formal quotations preserve the cited wording; the PMB definition comes from the separately identified 2026 lexicon. All numerical examples, diagrams and questions are original teaching material. Their probability assumptions are illustrative, and the official cases are interpreted within their dated evidence.

Abu Dhabi Media Office (2024) 'Unit 4 of Abu Dhabi's Barakah Nuclear Energy Plant begins commercial operations', 5 September. Official announcement.

Acebes, F., González-Varona, J. M., López-Paredes, A. and Pajares, J. (2026) 'Quantitative risk prioritization. A new risk-based approach to prioritize project risks', *Annals of Operations Research*, published online 20 May. Publisher DOI.

Cour des comptes (2025) *La filière EPR : une dynamique nouvelle, des risques persistants. Rapport de suites*. January, published 14 January, especially pp. 9-10 and 13. Official government report copy.

Deutsche Bahn (2026) 'Stuttgart 21: Deutsche Bahn stellt Inbetriebnahmeplan neu auf', 26 June. Published account of an internal audit and a revised commissioning plan. Official account.

Energy Market Consulting associates (EMCa) (2026) *Marinus Link project - Response to the AER's Supplementary Draft Decision: Assessment of Revised Risk Allowance Expenditure for Stage 1*. Public version prepared for the Australian Energy Regulator; January cover, February publication, especially pp. 26-27. Official AER publication.

Federal Authority for Nuclear Regulation (FANR) (2024) 'The Board of Management of the Federal Authority for Nuclear Regulation Discusses Barakah Nuclear Power Plant Progress; approves its 2024 National and International Cooperation Plan', 12 January. Official regulator account.

Government Project Delivery (2025) *Government Functional Standard GovS 002: Project delivery*. Version 2.1, 1 September, clauses 4.1.3, 7.2.3-7.2.5, 7.5 and 7.6. Official standard.

Government Accountability Office (GAO) (2015) *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, 22 December, especially pp. 99-120. Official guide.

Government Accountability Office (GAO) (2024) *NASA Artemis Missions: Exploration Ground Systems Program Could Strengthen Schedule Decisions*. GAO-25-106943, 17 October, especially pp. 21-24 and 27-28. Historical report; subsequent recommendation status.

Hasan, M. and Lu, M. (2024) 'Mitigating Project Schedule Risks by Identifying Subcritical Paths and Variance-Critical Activities', *Journal of Construction Engineering and Management*, 150(8), 04024096. Publisher DOI.

National Audit Office (NAO) (2026) *High Speed Two reset*. HC 52, Session 2026-27, 29 June, especially pp. 21-23 and Figure 8.5, note 4. Official report.

Project Management Institute (PMI) (2012) *PMI Scheduling Professional (PMI-SP) Examination Content Outline*, especially pp. 4-7. Official examination outline.

Project Management Institute (PMI) (2019) *Practice Standard for Scheduling*. Third edition. Newtown Square, PA: PMI. Principal coverage: sections 3.2.1.6-3.2.1.8, pp. 62-65; section 3.4.11, pp. 83-85; risk components, pp. 100, 106, 120 and 129; glossary definitions, pp. 178 and 189.

Project Management Institute (PMI) (2026) *PMI Lexicon of Project Management Terms*. Version 5.0, updated January, pp. 6 and 17. Official lexicon.

Presidency of the Arab Republic of Egypt (2025) 'President El-Sisi and First Lady Attend GEM's Historic Opening with Global Leaders and Guests', 1 November. Official record of the inauguration ceremony. Presidency account.

Song, Y. and Vanhoucke, M. (2025) 'Schedule risk analysis for project control with risk interactions', *Annals of Operations Research*, published online 6 June. Publisher DOI.

State Information Service, Egypt (2025) 'Spokesman: GEM's Inauguration Date To Be Announced soon', 23 July. MENA account of the Cabinet spokesperson's explanation. Official account.

Vaseghi, F., Martens, A. and Vanhoucke, M. (2024) 'Analysis of the impact of corrective actions for stochastic project networks', *European Journal of Operational Research*, 316(2), pp. 503-518. Publisher DOI.

CHAPTER 09

Applying Adaptive, Lean and Location-Based Scheduling

Selecting a method that fits the work

A credible schedule reflects the way that work can actually be delivered. Some work can be defined and sequenced well before execution; some must be explored through short cycles of development and feedback; some depends on a repeated flow of crews through physical locations. A project may contain all three conditions. A railway programme, for example, can combine repeatable civil works, uncertain software integration and fixed operational access windows. The scheduler's responsibility is to establish a coherent delivery model across these conditions, rather than expect one presentation or planning method to answer every question.

This chapter examines adaptive and hybrid planning, rolling waves, Scrum, Kanban, lean pull planning, location-based scheduling, line of balance and takt. It then explains how time-linked building information modelling and intelligent systems can support decisions. The central question throughout is practical: what evidence connects the chosen method to feasible work, accepted outputs and credible milestones? A board can make a queue visible, but it cannot by itself establish an external approval date. A location chart can expose a clash between crews, but its assumptions still require validation. A three-dimensional animation can communicate sequence, but it cannot make an infeasible sequence executable.

The chapter is self-contained and supports both PMI-SP examination preparation and the judgement expected at Project Controls Professional Level 6. It develops the approaches discussed in sections 2.2.3-2.2.5 and 2.6-2.6.1 of PMI's scheduling standard. Original examples use explicit assumptions and consistent units. Official cases distinguish documented delivery practice from the chapter's interpretation, while research findings are assessed according to their methods and limitations. The purpose is to explain when a method helps, what it cannot establish and how its information should enter the wider project control system.

The chapter framework: method, connection, readiness and evidence

Figure 9.1 presents an original six-stage framework. First, examine uncertainty, repetition, dependencies and the consequences of failure to select a suitable method. Second, connect detailed plans to releases, interfaces and authorised milestones. Third, make work ready by resolving the conditions necessary for execution. Fourth, manage the flow of work through real capacity. Fifth, interpret evidence about completed outputs, queues and handovers. Finally, review the method and the plan as circumstances change. The framework is a teaching model, not a named PMI process or a substitute for the organisation's governance arrangements.

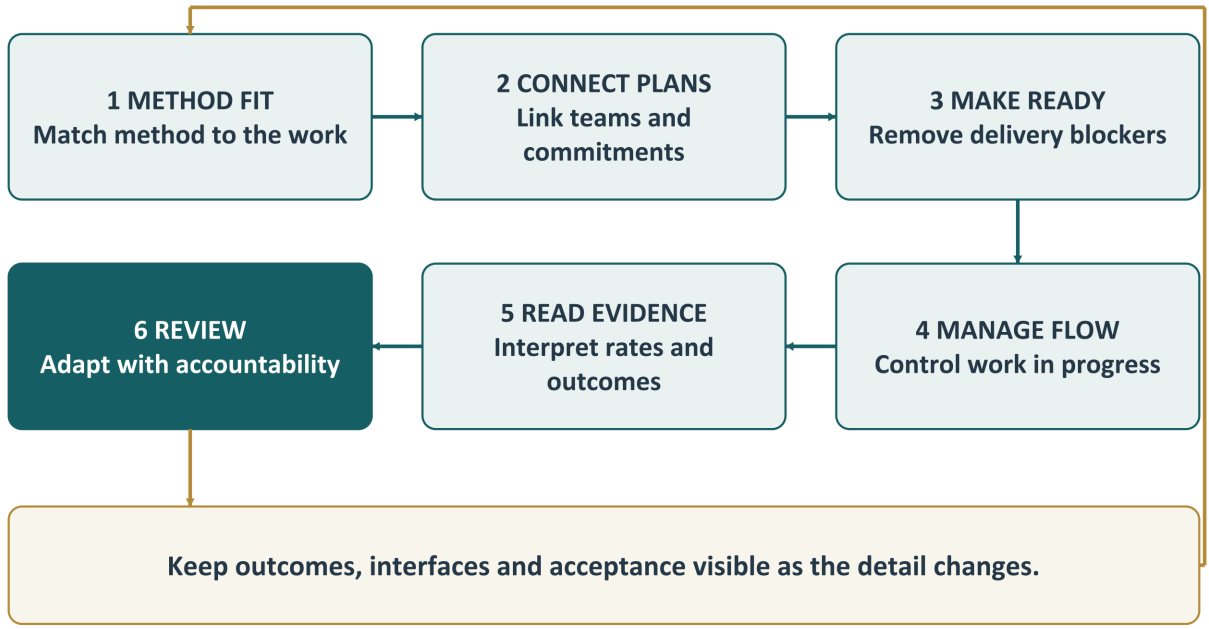


Figure 9.1. An original framework for adaptive, lean and location-based scheduling. The cycle connects method selection to the evidence needed for dependable delivery decisions.

9.1 Understanding adaptive and hybrid delivery

> **Agile.** 'A term used to describe a mindset of values and principles as set forth in the Agile Manifesto.' (PMI, 2019, p. 176)

PMI distinguishes relatively definable work from work in which requirements, solutions or both contain substantial uncertainty (PMI, 2019, pp. 21-23). The distinction concerns the work being undertaken, not simply the industry label. Repeated installation of an established component may be predictable even within a software-enabled programme. Developing an unfamiliar passenger interaction may require experimentation even within a construction project. The appropriate planning response depends on how much can be known, how quickly useful feedback can be obtained and which commitments must remain stable while learning takes place.

Adaptive delivery creates opportunities to inspect a result and revise what happens next. An increment adds usable capability; an iteration provides a cycle in which the team develops and learns. These ideas are related but should not be collapsed into one rule about release dates. A team can iterate on a design before a public release, and a product can receive several usable increments within a wider phase. The scheduling implication is that the level of detail and the timing of decisions should match the availability of evidence. Delaying all planning until certainty arrives is impractical, but pretending that every distant detail is already known is equally unhelpful.

Hybrid planning deliberately connects different approaches within one delivery arrangement. For an independent example, consider a hospital appointment service whose software is developed incrementally while a fixed date governs the withdrawal of an existing supplier. The software team can refine appointment features through user feedback, but data migration, clinical acceptance, staff training and operational support still require identifiable work and agreed interfaces. Calling the programme hybrid does not explain how these conditions interact. The scheduler must show which outputs enable

which successors, who owns each handover and what happens if the forecast moves outside the authorised tolerance.

Assess uncertainty and the cost of learning

A useful method-selection discussion examines more than changing scope. It considers whether work can be divided into meaningful outputs, whether feedback is available quickly, whether a change is reversible and whether scarce resources or statutory approvals dominate the timing. An experimental screen layout can often be revised cheaply after user testing. Reworking an installed structure may be expensive or physically impossible. Both situations can benefit from learning, but the point at which learning should occur and the evidence needed before commitment differ. Prototypes, simulations and early trials can move learning ahead of an irreversible decision without requiring every later activity to use the same adaptive method.

The team should also distinguish uncertainty from unresolved management responsibility. A missing decision owner is not a reason to describe a date as inherently unknowable. An unconfirmed access window may be an external dependency that needs escalation. Conversely, a genuinely novel technical problem should not receive an artificially precise duration merely to make a baseline look complete. Professional judgement involves stating what is known, identifying what can be learnt next and choosing a planning horizon that preserves both flexibility and accountability.

Table 9.1 | Matching planning arrangements to work conditions

Work condition	Useful planning response	Question the scheduler must resolve
Well-defined work with significant dependencies	Logic-linked activities, calendars and resource analysis	Does the sequence include every prerequisite and acceptance event?
Evolving requirements with frequent feedback	Adaptive backlog and incremental delivery	How do completed outputs support the release objective?
Repeated work arriving through a service system	Pull, explicit workflow and work-in-progress controls	What limits throughput, and where is work waiting?
Repeated construction across physical areas	Location-based or linear planning, with crew sequencing	Can each crew move through available work without conflict?
Mixed conditions in one programme	Connected hybrid planning	How are decisions, dates and interfaces reconciled between levels?

The approaches in the table can be combined. A repeatable installation package may use a critical-path network for its contractual interfaces, a location chart for production and a weekly collaborative plan for execution. These are complementary views only if their information remains consistent. Three attractive documents with different dates, scope boundaries or completion rules create uncertainty about which plan the team is following. Method selection therefore includes a decision about data ownership, update frequency and the authoritative record for each type of information.

Recognise the wider agile family

Figure 2-13 in the 2019 scheduling standard names Crystal, ScrumBan, AUP, FDD, XP and DSDM alongside Scrum, Kanban and Lean (PMI, 2019, p. 23). The figure is an orientation to a family of approaches, not a prescription to apply them all. The brief distinctions below help a planner recognise terminology encountered in a project's delivery strategy. They do not establish separate examination weightings or replace the detailed selection and integration decisions developed in this chapter.

Table 9.2 | An orientation to the agile family

Name in the source figure	Brief orientation
Crystal	A family associated with Alistair Cockburn, emphasising people, communication and project-appropriate working arrangements (Cockburn, 2024).
ScrumBan	Combines a Scrum starting point with pull, visible workflow and control of work in progress; the operating policies must be made explicit (Ladas, 2008).
AUP	Agile Unified Process: an agile tailoring of the Unified Process, retaining coordinated modelling, implementation, testing, deployment and management disciplines (Ambler, 2005).
FDD	Feature-Driven Development: organise the model and feature list, plan by feature, then design and build features incrementally (De Luca, 2003).
XP	Extreme Programming: software delivery using short feedback cycles and engineering practices such as testing, continuous integration and small releases (Jeffries, 2001).
DSDM	An agile project framework combining business priorities, iterative development and timeboxing, with prioritisation used to manage feature flexibility (Agile Business Consortium, 2014).

9.2 Connecting vision, releases and rolling-wave detail

Rolling Wave Planning. 'An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.' (PMI, 2019, p. 189)

Rolling-wave planning manages the timing of detail. It does not remove the need to understand the overall scope or the major dependencies. PMI describes near-term activities being elaborated while more distant work remains at a higher level, with the next wave detailed before execution (PMI, 2019, pp. 23-24). In a logic-linked schedule, future planning packages should retain the information needed to assess resources, costs, relationships and milestones at their current level. As packages are decomposed, the team reconciles the resulting detail with approved boundaries and explains any changes to the forecast.

The UK Government Service Manual connects a service vision with measurable objectives and a roadmap, while recommending more detail for imminent work and less for distant work. It also emphasises visible plans that can be revised as evidence develops (Government Digital Service, updated 2026). This provides a useful hierarchy for adaptive work. The vision explains the intended outcome; the roadmap shows the intended direction; release planning groups useful capability; near-term planning establishes executable work. None of these levels should become a substitute for checking the dependencies that connect a team output to operational use.

Connecting adaptive team plans to releases and programme milestones

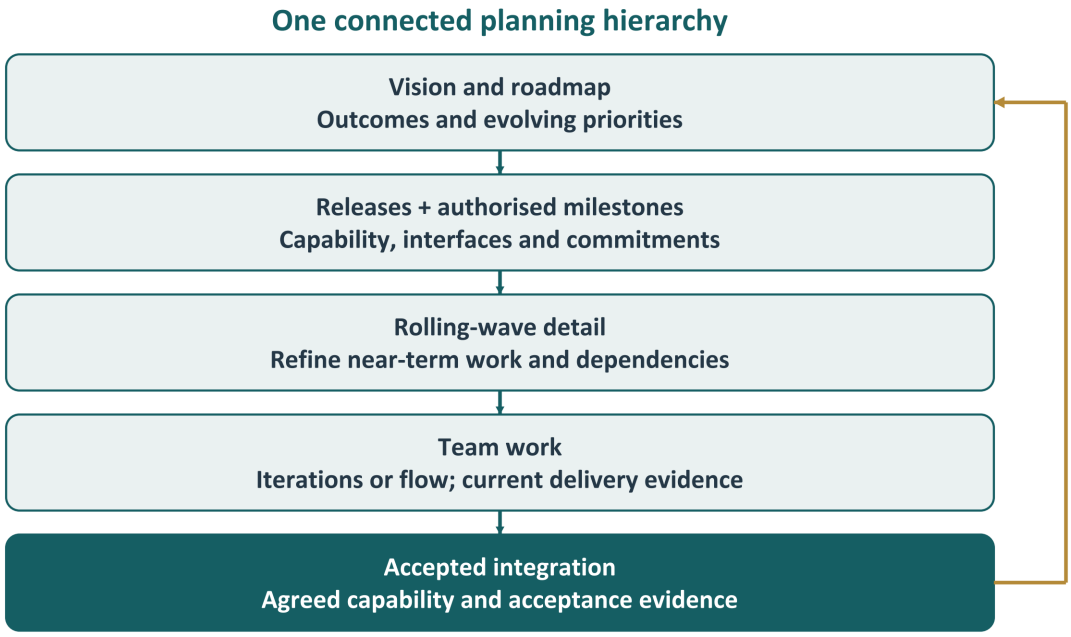


Figure 9.2. An original planning hierarchy. Detailed team decisions remain connected to release outcomes, integration conditions and authorised milestones, with feedback informing later detail.

Separate a target, a forecast and an authorised commitment

A release target expresses an intention. A forecast estimates what the current evidence supports. An authorised commitment establishes the date and conditions that the organisation has approved. These can coincide, but the scheduler should not assume that they do. If a team forecasts a release after a contractual milestone, changing the roadmap label does not resolve the conflict. The response is to analyse feasible options, assess the consequences and obtain the necessary decision. Likewise, a distant target should not be reported as a fully substantiated promise when the work, capacity or acceptance arrangements remain uncertain.

Consider an independent example in which a public service intends to introduce online applications in September. The near-term wave includes a prototype, accessibility testing and a working integration with an identity service. A later wave contains migration and operational readiness at a higher level. As the prototype exposes a new user need, the detailed backlog changes. The scheduler assesses whether the change remains within the agreed release outcome or alters scope, resources, interfaces or dates requiring approval. The distinction is between authorised adaptation within an established boundary and a change to that boundary. A useful governance arrangement makes this distinction explicit before pressure arises.

GAO's Agile Assessment Guide connects roadmaps and programme schedules to features, dependencies, people and traceability between planning levels (GAO, 2023, Table 13). Traceability need not involve duplicating every story in a second scheduling application. It requires a dependable relationship between the work that teams manage and the commitments that management must understand. Stable identifiers, release mappings and defined interface milestones can provide that connection, provided their completeness and currency are checked. A tool label does not establish whether the programme is integrated.

Documented cases: a roadmap and a defined end-state

In its February 2025 audit of the US Department of Veterans Affairs' Financial Management Business Transformation programme, GAO found that backlog refinement and other agile practices coexisted with weaknesses in requirements traceability. The implementation timeline showed deployment waves without the features and epics needed for a suitable roadmap. Backlog ranking and completion-related criteria were also inconsistent in the records examined. These are findings from the audit period, not a claim about the programme's current condition. The scheduling lesson is that local planning routines still need an explicit connection to programme outcomes (GAO, 2025, pp. 14-17, 45-46).

Australia's agricultural export digital reform offers a related lesson. ANAO recorded two-week sprints and quarterly plans containing objectives, features and dependencies, with initiative identifiers helping connect planning documents. Nevertheless, its June 2024 audit found that the first tranche's end-state had not been established before its original or amended completion dates, and recommended defining tranche end-states before implementation. This does not show that sprints caused the difficulty. It shows why a schedule needs a clear completion condition as well as a recurring planning cycle (ANAO, 2024, paragraphs 3.3-3.21).

Together, the cases support a practical test: can the team explain what a named release will enable, what evidence will establish its readiness and which activities or backlog items contribute to that result? If the answer is only a calendar of meetings or an unqualified percentage complete, the planning connection remains weak. At Level 6, the professional should be able to identify the missing relationship and propose a proportionate correction, rather than simply request more detail everywhere. Detail is useful when it resolves a decision or interface; volume alone does not improve control.

Choose what governs the release

PMI identifies feature-driven, time-driven and cost-driven release planning (2019, p. 43). These orientations distinguish the condition around which a release is organised; they do not make the other dimensions irrelevant. A feature-led release asks when a sufficiently defined package of capability can be ready. A date-led release asks which useful capability can credibly be completed by the required boundary. A budget-led release asks what outcome remains achievable within an authorised spending envelope. In each case, the planner should expose the decision variable, test dependencies and capacity, and identify who may change the governing condition. Acceptance and quality requirements remain part of the work to be delivered.

Table 9.3 | Comparing release-planning orientations

Release orientation	Governing planning condition	What the forecast must help decide
Feature-driven	An agreed capability or minimum feature set	Forecast the date and resources needed; escalate infeasibility instead of silently omitting required capability.
Time-driven	A required release date or market window	Select and sequence a useful feasible scope; keep deferred work visible and retain required acceptance work.
Cost-driven	An authorised budget or funding envelope	Compare prioritised outcomes with forecast expenditure, capacity and time; identify the decision needed before funds become insufficient.

These are planning orientations, not permission to alter contractual or authorised scope without agreement. For example, a team preparing for a fixed demonstration date may defer a lower-priority reporting feature while retaining the integration and testing needed for the demonstrated capability. A release requiring that same feature for an essential operating obligation would need a different decision. Where feature, date and funding conditions are all inflexible, labelling the approach cannot resolve an infeasible combination: the team must expose the conflict and seek an authorised response.

9.3 Planning iterations and managing adaptive dependencies

Product Backlog. 'An ordered list of user-centric requirements that a team maintains for a product.' (PMI, 2019, p. 184)

Iteration. 'A timeboxed cycle of development on a product or deliverable in which all of the work that is needed to deliver value is performed.' (PMI, 2019, p. 182)

PMI's adaptive scheduling discussion connects product vision, release planning, iteration planning and frequent inspection of work (PMI, 2019, pp. 31-37, 43-44). The backlog supports choices about what to develop next, but an ordered list is not automatically an executable schedule. An item may require specialist knowledge, an available test environment or an external decision. The team therefore considers priority alongside feasibility. A high-value item that is not ready may require enabling work before it can be completed, while a low-value item should not be started merely because it is easy to finish.

The 2020 Scrum Guide identifies Product Owner, Scrum Master and Developers as accountabilities. The Product Owner orders the backlog; Developers size and plan work. Sprints last one month or less. Scope can be renegotiated while protecting the Sprint Goal, and the Sprint Backlog adapts to learning. Usable Increments meet the Definition of Done (Schwaber and Sutherland, 2020). Figure 9.3 illustrates the cycle.

Iteration planning, inspection and feedback

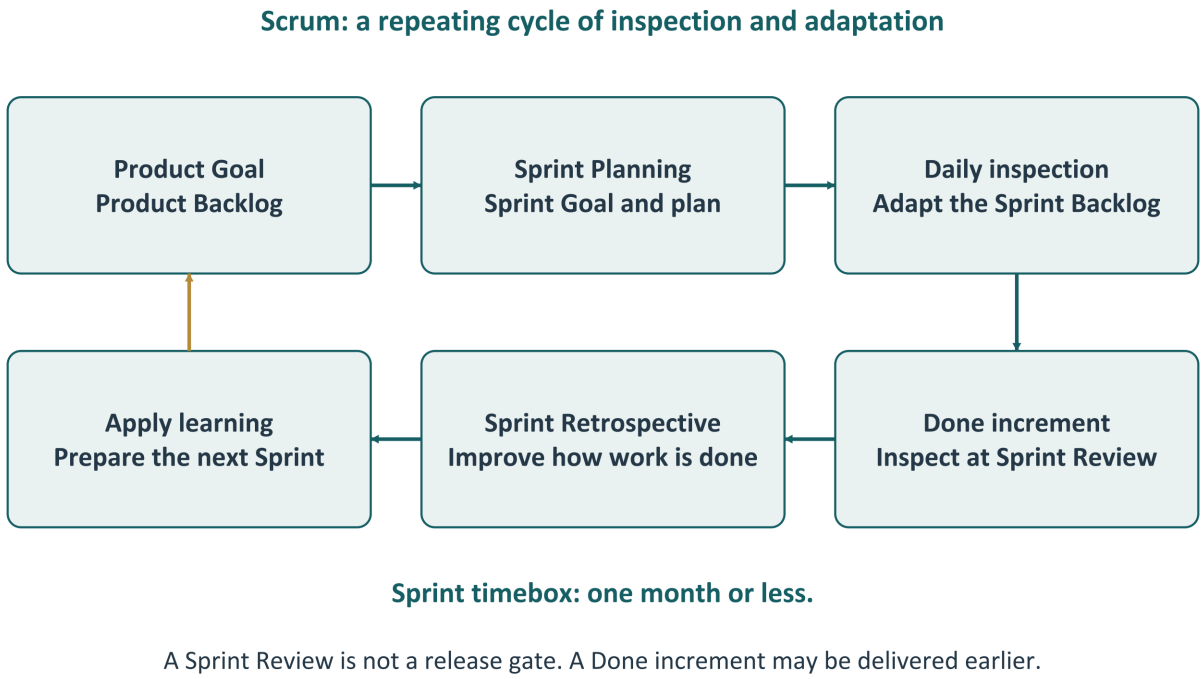


Figure 9.3. An original illustration of Scrum's inspection cycle and its connection to release governance.

Read the source standard with attention to its examples

PMI's 2019 iteration illustration discusses backlog estimates, selected work and clearing the board (PMI, 2019, pp. 33-35). Its examples should not become universal prohibitions on duration estimates or immutable item commitments. Current Scrum does not mandate story points, velocity or board resets (Schwaber and Sutherland, 2020). Distinguish scheduling principles from illustrative practices.

This distinction matters when a team discovers unexpected work. Suppose an interface defect threatens the purpose of an iteration. Simply insisting that every original card must finish can encourage hidden defects or superficial completion. Equally, allowing every new request to enter without considering the goal can destroy focus. The planning conversation should establish what has changed, what remains necessary to achieve the agreed purpose and what can reasonably be adapted. The scheduler supports that conversation by making capacity and dependencies visible and by identifying any effect on releases or external milestones.

Estimate for a decision, then learn from completed work

Relative sizing can help a team compare the effort or complexity of work it understands. Time estimates can help examine a particular task, resource requirement or interface. Neither becomes trustworthy merely because the team has adopted a named technique. Estimates need a defined purpose, a common interpretation and evidence from completed work. If stories are too large or materially different, apparent changes in velocity may reflect changes in decomposition rather than changes in delivery capability. A count of completed small items should not be compared uncritically with a count of completed large items.

PMI explains that completed story-point totals are specific to the team and can inform subsequent planning (PMI, 2019, pp. 42-43). They do not provide a universal conversion into hours, money or customer value. GAO similarly cautions that velocity is team-specific and that optimising it at the expense of quality is inappropriate (GAO, 2023, p. 192). For a professional scheduler, the important question is whether the measure improves a forecast or a decision. Increasing the numerical size assigned to work can increase reported velocity without delivering any additional capability.

Make dependencies visible before they become blocked work

Adaptive teams still encounter dependencies on domain knowledge, decomposition choices and technology or platform arrangements (PMI, 2019, pp. 36-37). A customer-facing feature may depend on an identity service, which in turn depends on an approved data arrangement. These relationships should be visible at the level where coordination is required. Within a team, the detail may sit on a board; across organisations, an interface milestone with an owner and acceptance criteria may be more useful. The aim is to expose the condition that enables work, not to create the maximum possible number of links.

An original example concerns two teams developing a booking service and a payment service. The booking team can use a mock payment response to test its own interaction design, allowing some work to proceed earlier. However, the mock does not prove that real payments reconcile correctly or that security acceptance has been achieved. The integrated test remains necessary. A sound plan separates the temporary test arrangement from the final acceptance dependency and states the assumptions about the real interface. Otherwise, a useful learning technique can accidentally conceal a release risk.

France's Mon Suivi Social illustrates progressive public-service development. Its official record describes investigation of staff needs, prototype testing and beta development with roughly ten organisations, followed by additional features informed by recurring interviews and user groups. The record dates acceleration to September 2024, while DINUM's April 2026 review lists the service among those recognised for national impact in 2025. These official accounts support a lesson about learning and

release detail; they do not establish a particular sprint length, velocity measure or independently demonstrated schedule saving (beta.gouv.fr, n.d.; DINUM, 2026).

Distinguish the three inspection decisions

The Daily Scrum is a 15-minute working-day event for Developers to inspect progress towards the Sprint Goal and adapt their plan. The Sprint Review brings the team and stakeholders together to inspect outcomes and adapt future work; the Retrospective examines ways to improve quality and effectiveness. Work failing the Definition of Done returns to the Product Backlog for future consideration; it is not an Increment or completed review output. Reassess priority and remaining effort rather than automatically committing it to the next Sprint (Schwaber and Sutherland, 2020).

9.4 Managing flow with Kanban and work-in-progress controls

> **Kanban Board.** 'A visualization tool that enables improvements to the flow of work by making bottlenecks and work quantities visible.' (PMI, 2019, p. 182)

A board makes states visible, but flow depends on the rules and behaviour around it. The team needs a shared understanding of when work enters the system, what each state means and what counts as finished. A card waiting for approval is still unfinished even if the person who prepared it has moved to another task. If that waiting is concealed, the board may suggest good performance while the actual queue grows. A useful flow view includes waiting, blocked work and the handovers that determine whether an item can progress.

The May 2025 Kanban Guide connects visualised workflow with explicit work-in-progress control, active management of items and improvement of the workflow. Its core flow measures include work in progress, throughput, work-item age and cycle time. It also uses a service level expectation to describe a probabilistic expectation of elapsed time through the workflow (Kanban Guides, 2025). These concepts help the scheduler ask where time is being spent and whether the system is becoming more predictable. They do not establish a contractual finish date for each item without further evidence.

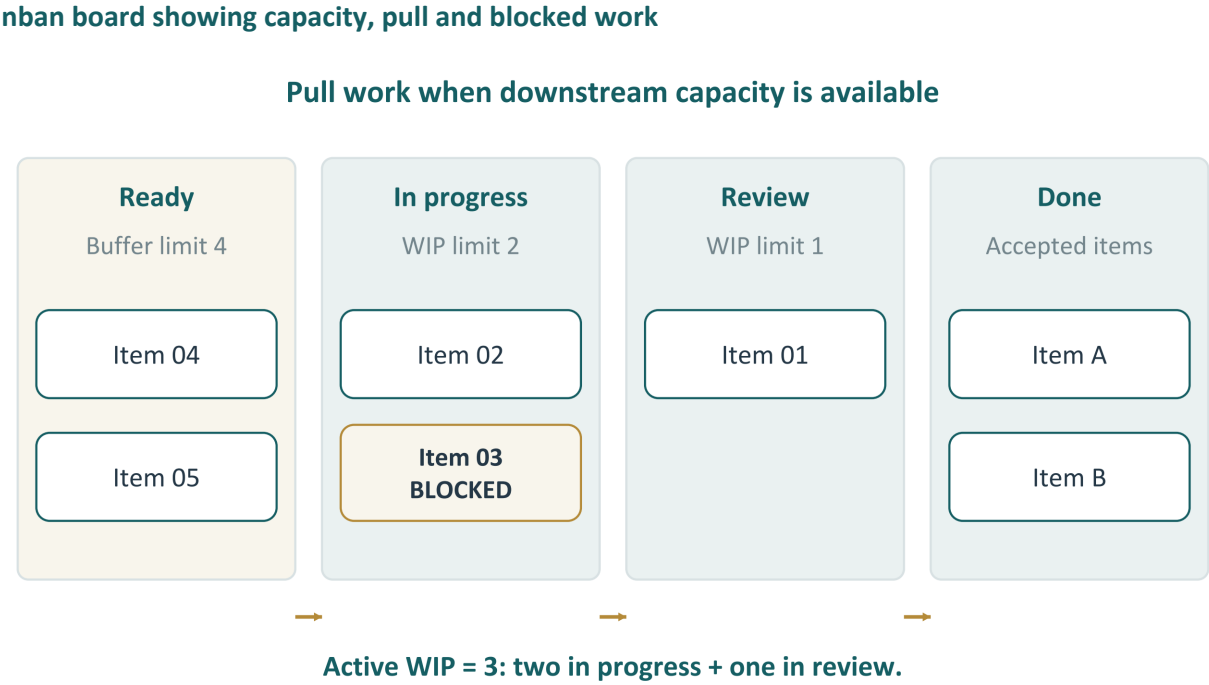


Figure 9.4. An original illustrative board. Work is pulled when capacity and readiness permit. A blocked item remains within work in progress if it has crossed the defined start boundary and has not crossed the finish boundary.

Control the queue rather than reward starting

Suppose an engineering review service has six items in preparation and three in review, with review limited to three. Starting a seventh preparation item may keep an individual busy, but it does not necessarily increase completed reviews. The immediate constraint may be the availability of a qualified reviewer or missing information on an existing item. The team can examine how to help finish current work, resolve the blockage or improve the handover. This is a system decision: local utilisation and overall delivery are not the same measure.

A WIP limit should be an explicit operating policy, supported by rules for exceptions and an understanding of the work. It is not a reason to hide blocked items in a separate uncounted column. Equally, the limit is not a universal constant that can be copied from another team. Different work sizes, review arrangements and service obligations may require different policies. An urgent item may justify a controlled exception, but repeated exceptions suggest that the ordinary policy or demand assumptions need review. The record should preserve the effect on other work rather than make urgency appear costless.

The boundary matters for every flow measure. If cycle time starts when preparation begins and finishes when an output is accepted, review waiting belongs inside it. A second team that measures only active preparation time is reporting a different quantity. Comparing the two numbers without understanding their boundaries is misleading. Similar care is needed with calendars: elapsed days and working days answer different questions, especially when handovers involve organisations with different operating patterns. Clear labels make a simple measure more useful than an elaborate dashboard whose units are uncertain.

Use Little's Law with its assumptions visible

For a separate, stable-flow illustration, consider a service whose long-run average WIP is ten comparable items and whose average throughput is five items per week. Little's Law relates average items in the system to average throughput and average time in that same system. The mean cycle time is therefore ten divided by five, or two weeks. The relationship is foundational queueing theory, not a newly invented agile rule (Little, 1961). It requires consistent system boundaries and suitably stable long-run averages; a short period with a rapidly growing queue should not be interpreted as though those conditions have already been established.

The result is a mean, not a promise that every item finishes within two weeks. A complicated item can take longer and a simple item less. It also does not prove that halving WIP will halve time while every other condition remains unchanged. Changing WIP can alter throughput if, for example, necessary work becomes unavailable to a specialist. The practical use is diagnostic: investigate why items accumulate, whether arrivals exceed completions and what prevents work from moving. A reduction in waiting should be evidenced through observations of the system, not assumed from a formula alone.

Scrum and Kanban therefore answer overlapping but different planning needs. A team may use a regular iteration goal while also improving flow within its workflow. The professional task is to ensure that the combined policies make sense. An iteration boundary should not conceal the age of unfinished work, and a continuous-flow view should not obscure a release objective or an external commitment. Both arrangements require honest evidence about what has actually been completed.

9.5 Interpreting burn charts and making conditional forecasts

> **Burndown Chart.** 'A graphical representation of the work remaining versus the time left in a timebox.' (PMI, 2019, p. 177)

PMI illustrates burndown and burnup charts as ways of discussing remaining work and completed output (PMI, 2019, pp. 38-43). A burndown highlights the work still to be done; a burnup can show cumulative completion alongside the total scope. The choice affects interpretation when scope changes. A flat remaining-work line may mean that nothing was completed, but it may also mean that newly added work offset completed work. The chart needs its underlying data and scope history if it is to support a defensible conclusion.

Worked example: six completed items and no visible burndown

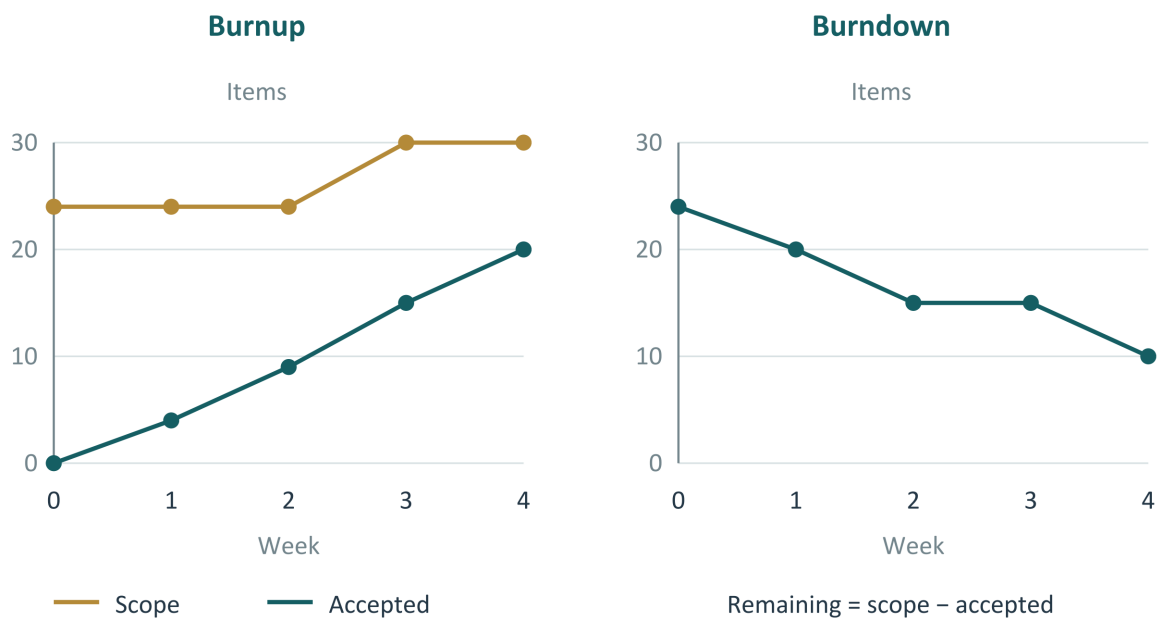
The following original example follows a team over four weeks. Its items are sufficiently comparable for a simple count to be useful, and an item counts as completed only when it meets the agreed acceptance conditions. The values are measured at weekly boundaries. The initial scope is 24 items; six more are added during Week 3. There are no removals or reopened items in this simplified example. These assumptions deliberately keep the arithmetic visible; a real dataset would need to record such changes if they occurred.

Table 9.4 | Why accepted work can coexist with a flat burndown

Week boundary	Total scope: items	Cumulative accepted: items	Remaining: items
0	24	0	24
1	24	4	20
2	24	9	15
3	30	15	15
4	30	20	10

During Week 3, the accepted total rises from nine to fifteen, so the team completes six items. At the same time, total scope rises from 24 to 30. Remaining work stays at fifteen because 30 minus 15 equals 15. It would be wrong to describe that week as having produced no progress. Equally, it would be wrong to ignore the additional scope and forecast against the original total. The burnup makes both movements visible, while the burndown shows the unchanged remaining quantity. The two charts describe the same dataset from different perspectives.

Burnup and burndown of the same four-week dataset



Week 3: scope +6 and accepted +6; remaining work stays at 15 items.

Figure 9.5. Original burn charts using accepted items throughout. In Week 3, six added items offset six completed items, leaving remaining work unchanged. The charts do not measure money, hours or percentage of customer value.

Weekly completions are four, five, six and five items, giving a mean throughput of five items per week. At the Week 4 boundary, ten items remain. Dividing ten by five suggests two further weeks if scope, item mix, capacity, acceptance conditions and dependencies remain sufficiently similar. This is a conditional rate-based forecast. Four observations do not establish a confidence level, and the calculation does not

prove that every remaining item can proceed independently. A single unresolved external approval could dominate the release even when the average throughput remains healthy.

The scheduler should therefore test the forecast against the composition of the remaining work. If the completed items were mainly straightforward configuration and the remainder involves integration testing, the past average may provide a poor guide. If the team loses a specialist or receives a new mandatory feature, the forecast must be revisited. A forecast can still be useful when it is approximate, provided it states its basis and the conditions that would change it. False precision is created when a simple ratio is presented as an assured delivery date without those qualifications.

Diagnose the pattern before acting on it

A late drop in a burndown can reflect batched acceptance, delayed updating, genuinely late completion or a mixture of these. The line alone cannot establish the cause. PMI's examples include smooth progress, unmet iteration expectations and late completion patterns (PMI, 2019, pp. 39-42). The useful response is to compare the chart with actual work records and acceptance evidence. If testing is left until the end, the improvement may concern work decomposition and earlier integration. If records are late, the improvement may concern the reporting process. The same visual symptom can require different action.

Table 9.5 | Interpreting flow and progress measures

Measure or view	What it can help explain	Interpretation to avoid
Burndown	Remaining work over time	A flat line always means nothing was completed
Burnup with scope line	Completion and changes to total scope	A rising completion line proves the release is ready
Throughput	Accepted items per defined period	Different item mixes are automatically comparable
Cycle time and work-item age	Time through the workflow and age of unfinished work	An average is a deadline for every item
Team velocity	Completed relative size within a team's convention	Story points convert universally to hours or compare teams

The comparison reinforces a central control principle: select the measure to answer a defined question. If management needs to know whether a release can be accepted, a throughput trend should be accompanied by the remaining acceptance conditions. If the team needs to understand congestion, a milestone chart alone may be insufficient. A balanced account combines flow evidence with scope, quality, dependencies and the specific decision being made. Chapter 10 develops the wider discipline of updating and forecasting; this chapter establishes why the units and completion rules must first be clear.

9.6 Lean pull planning and making work ready

Lean scheduling focuses attention on value, waste, coordination and dependable flow. PMI describes master scheduling, collaborative phase scheduling and look-ahead planning as connected activities, with downstream work pulling from upstream when capacity permits (PMI, 2019, p. 26). Pull does not mean that the project avoids advance planning. It means that the plan and the release of work are informed by what is needed next and by the conditions under which that work can be completed. A team that begins everything early can create congestion, handling, rework and unfinished inventory without improving the final milestone.

Phase pull planning works backwards from an agreed outcome to establish the handovers that make it possible. Participants identify what each party needs from others, how long the work requires and which constraints must be removed. This is a collaborative planning process, distinct from the mathematical backward pass used to calculate late dates in a critical-path network. The two can support one another: the collaborative discussion develops a credible production sequence, while network analysis tests its consequences for interfaces, float and completion. Agreement in a workshop is valuable, but the resulting plan still needs feasibility checks.

Lean planning from milestones to ready work and learning



Figure 9.6. An original workflow linking master milestones, phase pull planning, look-ahead readiness, weekly commitments, daily coordination and learning. Constraint removal requires action and evidence, not merely a meeting.

From a look-ahead plan to executable work

Look-ahead planning examines approaching work early enough to resolve prerequisites. The appropriate horizon depends on the time needed to obtain information, materials, access, resources and approvals. A requirement with an eight-week lead time cannot be controlled effectively by discovering it in a one-week plan. Conversely, excessive detail about distant work can create maintenance effort without improving the next decision. The scheduler should identify which constraints need early action and arrange the level of detail around those needs.

A ready-work check asks whether the planned operation can proceed under its stated conditions. In an independent installation example, the design must be suitable for the work, materials available, access released, predecessors accepted and the necessary people and equipment confirmed. If a condition is missing, the plan should identify its owner, required date and effect on successors. Marking a card red is a communication step; it is not evidence that the constraint has been resolved. A pool of ready work can support sensible flexibility, but substituting another task should still be tested against priorities, interfaces and the integrated schedule.

Definition of Done (DoD). 'A team's checklist of all the criteria required to be met so that a deliverable can be considered ready for customer use.' (PMI, 2019, p. 179)

Readiness and completion answer different questions. Readiness concerns the conditions for beginning the intended work; completion concerns the criteria for accepting its result. A task may be ready to start and still require inspection, records or testing before it is finished. Conversely, an exploratory task can be legitimately ready even though its purpose is to resolve an unknown. The readiness test should match that purpose, rather than demand that the answer to the investigation is already known. Clear boundaries prevent both premature release and excessive preparation requirements that stop useful learning.

England: a connected production-planning standard

National Highways' April 2023 minimum standards connect collaborative mapping, look-ahead planning, make-ready and production review. They call for attention to locations, crews, interfaces and owned constraint removal while maintaining links to the contractual programme. Their planned-work completion measure prompts investigation of missed commitments. This provides an official English infrastructure example of connected production control. Its particular planning horizons and conventions belong to that standard; they should not be presented as universal rules for every project or used to justify deleting legitimate float and risk allowances from an integrated schedule (National Highways, 2023, pp. 14-22, 34).

Worked example: reliability of weekly commitments

An independent team agrees eight eligible commitments for a working week, each with a clear completion criterion. Six meet those criteria by the cut-off; one is prevented by late information and one requires rework after a failed acceptance check. Percentage Plan Complete, or PPC, is six divided by eight, multiplied by 100, giving 75%. For this example, the denominator is the original agreed set. The team does not retrospectively remove the two misses to produce a perfect score. Any policy for genuinely cancelled or changed scope should be explicit and consistently applied.

PPC in this example measures the reliability of the commitments, not the percentage of the project physically complete. The eight tasks may differ substantially in size and importance. Completing six small tasks while missing a critical handover can produce the same PPC as completing six major tasks while missing two minor ones. The measure therefore needs reasons, consequences and trend information. It is also not a direct measure of labour productivity: additional effort could improve commitment completion while consuming more resources. The scheduler should resist using one percentage to answer several different management questions.

The next action follows from the causes. Late information may require an earlier design-release check or stronger ownership of an interface. Failed acceptance may require clearer quality criteria or a change to the execution method. Labelling both as poor performance without examining the mechanism is unlikely to improve the next plan. Equally, repeatedly accepting commitments that the team knows cannot be met undermines the planning process. The aim is to make realistic promises, investigate variation and improve the conditions for delivery while keeping the consequences for programme milestones visible.

9.7 Location-based scheduling, line of balance and takt

Location-based planning represents how work moves through physical areas or repeated units. PMI discusses its usefulness for railways, roads, pipelines and repeated building work, and describes line of balance as emphasising production rates over time (PMI, 2019, pp. 25-27). Related methods include linear schedules, flowlines and location-based management systems. Their terminology and calculations vary, so they should be treated as a family of approaches rather than as identical algorithms. Their common value is to make the relationship between time, place and production more visible.

A location chart requires meaningful location boundaries. Four identical rooms may support a simple repeated sequence; four floors with different quantities and access conditions may not. The scheduler should establish whether the work content, crew capability and handover rules are comparable. If one area contains twice the quantity, assigning it the same duration without a resource or method explanation hides the difference. Linear infrastructure may use chainage rather than discrete areas, but the same principle applies: the graphical units must correspond to the actual work and its constraints.

Worked example: earliest handover or uninterrupted crews?

Consider four equal areas, L1 to L4, with three operations in each. Preparation A takes two working days per area, installation B takes one, and checking C takes one. Each operation has its own single dedicated crew; a crew completes one area before moving to the next. Within each area, B starts only after A finishes and C starts only after B finishes. There are no additional access, resource or calendar restrictions. Times below are working-day boundaries measured from zero, so an interval of 0-2 contains two working days. The example is illustrative and does not describe a real project.

The preparation crew works continuously, finishing the four areas at days 2, 4, 6 and 8. If each following operation starts as early as its local predecessor and its crew permit, installation occurs at 2-3, 4-5, 6-7 and 8-9. Checking follows at 3-4, 5-6, 7-8 and 9-10. The first area is technically ready at day 4 and all four at day 10. However, the installation and checking crews each experience three internal idle days between their four productive days of work.

Table 9.6 | Comparing earliest handovers and continuous crews

Area	Preparation A	Earliest handovers: B then C	Continuous crews: B then C
L1	0-2	B: 2-3; C: 3-4	B: 5-6; C: 6-7
L2	2-4	B: 4-5; C: 5-6	B: 6-7; C: 7-8
L3	4-6	B: 6-7; C: 7-8	B: 7-8; C: 8-9
L4	6-8	B: 8-9; C: 9-10	B: 8-9; C: 9-10

To keep the installation crew uninterrupted across all four areas, its start must be delayed until day 5. It then works at 5-6, 6-7, 7-8 and 8-9. The checking crew starts at day 6 and works continuously to day 10. The final finish remains day 10, but the first area is technically ready at day 7. The change exchanges earlier local handovers for uninterrupted work by the following crews. It does not reduce the productive effort: A still requires eight crew-days, while B and C each require four. These are distinct trade crews, not interchangeable units of labour.

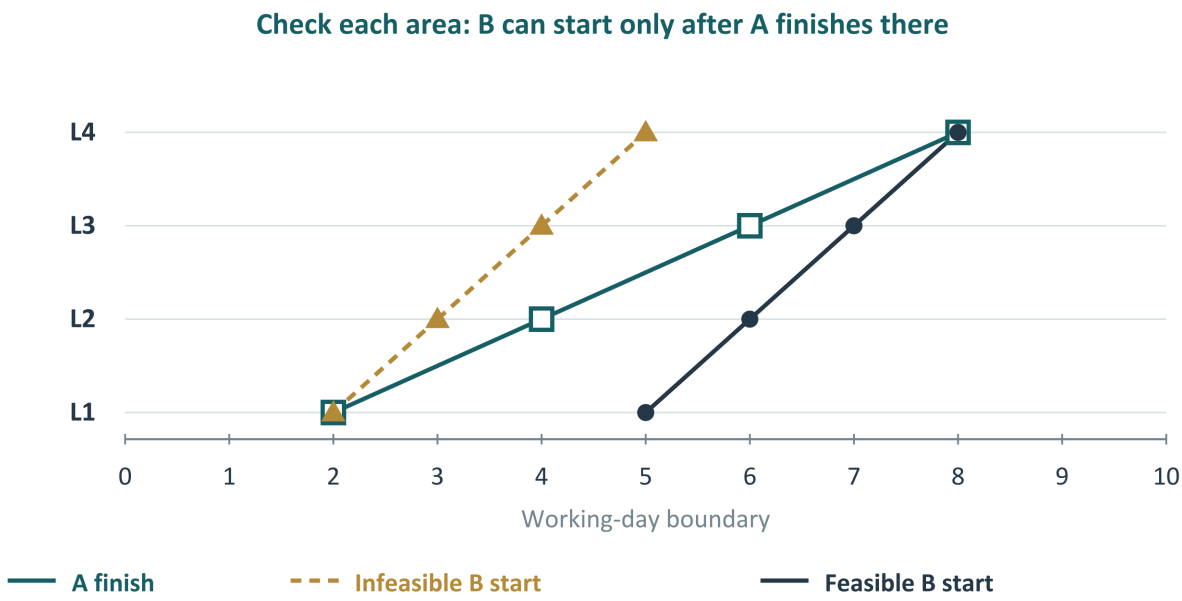


Figure 9.7. An original location-time illustration using the worked example. Preparation finish times are compared with installation start times. An uninterrupted installation sequence starting at day 2 would enter later areas before preparation is complete; a day 5 start satisfies all four local handovers.

Check the line mathematically and operationally

For area k, where k runs from one to four, preparation finishes at day 2k. If installation starts at day s and proceeds continuously at one area per day, its start in area k is s + k - 1. Feasibility requires s + k - 1 to be at least 2k, or s to be at least k + 1. The strongest requirement occurs at the fourth area, giving s of at least five. This small calculation shows why simply drawing a faster following line from day 2 is not feasible. The line must respect the actual predecessor conditions at every area.

The final area cannot finish before day 10 under the stated assumptions: its preparation ends at day 8, followed by one day of installation and one day of checking. Both alternatives achieve that lower bound. Nevertheless, they support different management objectives. If the first area is needed urgently, the earlier handover may be valuable. If crew attendance and remobilisation are costly, continuity may be attractive. Neither alternative automatically has the lowest cost, because standby, redeployment and mobilisation arrangements have not been priced. Technical readiness also does not automatically mean public opening or operational use; additional acceptance work may be required outside this deliberately small model.

With location on the vertical axis and time on the horizontal axis, slope expresses locations per unit of time. Preparation progresses at half an area per day, whereas installation and checking can each perform an area per day. A faster following crew will eventually catch a slower predecessor unless starts, rates or work fronts are arranged accordingly. Crossings or convergence deserve investigation, but feasibility depends on the meaning of the plotted lines and the handover rules. Comparing a finish line with a start line is different from comparing two completion lines. Labels are part of the technical model, not merely graphic decoration.

Takt establishes a rhythm; capacity makes it feasible

Takt planning arranges repeated work around a common rhythm through defined zones. In the example, a two-day rhythm reflects the preparation crew's capacity. Installation and checking each require one productive day per area, so a two-day slot for each would contain spare time unless the work is rebalanced or another justified arrangement is made. A planner might investigate a coordinated package in which the separate installation and checking crews work sequentially within a two-day window. That would still require distinct skills, valid handovers and suitable availability. The diagram alone does not allow one crew to perform both trades.

The rhythm must be checked against quantities, access, curing, inspections, shared plant and the ability to sustain output. A time buffer allows time for variation; capacity reserve provides additional capability; an inventory of unfinished areas provides something different again. They should not be treated as interchangeable simply because each can affect continuity. Overly tight production assumptions can move variation downstream and leave following crews waiting. Overly generous zones or buffers can delay useful handovers. The appropriate balance depends on the delivery objective and the evidence about variation.

Recent research helps explain this judgement. Seppänen's 2025 study extends location-based forecasting to takt by incorporating capacity buffers, using calculation examples, a practical case and practitioner feedback. It highlights the need for accurate progress and resource data and calls for further empirical evaluation. The teaching implication is to preserve a clear planned rhythm while showing an evidence-based forecast and investigating the cause of deviation. More labour cannot resolve every problem, particularly where design information or logistics is the actual constraint (Seppänen, 2025).

9.8 Linking schedules to BIM, cost information and intelligent systems

PMI describes the integration of a three-dimensional design model with time information as a basis for 4D scheduling visualisation, with cost information providing a further dimension (PMI, 2019, p. 27). The practical value is the opportunity to examine proposed execution in both time and space. The team can explore whether temporary access survives the planned sequence, whether work fronts are available and whether one operation obstructs another. These questions are particularly valuable when a conventional activity list makes the physical consequence difficult to imagine.

The integration requires deliberate information management. Model objects and schedule activities need stable identifiers, suitable granularity and documented relationships. One activity may relate to many objects, while one object may require several activities such as fabrication, delivery, installation and testing. A one-to-one mapping should not be assumed. If a large object represents work executed in several phases, the object may need subdivision or another suitable representation. Conversely, excessive fragmentation can make the model difficult to maintain without improving the decisions it supports.

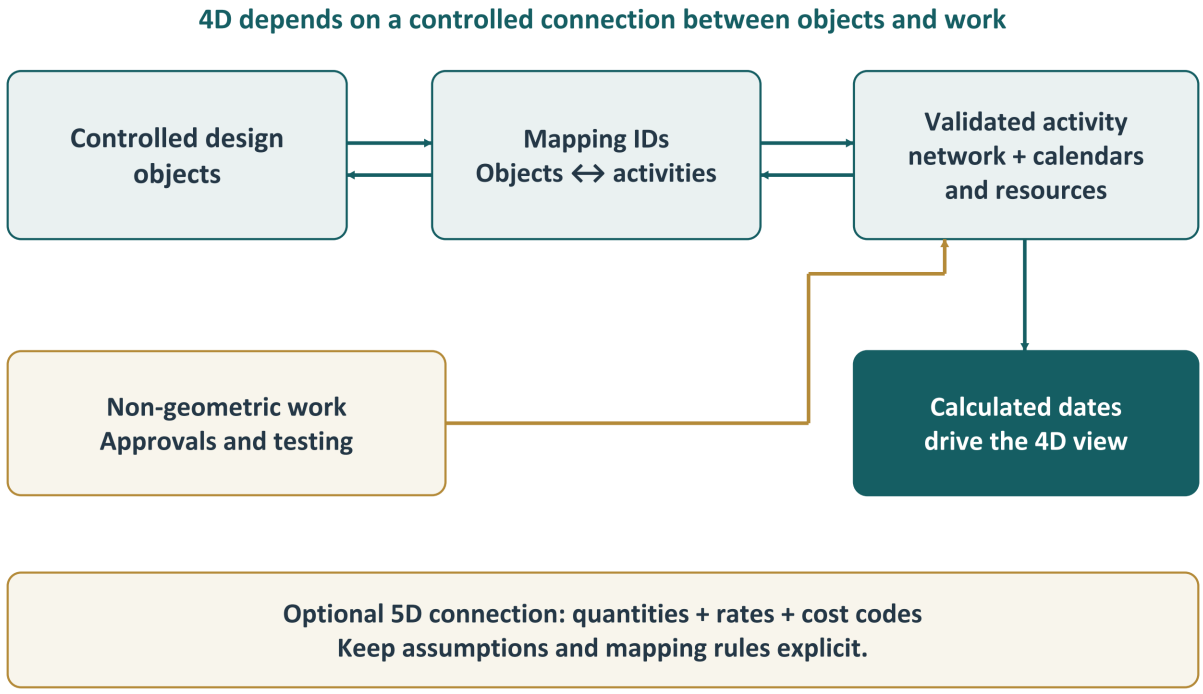


Figure 9.8. An original information model for 4D and optional cost integration. Geometry, activity logic, calendars, resources and non-geometric work must remain connected. A visual sequence inherits the strengths and weaknesses of the underlying data.

Preserve the work that has no visible object

A model can look complete while omitting important activities. Regulatory approval, procurement decisions, software commissioning, staff training and acceptance records may have no convenient geometric object, yet can determine whether an asset is usable. Their absence from an animation does not remove them from the schedule. The model should retain these activities and show their effect on relevant milestones and physical work. A visualisation that ends with the last object appearing may represent construction completion rather than operational readiness.

Cost integration needs equal care. Quantities, rates, cost codes, allocation rules and the timing of expenditure must relate to the same scope and version. Linking a monetary value to an object does not automatically establish an earned-value system or a valid cash-flow forecast. Materials may be purchased before installation, and one cost account may span several locations or activities. The scheduler should make the purpose of the cost view explicit and reconcile it with the authoritative cost records. The additional dimension is useful only when the relationship between the dimensions is understood.

Austroads' 2024 digital engineering guide describes using a federated model and programme to examine staging, alongside use cases involving temporary works and traffic arrangements. It also places digital adoption within governance, capability and evidence of outcomes. This supports using 4D to investigate interfaces while retaining responsibility for schedule validity (Austroads, 2024, Appendix B, p. 194). A historical English example appears in HS2's 2020 learning paper: trial models examined access and haul routes, platforms and staging, while later Greatworth modelling required division into 14 construction phases. The lesson concerns granularity and sequence, not a demonstrated saving in completion time (HS2 Learning Legacy, 2020).

Germany: distinguish an implemented capability from a future ambition

DEGES's July 2026 account of four A14 overbridges describes model attributes supporting preparation of a 4D construction-sequence representation, coordinated with traffic planning. It presents quantity, cost and tendering applications as trials with unresolved standardisation issues, and a digital twin as a future direction. These are different maturity states. The scheduling lesson is to establish which time information is actually linked and checked before relying on a visualisation. A 3D model, prepared 4D representation, 5D trial and operational digital twin should not be reported as interchangeable achievements (DEGES, 2026).

Intelligent systems: proposals need accountable validation

PMI discusses intelligent systems as an emerging scheduling approach capable of identifying patterns and proposing alternatives (PMI, 2019, pp. 26-27). Useful applications can include classifying activity descriptions, suggesting links between records or identifying unusual combinations of information. However, a plausible proposal can still be wrong. An algorithm trained on previous work may reproduce a historical omission, suggest a sequence unsuited to current access or confuse similar activity names. The scheduler needs to understand what the system was asked to do and which aspects of correctness it has actually tested.

Validation workflow for intelligent scheduling proposals

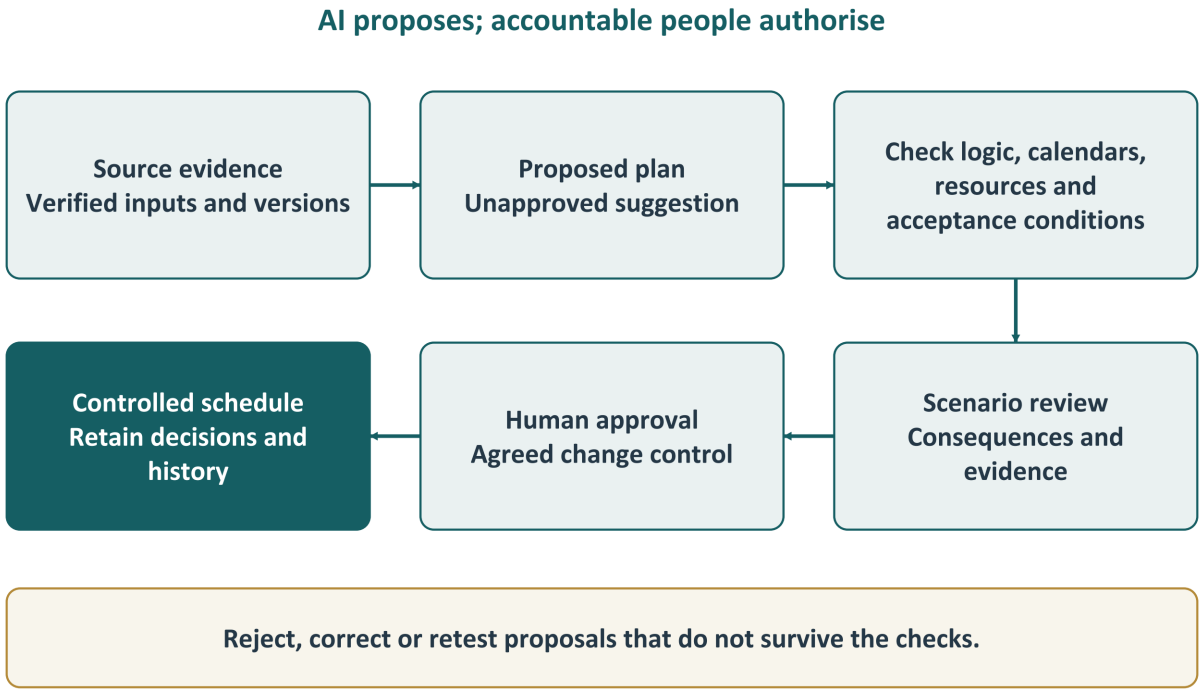


Figure 9.9. An original validation workflow. Automated suggestions pass through evidence, feasibility and governance checks before they become part of the controlled schedule. Classification or visual consistency is not proof of delivery feasibility.

An independent example concerns a proposed activity-to-model match for 'test installed pumps'. A language model may correctly identify the equipment family, but that does not establish that energisation, controls integration and witness availability are ready. The proposal should be checked against scope, identifiers, logical relationships, durations, calendars, resources and acceptance conditions. Any changed sequence should be evaluated as a scenario before approval. Preserve the source

data, model version, suggested change and review decision so that the resulting schedule remains explainable. Accountable people authorise the plan and remain responsible for its consequences.

DEGES's official BIM service catalogue provides a concrete parallel: its construction scheduling specification requires checking and manual reworking after automatic derivation of a schedule from model information (DEGES, n.d., application case 120, p. 8). Automatic derivation is not necessarily generative AI, but the control lesson applies. Separately, Abu Dhabi's June 2025 Binaa launch described phased introduction beginning with private villas and retained manual review of two-dimensional plans while AI was introduced gradually. That account establishes planned adoption and review responsibilities, not a proven 4D scheduling system or measured schedule saving (DMT, 2025).

Egypt's June 2026 review of the unified services card offers a complementary readiness example. The official account described an initial Port Said deployment and dependencies involving data, application development, payment activation, accounts and delivery. It also recorded a direction to address observations and complete studies before national expansion. The scheduling interpretation is that a geographic rollout requires evidence of operational readiness at each stage. The source does not identify Scrum, Kanban or lean as the delivery method, and a staged rollout should not be labelled with those methods without evidence (State Information Service, 2026).

9.9 Evaluating evidence and choosing a coherent combination

The strongest method is the one whose assumptions fit the decision and whose information can be trusted. A useful evaluation considers the work pattern, the feedback available, the resource constraints, the integration burden and the evidence needed for acceptance. It also considers the effort required to maintain the model. A highly detailed representation that cannot be kept current may be less useful than a simpler one with clear ownership and reliable updates. The decision should therefore include how the method will operate during delivery, not only how impressive its initial output appears.

Research should inform this judgement without becoming an automatic endorsement. Steegh and colleagues studied 319 respondents in 71 agile teams across seven Dutch organisations. They found a positive association between agile working and adaptive team performance, with goal specificity partly explaining the relationship. The cross-sectional design and absence of a non-agile control group limit causal claims. The chapter's inference is that adaptive planning still benefits from clear goals; the study does not prove that an adaptive approach will outperform predictive scheduling on every project (Steegh et al., 2025).

Power, Sinnott and Lynch examined a residential project combining the Last Planner System, takt and Scrum. Their mixed-method case reported improved and more consistent completion of planned work. This supports examining how collaborative commitments and location flow can complement one another, but a single case without a controlled comparison cannot establish general productivity gains or guaranteed time savings. The distinction between PPC and physical output remains essential when interpreting the result (Power, Sinnott and Lynch, 2024).

Jung, Hockenmaier and Golparvar-Fard's UniformatBridge research demonstrates a more specific digital capability. It used a transformer model to classify schedule activities into Uniformat categories, reporting F1 scores of 0.93 and 0.87 at two classification levels. These are measures of classification performance on the evaluated data, not probabilities that a whole schedule is correct. The implication is to use automation for a defined task while separately checking logic, durations, capacity and approvals (Jung, Hockenmaier and Golparvar-Fard, 2024). Narrow evidence can be valuable without being expanded into a claim it does not support.

Table 9.7 | Combining scheduling approaches coherently

Approach or representation	Principal contribution	Necessary connection to wider control
Rolling-wave planning	Introduces detail as knowledge becomes useful	Reconcile later detail with scope, interfaces and approved commitments
Scrum and iteration planning	Organises learning and delivery around short goals	Connect accepted increments to release and integration conditions
Kanban and pull	Makes workflow and capacity constraints visible	Retain priority, external dependencies and a defensible forecast
Lean collaborative planning	Develops dependable handovers and ready work	Preserve programme logic, milestone effects and cause-based learning
Location, line of balance and takt	Exposes production rates, zones and crew movement	Validate quantities, resources, access and local acceptance rules
4D and intelligent support	Makes interfaces visible and assists data analysis	Maintain checked mappings, complete scope and accountable approval

For PMI-SP preparation, concentrate on selecting an appropriate scheduling approach, integrating activities and dependencies, assessing resources, interpreting progress and communicating implications. These themes connect to the existing examination domains rather than forming a separately weighted agile or AI examination domain. PMI's current certification page continues to link its 2012 Examination Content Outline; learners should use that outline alongside the scheduling standard and current official guidance (PMI, 2012; PMI, n.d.). The chapter's original questions below practise the relevant judgement and are not official PMI examination questions.

The bridge to Chapter 10 is the reporting position. Once the team has chosen its methods and connected its plans, it must collect reliable actuals, preserve the approved baseline, assess remaining work and explain a current forecast. Adaptive delivery does not remove that responsibility; location planning does not remove it either. What changes is the form of evidence and the level at which it is collected. A credible control process brings that evidence together without confusing started work with completed output, a planning rhythm with a guarantee, or an attractive presentation with a feasible plan.

Knowledge check and examination practice

The eight original questions test the chapter's scheduling reasoning. Select the best answer under the stated conditions. Where a calculation is involved, retain the units and assumptions rather than relying on a familiar formula without checking its meaning.

Question 1: selecting an approach

A programme combines repetitive installation, evolving user-interface requirements and a fixed regulatory acceptance milestone. Which planning response is most appropriate?

A Use the same iteration calendar for every activity because this guarantees integration.
B Select suitable approaches for the work streams and connect their interfaces and acceptance conditions.
C Remove the regulatory milestone because adaptive work cannot be planned against dates.
D Build a location chart and use it as the complete programme schedule.

Question 2: elaborating a planning package

A future planning package is decomposed before execution. Its detailed work now forecasts an interface later than the authorised milestone. What should the scheduler do?

A Change the baseline date automatically because rolling-wave planning permits any change.
B Hide the detailed forecast until the work starts.
C Reconcile the detail, analyse feasible responses and obtain the required decision about the affected commitment.
D Delete the interface relationship so that the milestone appears unchanged.

Question 3: interpreting a flat burndown

At the end of Week 2, scope is 24 items and nine are accepted. At the end of Week 3, scope is 30 and fifteen are accepted. What is the correct interpretation?

A Six items were completed and six added, leaving fifteen remaining.
B Nothing was completed because remaining work stayed constant.
C The team completed fifteen items during Week 3.
D The project is guaranteed to finish within two more weeks.

Question 4: the meaning of a flow calculation

A stable service has average WIP of ten comparable items and average throughput of five items per week, measured across consistent boundaries. What follows from Little's Law?

A Every item will finish within two weeks.
B The next ten items are guaranteed to finish in two weeks.
C The team has completed 50% of the project.
D Mean time through the measured system is two weeks under the stated conditions.

Question 5: interpreting PPC

Six of eight agreed weekly commitments meet their completion criteria. One miss affects a major handover. Which statement is best?

A Physical project progress is 75%, so the major handover can be ignored.
B PPC is 75%; the missed handover still requires cause and milestone-impact analysis.
C Remove the two missed tasks from the denominator and report 100%.
D Labour productivity has increased by 75%.

Question 6: maintaining crew continuity

In the four-area example, preparation finishes at days 2, 4, 6 and 8. Installation requires one day per area with one crew, in area order, and must wait for preparation in each area. What is its earliest start if it must work continuously through all four areas?

A Day 2, because the first area is available then.
B Day 4, because half the areas have been prepared.
C Day 5, because this is the earliest start satisfying every local handover without interruption.
D Day 8, because all preparation must finish before any installation.

Question 7: assessing a 4D presentation

A 4D animation shows all permanent works appearing in a plausible sequence. Procurement approval, testing and shared-crane availability have not been checked. What should the scheduler conclude?

A The presentation supports discussion, but schedule completeness and feasibility still require validation.
B The animation proves the baseline is resource-feasible.
C Activities without geometry can be removed from the schedule.
D Linking the model to cost data will automatically resolve the omissions.

Question 8: interpreting an AI research result

A classification system reports an F1 score of 0.93 when mapping activities to a construction classification. A manager interprets this as a 93% probability that a proposed schedule will meet its finish date. What is the best response?

A Accept the claim because both figures are numerical measures of confidence.
B Increase every activity duration by 7% to compensate.
C Approve the schedule if the visual sequence looks reasonable.
D Explain that classification performance does not establish schedule feasibility or completion probability, and carry out the appropriate checks.

Answer explanations

1: B. The programme contains different work conditions, so method selection should respond to those conditions while preserving integration. Repetitive production, adaptive feature development and regulatory acceptance can coexist. Their plans need shared interface information and clear completion conditions. Neither a common calendar nor a single graphical representation guarantees this connection, and the external milestone remains a real obligation to be assessed.

2: C. Rolling-wave planning introduces detail before execution; it does not authorise an unexplained change to an approved commitment. The scheduler should establish why the detailed forecast differs, examine feasible responses and follow the applicable decision process. Hiding the forecast or removing a real dependency would undermine control. The response preserves the distinction between elaborating a plan and changing its authorised boundary.

3: A. Cumulative completion increases by six, from nine to fifteen. Scope also increases by six, from 24 to 30. Remaining work is fifteen at both boundaries. The flat burndown therefore conceals productive work when viewed without the scope history. Neither the chart nor these two observations establish a guaranteed completion date.

4: D. Ten items divided by five items per week gives a mean of two weeks through the defined system. The result concerns average flow under the stated assumptions. It is not an individual service guarantee, a project percentage or a commitment for a selected batch. An average can coexist with substantial variation between items.

5: B. Six divided by eight gives 75% completion of the agreed commitments. Task size and significance differ, so the ratio does not establish physical project progress or labour productivity. The missed major handover requires analysis of its cause and consequences. Retrospectively deleting misses would distort the evidence rather than improve performance.

6: C. A continuous crew starting at day s reaches area k at s + k - 1. That start must be at least 2k, so s must be at least k + 1. The fourth area produces the limiting requirement, s of at least five. Starting at day 2 is possible only if the crew accepts interruptions. Waiting until day 8 is unnecessary under the stated local handover rules.

7: A. The animation can help people inspect spatial and temporal interfaces, but it inherits the limitations of the underlying data. Missing non-geometric work and unchecked shared resources may determine the actual finish. Cost integration adds another information relationship; it does not repair those omissions automatically. The model needs a complete and validated schedule basis before it supports an authorised commitment.

8: D. F1 evaluates a classification task, combining aspects of classification precision and recall. It is not the probability of delivering a schedule by a target date. The proposal still needs checks of scope, dependencies, calendars, resources and acceptance, with appropriate uncertainty analysis where required. Neither a blanket duration uplift nor visual plausibility supplies that missing evidence.

References and further reading

PMI page citations refer to printed pages in the third edition. Cases retain their publication dates and describe the documented position, rather than implying that every historical finding remains current. The chapter's diagrams, numerical examples and six-stage framework are original teaching material.

Agile Business Consortium (2014). *The DSDM Agile Project Framework*. Sections 4.3, 10 and 13. Official handbook. The publisher identifies 2014 as the original publication year.

Ambler, S.W. (2005). *The Agile Unified Process (AUP)*. Author presentation, slides 7-9 and 12. Author-hosted copy.

Australian National Audit Office (ANAO) (2024). *Digital Reform of the Agricultural Export Systems*. Auditor-General Report No. 35 of 2023-24, 11 June. Especially paragraphs 3.3-3.21. Official audit.

Austroads (2024). *Guide to Digital Engineering*. AGDE-24, edition 1.0, 10 December. Especially Appendix B, p. 194. Official publication.

beta.gouv.fr (n.d.). *Mon Suivi Social*. Official French government service record, particularly 'Solution proposée', 'Stratégie' and 'En quelques dates'. Project record.

Cockburn, A. (2024). 'Crystal, the Un-Methodology'. October. Author's article.

De Luca, J. (2003). 'How to Reduce the Risk of Fixed-Price Estimates'. *De Luca on FDD Newsletter*, issue 2, 20 February. Original newsletter.

DEGES (2026). *Vom Bauwerksmodell zum Leistungsverzeichnis: Modellbasierte Planung an vier A-14-Überführungsbauwerken und Erprobung von BIM 5D*. 13 July. Official project account.

DEGES (n.d.). *BIM-Leistungskatalog, Anlage 1: Leistungsbeschreibungen*. Version 15.0, application case 120, p. 8. Official specification.

Department of Municipalities and Transport, Abu Dhabi (DMT) (2025). *Binaa Construction Permits Platform Launched as Department of Municipalities and Transport Signs Multilateral Cooperation Agreement*. 18 June. Official announcement.

Direction interministérielle du numérique (DINUM) (2026). *beta.gouv.fr: 10 ans d'impact et une ambition renouvelée*. 2 April. Official review.

Government Digital Service (2016, updated 2026). *Planning in agile*. Service Manual, updated 31 March 2026. Official guidance.

HS2 Learning Legacy (2020). *Infraworks models to assist with construction sequencing and planning*. 17 September. Official learning paper.

Jeffries, R. (2001). 'What is Extreme Programming?'. 8 November, pp. 1-2. Preserved primary article.

Jung, Y., Hockenmaier, J. and Golparvar-Fard, M. (2024). 'Transformer language model for mapping construction schedule activities to uniformat categories'. *Automation in Construction*, 157, 105183. https://doi.org/10.1016/j.autcon.2023.105183.

Kanban Guides (2025). *The Kanban Guide*. May 2025 version. Official guide.

Ladas, C. (2008). Extract from *Scrumban*, reproduced with the author's permission as 'What is Scrumban?' on Agile Alliance. Authorised primary extract.

Little, J.D.C. (1961). 'A proof for the queuing formula: L = λW'. *Operations Research*, 9(3), pp. 383-387. https://doi.org/10.1287/opre.9.3.383.

National Highways (2023). *Lean Collaborative Planning Minimum Standards*. Version 1.2, April, especially pp. 14-22 and 34. Official standard.

Power, W., Sinnott, D. and Lynch, P. (2024). 'Synthesizing Last Planner® System, Takt, and Scrum Theory and Practice to Enhance Construction Project Delivery'. *Lean Construction Journal*, 2024, pp. 16-28. https://doi.org/10.60164/3xymkr1ws.

Project Management Institute (PMI) (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Especially the Schedule Strategy, Schedule Planning and Development, Schedule Monitoring and Controlling, and Stakeholder Communications Management domains. Official outline.

Project Management Institute (PMI) (2019). *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: PMI. Core coverage: sections 2.2.3-2.2.5, pp. 21-27, and 2.6-2.6.1, pp. 31-44; glossary definitions cited individually by printed page.

Project Management Institute (PMI) (n.d.). *PMI Scheduling Professional (PMI-SP)*. Current certification page and linked examination resources. Official certification page.

Schwaber, K. and Sutherland, J. (2020). *The Scrum Guide*. November 2020. Official guide.

Seppänen, O. (2025). 'Integrated Forecasting Approach for Takt and Location-Based Scheduling'. *Journal of Construction Engineering and Management*, 151(12), 04025199. https://doi.org/10.1061/JCEMD4.COENG-16877.

State Information Service, Egypt (2026). *PM stresses state efforts to unify, digitize citizen support via unified card system*. 14 June. Official report.

Steegh, R., Van De Voorde, K., Paauwe, J. and Peeters, T. (2025). 'The agile way of working and team adaptive performance: A goal-setting perspective'. *Journal of Business Research*, 189, 115163. https://doi.org/10.1016/j.jbusres.2024.115163.

US Government Accountability Office (GAO) (2023). *GAO Agile Assessment Guide: Best Practices for Adoption and Implementation*. GAO-24-105506, published 28 November, reissued with revisions 15 December. Especially Table 13 and p. 192 in the revised official edition. Official guide.

US Government Accountability Office (GAO) (2025). *Financial Management Systems: VA Should Improve Its Requirements Development, Cost Estimate, and Schedule*. GAO-25-107256, 24 February, especially pp. 14-17 and 45-46. Official audit.

CHAPTER 10

Updating Schedules, Measuring Performance and Forecasting

Turning progress evidence into a credible forecast

A schedule update should change what the project knows about delivery. It establishes what has happened, what remains and what the current plan now predicts. Moving a reporting date, colouring completed bars or displaying a percentage is only useful when the underlying information supports those conclusions. A project can spend more than planned while completing less work, report substantial physical progress while a small unresolved interface controls the finish, or show improving indices without making the contractual milestone achievable. The scheduler must connect evidence, calculation and explanation before recommending action.

This chapter develops a complete update cycle, from the reporting cut-off to a decision-focused performance narrative. It distinguishes physical progress, elapsed duration, resource effort and earned value; examines out-of-sequence work; compares current, previous, target and baseline schedules; and calculates cost and time performance measures. A common worked dataset shows how earned value and earned schedule answer different questions. A remaining-work network then tests the forecast against actual dependencies, resource assumptions and acceptance work. Numerical examples are original teaching material and do not describe the performance of a named organisation.

The chapter supports PMI-SP preparation and Project Controls Professional Level 6 judgement. It develops sections 3.3.1-3.3.3, 3.4.6 and 3.4.12 of PMI's scheduling standard, relevant communication guidance in section 3.5, and the progress, earned-value and earned-schedule components in section 4. Learners should be able to challenge an unsupported progress claim, explain a variance without confusing its units and select a forecasting method whose assumptions fit the remaining work. The explanations do not assume prior formal study of risk, cost management or scheduling software.

The chapter framework: establish, validate, update, compare, forecast and decide

The original framework in Figure 10.1 links six responsibilities. Establish a common cut-off and the required evidence; validate progress and resource information; update the model without rewriting history; compare the resulting position with appropriate reference versions; forecast the remaining work using explicit assumptions; and communicate the decision while preserving the record. The sequence contains feedback. A surprising result can reveal an input error, a changed dependency or an unrealistic remaining-duration estimate. Investigating that result is part of control, whereas adjusting inputs merely to recover a preferred date undermines it.

An evidence-based schedule update and forecasting cycle

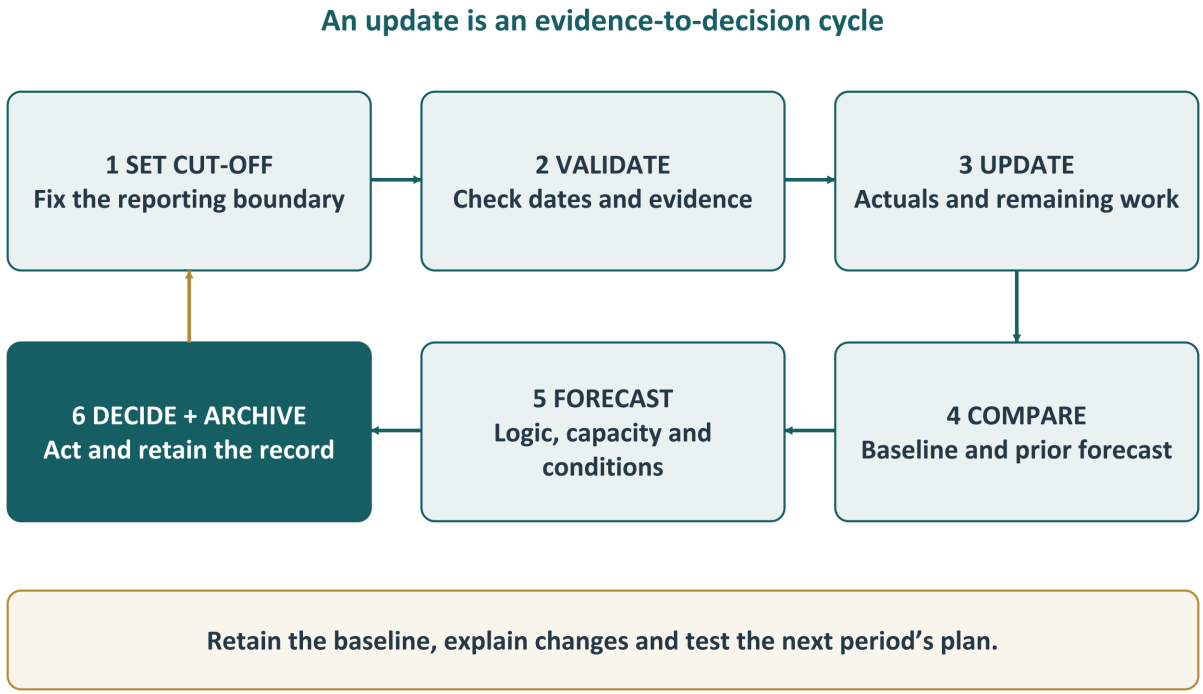


Figure 10.1. An original framework connecting the reporting cut-off, validated evidence, model calculation, comparison, forecasting and accountable decisions. Retain the inputs, assumptions and resulting schedule instance for later review.

10.1 Establishing the reporting position and validating actuals

The reporting cut-off creates a shared boundary between history and forecast. It needs a date, a time of day and an understood calendar convention. A Friday close-of-business cut-off differs from the beginning of Friday, particularly where overnight shifts or international teams are involved. Information collected on Monday may describe the previous Friday's position, but the collection date does not automatically become the data date. The report should identify both when necessary. Otherwise, one work package may include an extra weekend of progress while another reflects an earlier position.

Data Date (DD). 'A point in time when the status of the project is recorded.' (PMI, 2019, p. 179)

PMI's update process calls for actual starts and finishes, remaining work or duration, and progress information at a specific data date, followed by recalculation of incomplete work (PMI, 2019, pp. 67-68). Actual dates should represent events that occurred under the agreed start and finish criteria. They should not be inferred from an original plan or inserted because the software expects a value. An activity that has not started by the cut-off remains unstarted, even if its baseline start lies in the past. An activity forecast to finish next week cannot legitimately receive an actual finish this week.

Evidence should be proportionate to the significance of the claim. A signed acceptance record may establish a major completion; a verified quantity record may support repeated production; a timesheet may establish effort charged but not acceptance. If different records disagree, the update needs a resolution or a clearly stated provisional treatment. The scheduler should identify who supplied the information, its effective date and the basis on which it was accepted. A confident verbal estimate may be useful as an early signal, but it should not silently acquire the status of verified completion.

Validate relationships between fields, not just individual entries

A date can look plausible in isolation and still conflict with the rest of the record. An actual finish before an actual start, an actual finish after the cut-off, a completed activity with unexplained remaining work, or a claim of physical completion without required acceptance all need investigation. Conversely, a started activity with no output may be legitimate if its early work concerns preparation, but the start criterion and remaining estimate should explain that position. Automated checks can identify contradictions; they cannot determine the truth of a disputed site event without evidence.

Table 10.1 | Validating progress information at the cut-off

Progress information	What to establish at the cut-off	Control implication
Activity Actual Start Date and Activity Actual Finish Date	The events occurred and satisfy the agreed criteria	Keep actuals factual; separate forecast dates from history
Activity Actual Duration and Activity Remaining Duration	The elapsed working periods and the current time needed to finish	A revised remaining estimate can change the finish without changing the actual start
Activity Actual Cost	Costs incurred for the same scope and reporting period	Reconcile accounting timing, accruals and corrections before using indices
Project Actual Start Date and Project Actual Finish Date	The relevant earliest start and final completion within the defined project boundary	Do not record a project actual finish while required project work remains
Project Actual Duration and Project Remaining Duration	Elapsed project time and the calculated remaining span	Respect the project calendar and network; do not sum parallel durations

The table brings together the progress fields discussed across PMI's component entries on printed pages 98-105 and 120-124. Their relationship is more important than merely populating them. An actual cost can be available only at a work-package or control-account level; creating fictitious activity-level precision would not improve the analysis. Similarly, a project finish should reflect the defined completion boundary. Equipment delivery, installation completion, integrated testing and operational acceptance can be separate milestones, each requiring different evidence.

Reconcile costs and progress on the same basis

Costs incurred and cash paid are different events. If work has been performed but an invoice has not yet arrived, a performance comparison may require an accrual under the organisation's accounting rules. If payment is made in advance, it does not automatically establish earned work. The scheduler and cost professional should agree the period, scope mapping and treatment of late entries. When an accrual is replaced by an invoice, avoid counting both. The aim is a comparable dataset, rather than a temporarily favourable index created by a reporting lag.

A late correction to a historical actual is sometimes necessary. A transposed date or duplicate cost should be corrected with a traceable reason, authorised treatment and preserved previous record. This differs from moving a genuine actual to make the model conform to the original plan. The former improves the factual record; the latter conceals what happened. The update narrative should explain material corrections so that a change in performance is not mistaken for a change in delivery capability.

Egypt's State Information Service reported an April 2026 inspection of the Zilal housing project in Obour City. Officials checked completion rates on site across construction stages and reviewed quality reports

and technical testing. The account illustrates a progress-collection process that considers both observed work and acceptance evidence. It does not publish the underlying records or independently certify a progress percentage. The scheduling lesson is to establish what has been completed and what still requires action before using the information to forecast successors (State Information Service, 2026).

10.2 Measuring progress without confusing time, effort and output

Percentage complete is incomplete information unless the basis is stated. Duration percentage concerns elapsed time relative to the current total duration. Physical percentage concerns completed output under the chosen measurement rule. Work percentage may reflect actual and remaining effort, depending on the scheduling tool and configuration. These values can all be useful, but they are not interchangeable. A large proportion of labour may have been used while a small amount of testing still requires several elapsed weeks, or much visible installation may be complete while documentation and acceptance remain outstanding.

Worked example: three percentages for one activity

An independent activity has four elapsed working days and six estimated working days remaining. Its duration-based percentage is 4 divided by 10, or 40%. Sixty of 100 equally weighted units have been accepted, giving 60% physical completion under that quantity rule. Timesheets record 400 hours, with 100 further hours currently estimated. An effort-based calculation using actual hours divided by actual plus remaining hours gives 80%. The three results answer different questions. They do not contradict one another, and averaging them would create a number without a clear meaning.

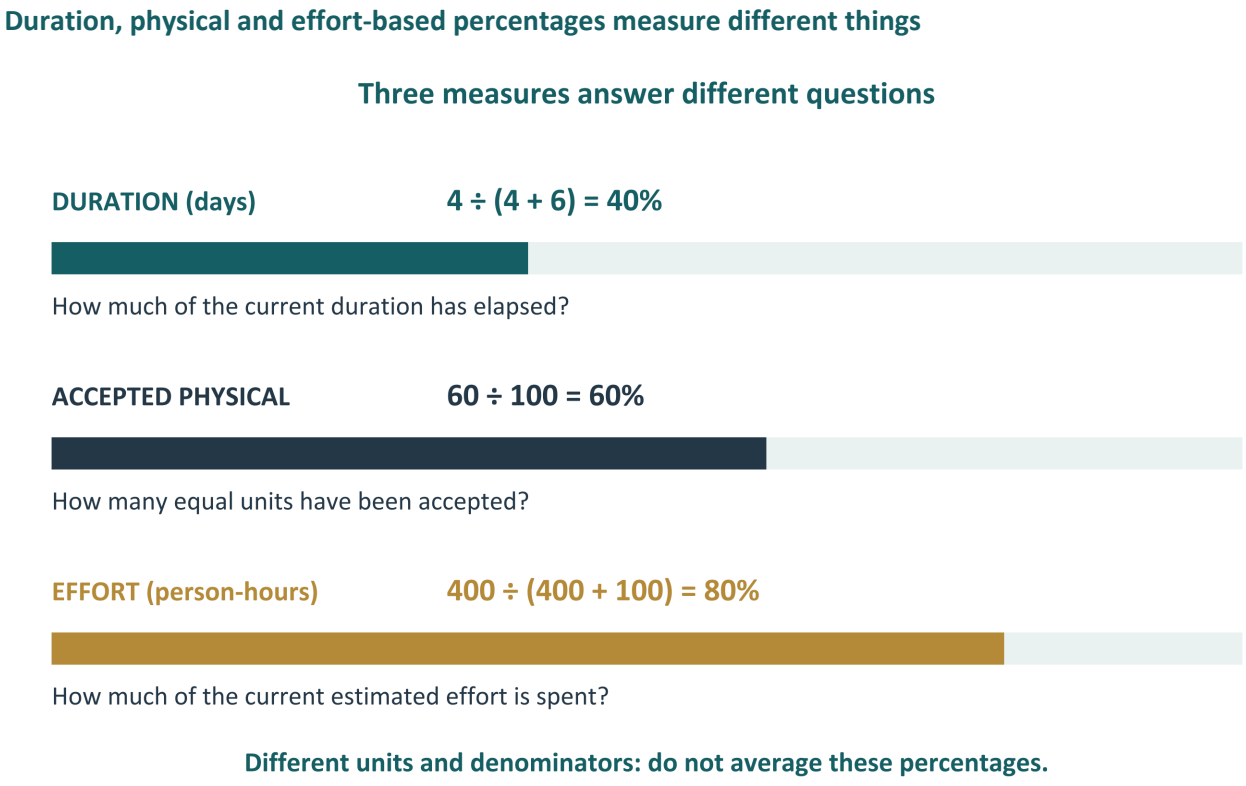


Figure 10.2. An original comparison: 40% of the current duration has elapsed, 60% of the defined output is accepted and 80% of the currently estimated effort has been used. Effort consumed is not automatically output earned.

These figures do not assume a constant relationship between hours, units and elapsed time. Early work may be labour-intensive, while the remaining work involves a smaller crew, access restrictions or test intervals. The estimated six remaining days must therefore be justified directly. Deriving it mechanically as 40% of the original duration would ignore the current work conditions. Likewise, the estimate of 100 remaining hours should be challenged if it is inconsistent with the quantities, quality requirements or available people. Each measure needs a credible basis, even when the measures legitimately differ.

PMI discusses Activity Duration Percent Complete, Activity Physical Percent Complete and Activity Work Percent Complete as distinct components (PMI, 2019, pp. 101, 104, 107). The physical measure may be assessed from quantities or other appropriate completion evidence; the work measure depends on the tool's treatment of work and assignments. Document the chosen calculation rather than assuming that similarly named fields in two applications behave identically. An automatic recalculation of a percentage can be mathematically correct while answering a different question from the one the report intends to address.

Aggregate compatible information and preserve its meaning

At project level, percentages require an explicit weighting basis. If one package contains ten units and another contains ninety comparable units, their completion percentages should not receive equal weight simply because they are two rows in a report. Where quantities are not comparable, agreed budgeted weights or weighted milestones may provide a more suitable basis. PMI's Project Physical Percent Complete component discusses an earned-value approach to aggregation (PMI, 2019, p. 124). Such a result measures budget-weighted accomplishment; it should not be described as an unweighted count of physical objects or a measure of benefits achieved.

Project Duration Percent Complete similarly needs a declared convention. If six weeks have elapsed and the current forecast contains five more, elapsed time divided by the current total gives 6/11, or approximately 54.5%. That percentage can change when the remaining forecast changes even though no historical time has changed. It does not mean that 54.5% of the required output has been accepted. A project can also be physically almost complete while a small remaining task controls several weeks of access or approval. A high aggregate percentage therefore provides no independent proof that the finish is secure.

Reconcile actual, remaining and total resource quantities

The activity and project resource fields need the same discipline. Activity Resource Actual Quantity records resources used to the cut-off; Activity Resource Remaining Quantity represents the current requirement for unfinished work; Activity Resource Total Quantity connects the two on a consistent measurement basis. Their project-level counterparts aggregate compatible quantities across the relevant scope (PMI, 2019, pp. 105-106, 125-126). Labour hours, equipment hours and material units should remain distinguishable. A single total of unrelated quantities has no useful operational meaning.

Reconciliation should also distinguish resource consumption from future availability. Four hundred hours already used do not establish that the necessary specialist will be available next week. A revised shift pattern, an absence, a plant breakdown or another project's demand can change the remaining duration. The scheduler should update the assignments and calendars that represent those conditions, then recalculate their effect. Assuming that the original crew remains available can make a forecast appear feasible even when the recorded progress is accurate. Reliable updating requires both a truthful history and a realistic future resource plan.

Dubai RTA's 3 May 2026 Blue Line announcement reported 20% completion and more than 13 million work hours, expected 30% completion by the end of 2026 and stated an opening date of 9 September 2029. These are an owner-reported status, effort expended, a future progress expectation and an opening

target. The announcement does not disclose an EVM dataset or the percentage-weighting method. Its figures should therefore not be converted into CPI, SPI or a straight-line finish forecast (RTA, 2026).

10.3 Updating the model and resolving out-of-sequence work

After validating the evidence, update a controlled working copy of the schedule. Preserve the baseline and previous reporting instance, enter the actuals and remaining estimates, set the agreed data date and recalculate the remaining work. Inspect the resulting schedule rather than assuming that successful calculation proves correctness. Incomplete work should be represented in the forecast portion of the model under the tool's calendar and status-date conventions. A future actual or an unstarted activity left unrealistically in the past should trigger investigation, not merely a formatting correction.

Out-of-sequence progress occurs when recorded execution conflicts with a modelled relationship. A successor may have started before its finish-to-start predecessor was complete, or another relationship condition may have been violated. The actual event must be retained if it is correct, but the team must decide what the event means for the remaining work. Possible explanations include incorrect reporting, an over-broad activity, a genuinely changed execution method or a real sequence violation. Each requires a different response. A scheduling option is not a substitute for identifying which explanation applies.

> **Retained Logic.** 'A schedule calculation which requires that an out-of-sequence activity cannot resume until all predecessors' logical relationships have been satisfied.' (PMI, 2019, p. 189)
>
> **Progress Override.** 'Schedule calculation that ignores logical relationships and allows activities with progress to continue even if the predecessors' logical relationships have not been satisfied.' (PMI, 2019, p. 184)

PMI recommends addressing every out-of-sequence occurrence and describes retained logic as good practice, while explaining that the appropriate resolution still depends on the validity of the relationships (PMI, 2019, pp. 79-81). If the original logic remains necessary, allowing unfinished successor work to continue can create an impossible forecast. If the activity definition hides separate work fronts, retaining an unnecessarily broad dependency can also distort the model. Decomposition or a justified change to remaining logic may be needed, with the reasoning recorded and the applicable approval process followed.

Worked example: one history, two calculated futures

Use zero-based working-day boundaries and one common calendar. Activity A started at day 0 and remains in progress at the day 6 cut-off, with four days remaining, so it is forecast to finish at day 10. Activity B has an original finish-to-start relationship from A, but actually started at day 4 and worked to day 6. It has three days of unfinished work. The recorded history is the same in both calculations. Under retained logic, B's remaining work waits until day 10 and finishes at day 13. Under the simplified progress-override treatment, it continues at day 6 and finishes at day 9.

The effect of retained logic and progress override on remaining work

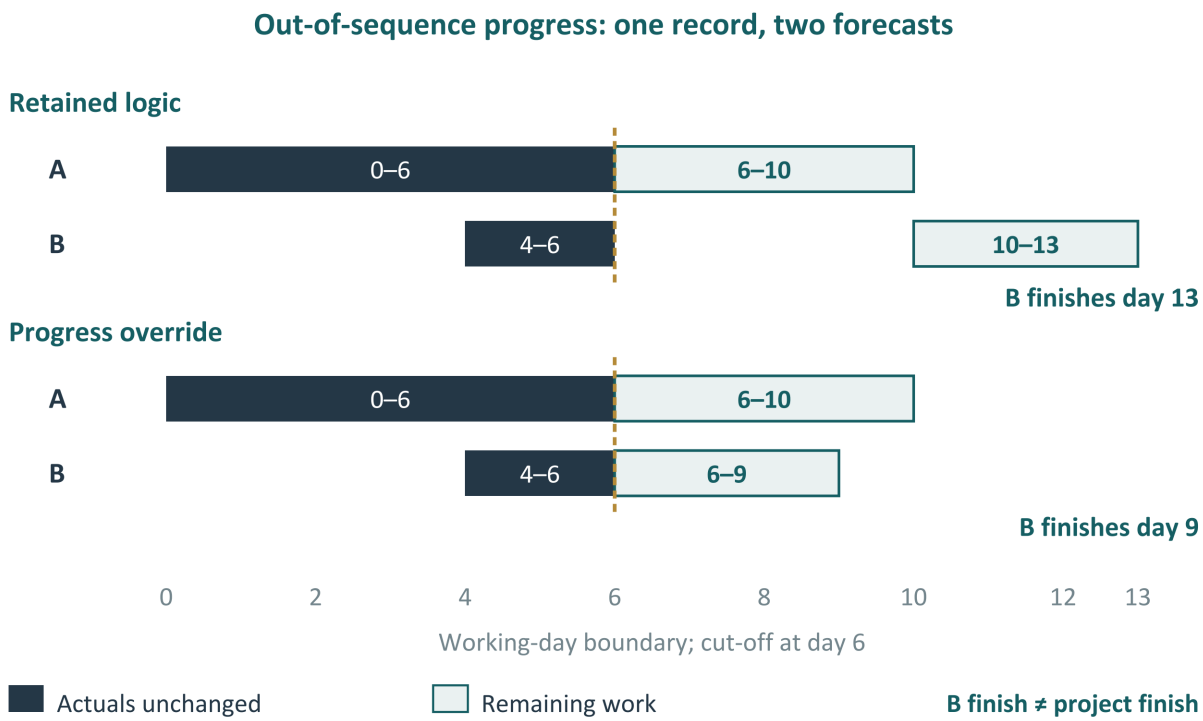


Figure 10.3. An original out-of-sequence example. Actuals remain unchanged; only the treatment of B's remaining work differs. Day 9 and day 13 are B's forecast finishes, not automatically the project finish.

The four-day difference is a consequence of the calculation policy, not evidence of an achieved recovery. The team must establish whether B's remaining work can proceed while A is unfinished. If B started only on a separately released area, the model may need to distinguish that area from the dependent remainder. If A provides an essential safety or acceptance condition for all remaining B work, override would be inappropriate. Tool implementations and options differ, so a practitioner should verify the precise calculation behaviour and document the configuration used for the report.

The example also explains why historical dates should not be forced back into the planned sequence. Moving B's actual start from day 4 to day 10 would manufacture a different history and conceal the issue that needs management attention. A valid update preserves what occurred and improves the representation of what remains. The resulting log can then explain whether the difference arose from a reporting correction, a model refinement or an approved change in execution. That record becomes valuable when later reviews ask why the forecast moved.

Find open ends created by progress

A model can acquire a virtual open end even when every activity still has a relationship. Suppose activity B has an actual start at working-day boundary 4 and is connected to an unstarted activity C by a zero-lag start-to-start relationship. At data date 8 the relationship permits C to have started, but C has not started and has no other predecessor. Its remaining start can now move with the data date because the recorded trigger has already occurred. The relationship count looks satisfactory while the model fails to explain the continuing wait. This is the progress-created situation illustrated by PMI's Figure 3-10 (2019, pp. 78-79).

Investigate the actual cause: a missing release, unavailable resource, incorrect relationship or an activity that needs decomposing. Represent the defensible remaining dependency or availability and retain the reason for the correction. Do not add an arbitrary predecessor simply to improve a diagnostic score.

Recalculate the affected path and check whether the proposed repair explains both the observed progress and the remaining forecast.

10.4 Comparing schedule instances and explaining movement

Variance. 'The difference between two selected attributes expressed in appropriate units such as work days or currency.' (PMI, 2019, p. 136)

Comparison requires a named reference. The current schedule shows the latest forecast; the previous instance shows the last reported position; the approved baseline provides the authorised reference; and a target instance may represent an alternative or desired outcome. Comparing current with baseline answers a different question from comparing current with the previous period. A project can remain late against its baseline while improving since the last update. It can also appear unchanged against a revised target while continuing to drift from the original commitment. The report should state which relationship each variance describes.

In the chapter's illustrative project, the approved completion is Week 10, the previous forecast was Week 10.5 and the current network forecasts Week 11. The baseline finish variance is therefore one week late, while the period-to-period drift is half a week later. Management's desired Week 10 finish remains a target requiring a feasible response. It is not a new forecast merely because it appears on a dashboard. Figure 10.4 keeps these four positions distinct so that the discussion can focus on what changed and what action is required.

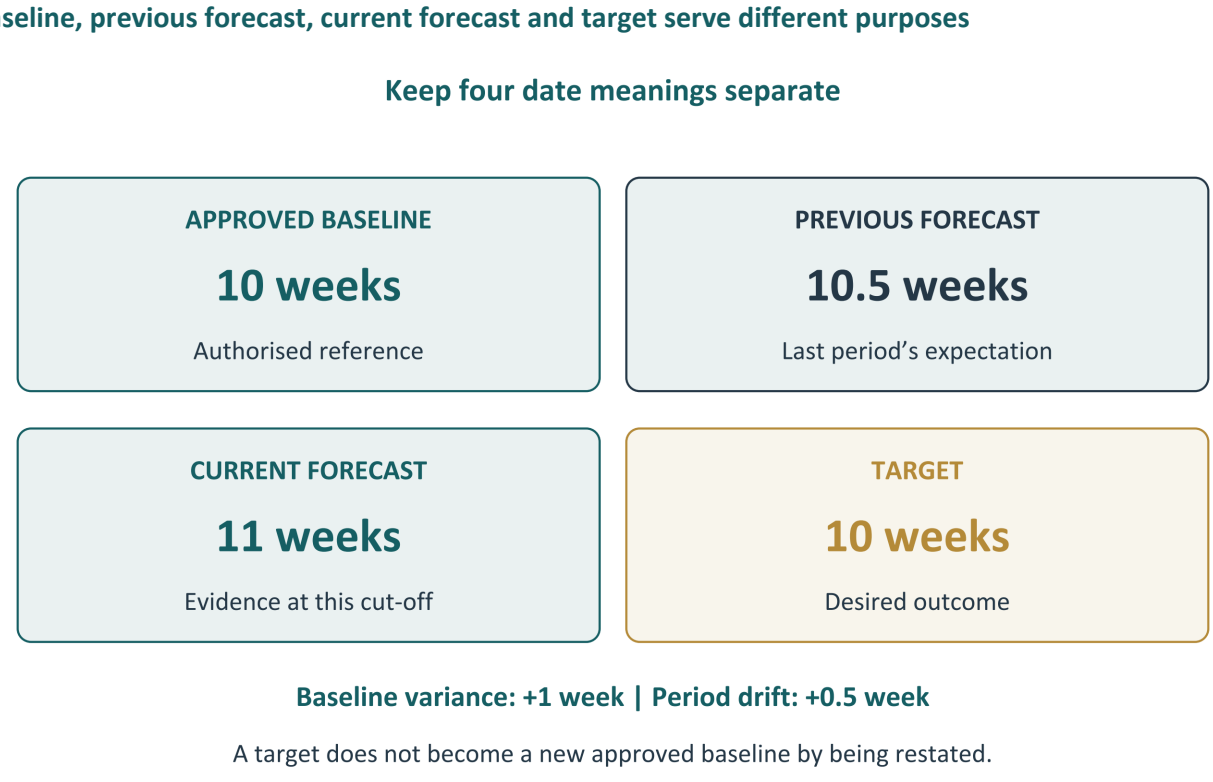


Figure 10.4. An original comparison of schedule instances. This chapter reports finish-date variance as current minus reference, so a positive value means later. EVM variance signs use a different convention and are labelled separately.

Follow the controlling path and the erosion of float

A completion date alone can conceal deterioration elsewhere. A path that previously contained substantial float may become near-critical while the final milestone remains unchanged. At the next update, a small additional delay may make it the controlling path. The scheduler should therefore examine changes in path logic, remaining durations, calendars, resource availability and constraints, as well as changes in the finish. An activity's baseline importance does not guarantee that it remains the main driver throughout delivery.

For an independent illustration, two remaining paths have durations of four and three weeks before a common acceptance activity. If the shorter path grows to four weeks, its available separation from the longer path disappears even though the common finish need not move. Both paths now deserve attention. If it grows again to five weeks, it may become controlling. The report should explain the cause of that growth, such as slower design release or reduced specialist availability, rather than describe the change only as a new critical path. The calculation identifies the consequence; management needs the mechanism.

Do not add every activity's date variance to calculate project delay. Parallel activities can share an effect, some delays can be absorbed within float and a common predecessor can influence several successors. A finish-date movement should be traced through the network and its assumptions. When comparing versions, confirm that scope, calendars, cut-offs and milestone meanings are compatible. An apparent improvement created by deleting acceptance work is not a recovery. A change in the project boundary should be identified explicitly rather than buried within a favourable date movement.

Germany provides a documented distinction between a forecast and an actual milestone. On 15 May 2026, Deutsche Bahn forecast that through operation on the remaining Hamburg-Berlin route would resume on 14 June. Its 14 June announcement reported that event, while also identifying remaining acceptance runs, temporary speed restrictions and station work. These operator reports support a defined reopening milestone with residual work still visible; they do not establish that every project activity was complete or that the original baseline had been met (Deutsche Bahn, 2026a; 2026b).

10.5 Earned value: relating accomplishment to plan and cost

Earned value management connects planned scope, budgeted accomplishment and actual cost at the same reporting position. Its schedule indicators use budgeted value to compare the work performed with the work planned. They do not directly calculate days of delay. This distinction is particularly important for schedulers because the word 'schedule' appears in measures whose units are monetary. A negative schedule variance can identify less budgeted work accomplished than planned, but the effect on the completion milestone still depends on which work is unfinished and how it sits in the network.

Earned Value (EV). 'The measure of work performed expressed in terms of the budget authorized for that work. See also actual cost (AC), budget at completion (BAC), estimate at completion (EAC), estimate to complete (ETC), and planned value (PV).' (PMI, 2019, p. 180)

Planned Value (PV). 'The authorized budget assigned to scheduled work.' (PMI, 2019, p. 184)

Actual Cost (AC). 'The realized cost incurred for the work performed on an activity during a specific time period.' (PMI, 2019, p. 175)

Budget at Completion (BAC). 'The sum of all budgets established for the work to be performed.' (PMI, 2019, p. 177)

These quantities must use the same scope, accounting basis and reporting period. EV values accomplishment at its authorised budget, independently of what that accomplishment actually cost. A

funding limit, sales value or anticipated benefit is not automatically the BAC of the performance measurement baseline. Management reserve and other amounts outside that baseline must remain distinguishable where the organisation's system uses them. Their treatment should be explained before interpreting a comparison between a project budget and its forecast final cost.

Establish earning rules before observing performance

PMI identifies Earned Value Measurement Type and Earned Value Weight as components that connect schedule activities to the work package's earning rules (PMI, 2019, p. 113). A 0/100 rule gives no credit until the defined work is complete; a 50/50 rule allocates a stated portion at start and the remainder at completion; weighted milestones allocate credit to specified achievements. The choice should fit the work and be agreed before reporting. Changing the rule after seeing disappointing performance can make a metric look better without changing the underlying output.

An original £20,000 package could allocate 20% to accepted design, 30% to delivery under its agreed acceptance condition and 50% to tested installation. If only the first two milestones are achieved, EV is £10,000. That amount is determined by the agreed weights, not by the supplier's invoice or the cost incurred so far. The weights for the package should reconcile to 100%, and the same accomplishment must not be counted once in an activity and again in its summary. An activity's weight is an allocation rule, not independent evidence that its result has been accepted.

Level-of-effort work also requires care. Where its earning rule follows the passage of planned support time, it can earn value without demonstrating that a discrete deliverable is advancing. Combining large support budgets with troubled production can therefore obscure the underlying issue. A scheduler should inspect the discrete work and its milestones rather than rely entirely on a project-level index. The relevant question is whether the measurement method is appropriate and whether its aggregation preserves the information needed for the decision.

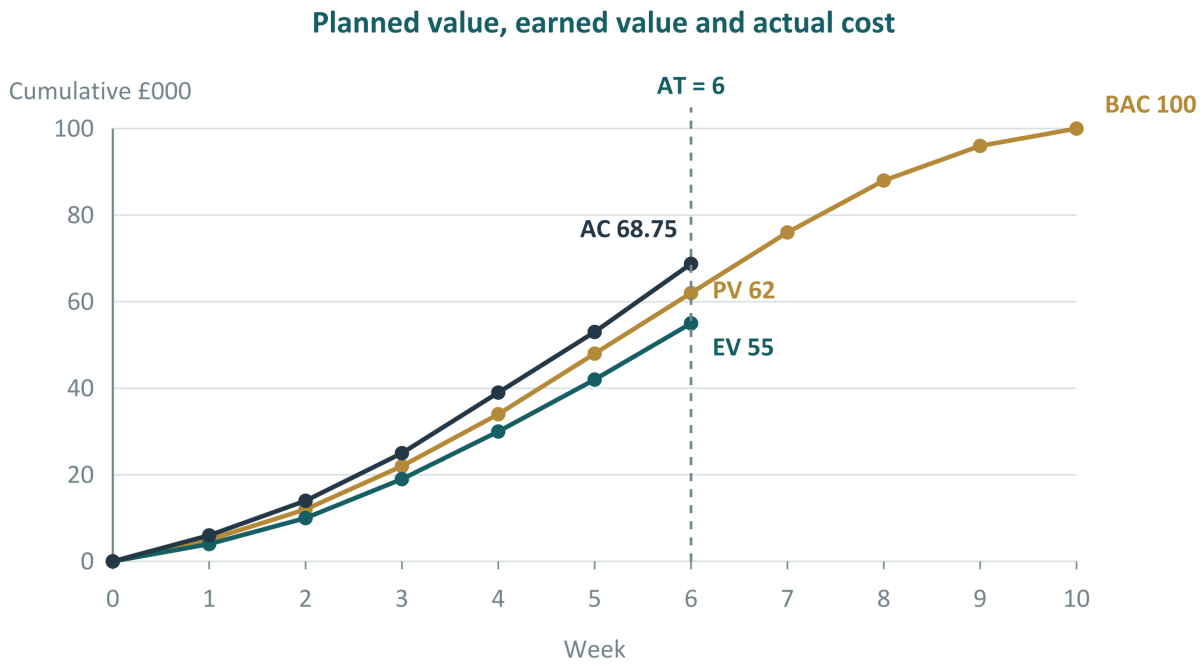
The common worked dataset

The illustrative project has a baseline duration of ten equal reporting weeks and BAC of £100,000. The table shows cumulative values at week boundaries, in £000. At the Week 6 cut-off, PV is 62, EV is 55 and AC is 68.75. The values are reconciled to the same scope and cut-off. Future EV and AC are not reported as actuals. The baseline PV profile is retained through Week 10 because it is needed for both the earned-value and earned-schedule calculations.

Table 10.2 | The common earned value dataset

Week boundary	Cumulative PV: £000	Cumulative EV: £000	Cumulative AC: £000
0	0	0	0
1	5	4	6
2	12	10	14
3	22	19	25
4	34	30	39
5	48	42	53
6: data date	62	55	68.75
7	76	Not yet observed	Not yet observed
8	88	Not yet observed	Not yet observed
9	96	Not yet observed	Not yet observed
10	100	Not yet observed	Not yet observed

Cumulative planned value, earned value and actual cost



Future planned value remains visible; EV and AC stop at the cut-off.

Figure 10.5. The original common dataset. At Week 6, the project has earned £55,000 of budgeted work against £62,000 planned and incurred £68,750. The PV line beyond the cut-off is a baseline, not a record of future actual performance.

Calculate the indices and preserve their units

Table 10.3 | Calculating and interpreting performance indices

Measure	Calculation at Week 6	Interpretation
Cost Variance, CV	EV - AC = -£13,750	Accomplishment has cost more than its budgeted value
Schedule Variance, SV	EV - PV = -£7,000	Less budgeted work is accomplished than was planned by this point
Cost Performance Index, CPI	EV / AC = 0.800	£0.80 of budgeted accomplishment per £1 incurred
Schedule Performance Index, SPI	EV / PV = 0.887	Accomplishment is about 88.7% of the budgeted work planned to date
Cost Variance Percent, CV%	100 × CV / EV = -25.0%	Cost variance expressed relative to earned value
Schedule Variance Percent, SV%	100 × SV / PV = -11.29%	Schedule-value variance expressed relative to planned value

The calculations follow the conventional EVM relationships, supported by PMI's glossary and the US Department of Energy's EVMS Gold Card (PMI, 2019, pp. 178, 190; DOE, 2019). The percentage denominators differ: CV% uses EV, while SV% uses PV in the conventions used here. State the convention, include the multiplier when expressing a percentage and avoid treating all percentages as though they describe the same relationship. An index is dimensionless; CV and SV retain the currency unit. Neither £7,000 nor 11.29% can be relabelled as a number of weeks without a separate time analysis.

The project has earned 55% of BAC, planned 62% of BAC by Week 6 and incurred 68.75% of BAC. These are three different comparisons. The first is budget-weighted accomplishment, the second is scheduled budget and the third is budget consumption. They are not three independent estimates of physical completion. At lower levels, the same calculations can reveal where performance differs, provided the inputs remain comparable. Project indices should be calculated from aggregated EV, AC and PV rather than from an unweighted average of package indices.

Examine period performance and undefined values

During Week 6 alone, EV increases by £13,000 and AC by £15,750. The period CPI is therefore approximately 0.825, compared with cumulative CPI of 0.800. That modest improvement may deserve investigation, but one period does not establish that the remaining work will achieve the original budget. Cumulative performance includes earlier experience; period performance is more responsive and potentially more variable. Both can be informative when the report labels them clearly and explains significant accounting corrections or changes in work mix.

A denominator of zero makes a ratio undefined. CPI cannot be calculated from EV/AC when AC is zero; SPI requires non-zero PV; CV% requires non-zero EV. Report an appropriate 'not applicable' or 'undefined' status with an explanation instead of manufacturing a zero or infinity that appears meaningful. If EV is zero and AC is positive, CPI is zero, but CV% still divides by zero. This distinction matters early in a project and for packages whose earning rules defer credit until completion.

USA: measurement design can undermine an apparently complete dashboard

GAO's September 2025 Uranium Processing Facility audit reported DOE-PM findings that extensive indirect-funded, zero-budget tasks representing discrete contractual work distorted completed-work performance and weakened completion estimates. It also reported concerns about management-reserve use obscuring variance. Nineteen of twenty corrective actions had been implemented by July 2025, but the scheduling-task action remained open in August. The lesson concerns classification, budgets and evidence; it does not imply that every zero-budget activity is invalid. External milestones can legitimately have no assigned budget (GAO, 2025, pp. 16-19).

10.6 Forecasting cost and testing the efficiency required

> **Estimate at Completion (EAC).** 'The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete. See also actual cost (AC), budget at completion (BAC), earned value (EV), estimate to complete (ETC), and planned value (PV).' (PMI, 2019, p. 180)

An EAC is a forecast, not an authorised increase in budget. Its fundamental relationship is EAC = AC + ETC, where Estimate to Complete concerns the remaining cost. Actual cost is already incurred; the forecast question is what unfinished work will require under the conditions now expected. A credible ETC considers remaining quantities, productivity, staffing, rates, procurement, indirect costs and relevant uncertainty. The calculation may use a statistical assumption, a detailed estimate or a combination, but the report should identify the method and the reason it is appropriate.

The common example has £45,000 of budgeted work remaining, calculated as BAC minus EV. This differs from the £31,250 remaining within the original budget after actual spending, calculated as BAC minus AC. The first expresses the budgeted value of unfinished scope; the second is the unspent portion of the budget. Confusing them can make an overrun disappear from a forecast. The work still has to be done even when the money available within the original budget has fallen below its original budgeted value.

Table 10.4 | Comparing estimate-at-completion assumptions

Forecast assumption	EAC relationship	Example EAC: £000
Remaining work performs at its original budgeted efficiency	AC + (BAC - EV)	113.75
Cumulative cost efficiency continues	AC + (BAC - EV) / CPI; equivalent here to BAC / CPI	125.00
Detailed remaining estimate is £58,000	AC + bottom-up ETC	126.75
Both cumulative CPI and SPI are assumed to influence remaining cost	AC + (BAC - EV) / (CPI × SPI)	132.16

These conditional formulas are consistent with DOE's Gold Card, but none is automatically the correct management forecast (DOE, 2019). The first assumes future work achieves budgeted efficiency despite historical cost variance. The CPI case assumes historical cost efficiency remains relevant. The composite case additionally assumes that the schedule-value index is informative about future cost pressure. That may be reasonable in some settings and misleading in others. If the remaining work is structurally

different, a fresh estimate may be more informative than extrapolating the average performance of completed packages.

Four conditional cost forecasts from the common dataset

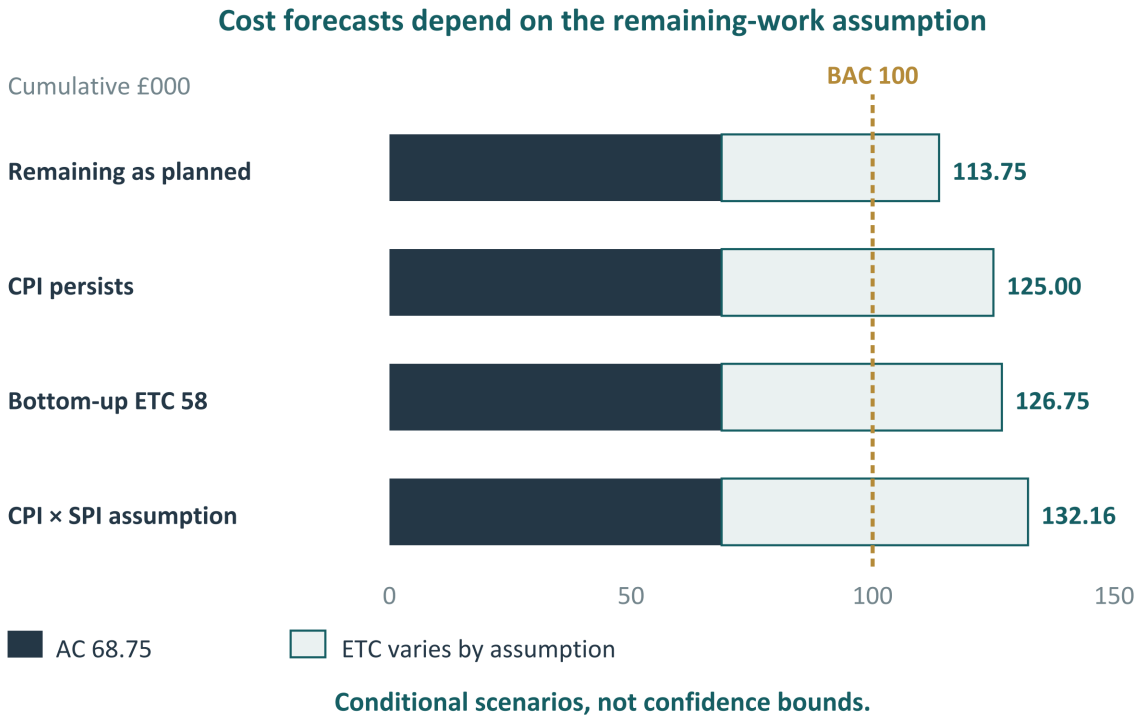


Figure 10.6. Original EAC scenarios. Each total includes the same £68,750 already incurred. The differences arise from assumptions about the remaining cost; the alternatives are not statistical confidence bounds.

In the CPI case, ETC is £56,250 and EAC is £125,000. Cost Variance at Completion, using BAC minus EAC, is therefore -£25,000. The bottom-up alternative instead gives ETC of £58,000, EAC of £126,750 and variance at completion of -£26,750. Keep the label explicit: variance at completion concerns the forecast total, whereas current CV concerns accomplishment and actual cost at the cut-off. A project can have a current adverse variance yet forecast partial recovery, but the remaining assumptions must explain how that improvement is expected to occur.

Calculate TCPI as a requirement, not a prediction

The To Complete Performance Index compares the budgeted work remaining with the cost allowance remaining to a selected objective. To finish at the original BAC, TCPI is (BAC - EV) / (BAC - AC). In the example, £45,000 divided by £31,250 gives 1.44. The project would need to earn £1.44 of budgeted work per remaining £1 spent, compared with the cumulative £0.80 achieved so far. This difference should prompt a feasibility discussion. It does not prove that the required improvement is available simply because the formula returns a number.

For a selected EAC of £125,000, TCPI is (BAC - EV) / (EAC - AC), or £45,000 divided by £56,250, giving 0.80. The numerator remains the budgeted value of unfinished work; changing the cost objective does not change that work's authorised budgeted value. The result matches the CPI-persistence assumption used to generate that EAC. A target EAC that is equal to or below actual cost leaves no positive allowance for unfinished work; the ratio then ceases to provide an ordinary achievable efficiency target. Explain the condition rather than treating a negative or undefined result as favourable.

France: an estimate revision is not expenditure already incurred

The Cour des comptes' September 2025 report on Nantes Saint-Nazaire port described the proposed Eole floating-wind assembly platform being re-estimated from €100 million to €235 million after studies and industry consultation, including changed loading and quay requirements. Works were then envisaged for 2027-2029, with commissioning in 2030. The amounts were successive estimates, not actual spending or a verified EVM baseline. The case illustrates why a report must separate scope development, estimate revision, authorised budget and expenditure before attributing a difference to performance (Cour des comptes, 2025, pp. 94-96).

10.7 Earned schedule: translating accomplishment into a time comparison

> **Earned Schedule.** 'An earned value technique that measures the time at which planned value equals earned value.' (PMI, 2019, p. 180)

Earned schedule asks when the current amount of earned value was planned to have been achieved. It locates EV on the baseline planned-value curve and reads the corresponding time. Actual Time, or AT, is the number of periods elapsed at the reporting position. Comparing earned schedule with actual time produces a time variance and a time-based performance index. The method supplements EVM; it does not replace the activity network or independently establish which unfinished task controls the finish (PMI, 2019, pp. 85-88).

Interpolate within the planned-value profile

At Week 6, the common dataset has EV of £55,000. Baseline PV was £48,000 at Week 5 and £62,000 at Week 6, so the earned amount lies halfway through that £14,000 increase. Assuming a linear increase within the reporting interval, ES is 5 + (55 - 48) / (62 - 48), giving 5.5 weeks. The project has therefore earned the amount of work that the baseline associated with Week 5.5, although six weeks have elapsed. Figure 10.7 shows the horizontal movement from value to the baseline curve and the vertical reading of earned time.

Deriving earned schedule from the baseline planned-value curve

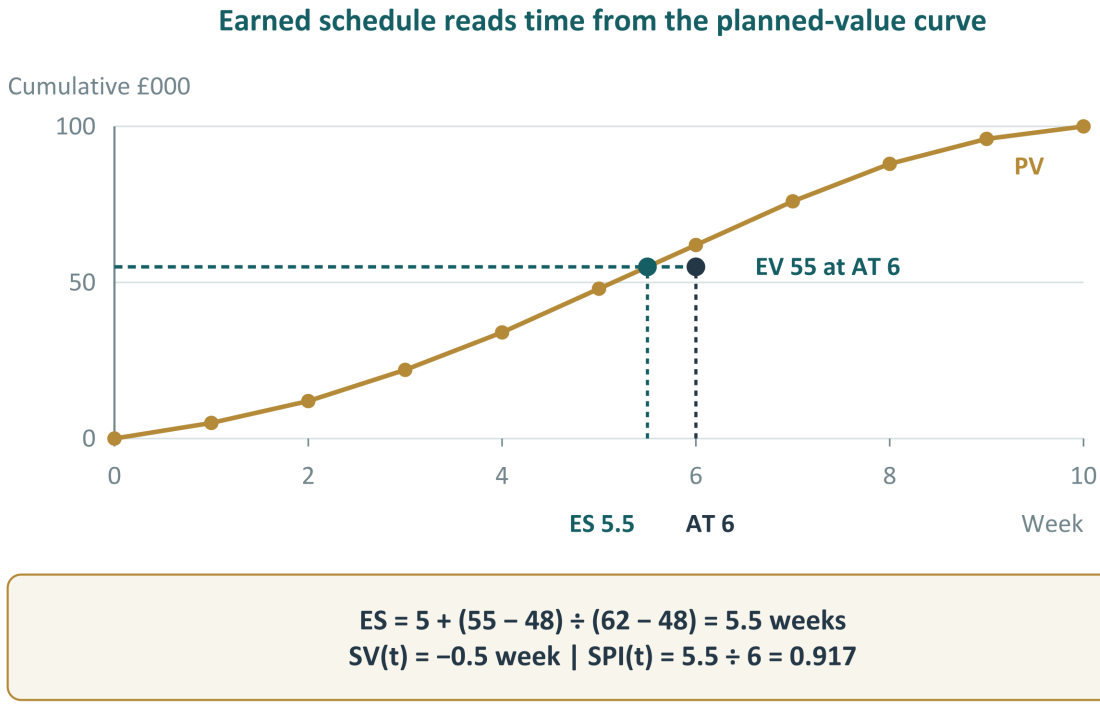


Figure 10.7. Original earned-schedule interpolation. EV of £55,000 maps to baseline time 5.5 weeks, between PV of £48,000 at Week 5 and £62,000 at Week 6. Interpolation assumes a linear profile within that interval.

The general calculation is ES = C + I for equal reporting periods, where C is the number of complete baseline periods earned and I is the fraction of the next period. For this example, I is 0.5. If reporting intervals have unequal lengths, interpolate using their actual time coordinates rather than assuming that every interval is one week. A flat PV interval creates a zero denominator and potentially several time positions for the same value. Use a documented convention for that situation and disclose its effect. Do not conceal an ambiguous mapping behind spurious decimal precision.

Table 10.5 | Earned schedule and time-based measures

Time measure	Calculation at Week 6	Meaning and unit
Earned Schedule, ES	5 + 7/14 = 5.5	Baseline time associated with the earned value: weeks
Actual Time, AT	6	Elapsed reporting time: weeks
Schedule Variance Time, SV(t)	ES - AT = -0.5	Behind the earned-time position by half a week
Schedule Performance Index Time, SPI(t)	ES / AT = 0.9167	Dimensionless earned-time efficiency ratio
SV(t)% using PMI Table 3-1's denominator	100 × (ES - AT) / ES = -9.09%	Time variance expressed relative to ES

Both ordinary SPI and SPI(t) are dimensionless ratios. Ordinary SV uses the budget unit, while SV(t) uses time. The distinction should appear in labels and explanations, particularly when a dashboard places the

figures next to one another. The time-variance percentage convention above uses ES in its denominator, as in PMI's Table 3-1. A report using another convention must state it explicitly. The percentage is not the same as the half-week time variance, and neither automatically equals the delay to a particular contractual milestone.

Forecast duration with an explicit performance assumption

Let Planned Duration, PD, be ten weeks. If the historical SPI(t) of 5.5/6 continues, an Independent Estimate at Completion in time, IEAC(t), is PD / SPI(t), giving approximately 10.91 weeks. Estimated time to complete is then IEAC(t) minus AT, or approximately 4.91 weeks. An equivalent form is AT + (PD - ES) / PF(t), where PF(t) is the assumed future earned-time performance factor. Using PF(t) equal to the current SPI(t) produces the same result. Using PF(t) of one instead assumes that the remaining baseline-equivalent work proceeds at the planned rate, giving 10.5 weeks.

Estimated Duration, ED, is the selected forecast total duration, and Estimate to Complete Time, ETC(t), is the forecast remaining span. At project level, ED = AT + ETC(t) when the quantities use the same origin and time basis. In this chapter, IEAC(t) labels an independent calculated forecast, while ED can also label a selected network-based estimate. State which forecast is being used. Parallel activity durations cannot simply be added to obtain the project ETC(t); the relationships, resources and calendars determine the span. Section 10.8 demonstrates the distinction.

Test the time performance required to meet a target

The To Complete Schedule Performance Index compares remaining baseline-equivalent work with the time available to a chosen target. For the original planned duration, TSPI = (PD - ES) / (PD - AT). The example gives (10 - 5.5) / (10 - 6) = 1.125. To meet an eleven-week duration objective, the denominator becomes 11 - 6, giving TSPI of 0.90. The original deadline therefore requires a stronger future earned-time rate than the historical 0.9167, while the eleven-week objective requires a slightly lower rate. These are required rates under the aggregate model, not instructions to accelerate every activity by the same percentage.

If the target time has already arrived and unfinished work remains, the available-time denominator is zero or negative. Report the missed or infeasible time allowance directly; a negative ratio is not an improvement. Similarly, a target duration selected for the TSPI calculation should not be confused with an approved rebaseline. Time Variance at Completion can be expressed as PD minus the chosen forecast total duration. Against the 10.91-week independent estimate it is approximately -0.91 weeks; against the eleven-week network estimate it is -1 week. Name the forecast used so that the comparison remains reproducible.

Why the traditional schedule index can look healthy at late completion

Suppose the same authorised scope is eventually completed at Week 12, against the ten-week baseline. At that late completion point, cumulative EV equals BAC and baseline PV has also reached BAC. Conventional SPI is therefore one and SV is zero. Those values show that all budgeted work has now been earned; they do not show that it was delivered on time. ES reaches the planned duration of ten weeks while AT is twelve, so SPI(t) is 10/12, or 0.833, and SV(t) is -2 weeks. Actual remaining duration is zero because the work is complete.

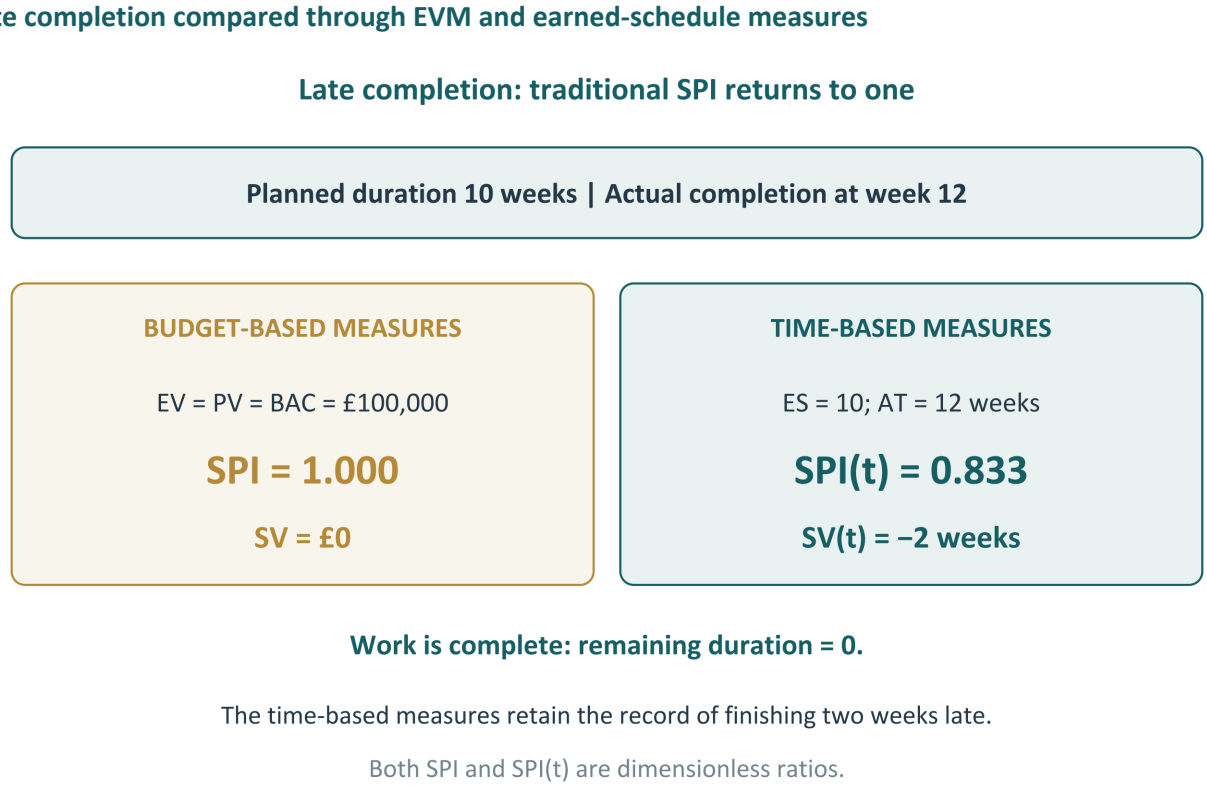


Figure 10.8. An original late-completion comparison. For the unchanged scope at Week 12, EVM's schedule-value gap has closed, while earned schedule retains the two-week time difference. This illustration concerns late completion after baseline PV has reached BAC.

Earned schedule is still an aggregate measure. Budget-heavy non-critical work can influence the result, and a low-budget critical task can determine the actual finish. The aggregate ES value does not identify an out-of-sequence activity by itself; that requires activity-level evidence and network review. DOE's analysis procedure likewise cautions about non-critical and level-of-effort influences when interpreting performance (DOE, 2020, section 2.4.1.1). The useful practice is to compare the time signal with the controlling work and investigate disagreement, rather than promote either metric into an automatic judgement about the whole project.

Reading the supplied formula entries consistently

Several entries in the third edition need care. The Schedule Variance component on printed page 131 gives a ratio, while the glossary on page 190 correctly expresses ordinary SV as EV minus PV. The TCPI expression for an EAC target on page 134 shows EAC in the numerator; the remaining budgeted work must instead remain BAC minus EV, consistent with DOE's guidance. The page 111 zero-value note does not make division by zero valid. This chapter preserves quoted definitions and uses the dimensionally consistent relationships explained above (PMI, 2019; DOE, 2022, p. 44).

Table 3-1 on page 88 expresses SV(t)% as a fraction; multiply by 100 when presenting it as a percentage. Its time variance at completion should be read as PD minus the selected total-duration forecast, whether IEAC(t) or ED. Finally, the component discussion on page 114 should not be interpreted as permission to sum parallel remaining durations into a project forecast. These clarifications matter for examination preparation as well as practice: check what the numerator, denominator and units represent before memorising a formula.

10.8 Forecasting the remaining network, productivity and uncertainty

A statistical forecast is a useful challenge to the plan, but delivery occurs through actual work and dependencies. The remaining network should therefore explain how the forecast finish can be achieved with the available resources and known conditions. For the common example, use the Week 6 cut-off and equal reporting weeks. Equipment release requires two more weeks, followed by two weeks of installation. Controls work requires three weeks in parallel. One week of integrated testing follows both installation and controls completion. Assume separate available resources, finish-to-start relationships with zero lag and a common calendar.

Remaining-work network and the resulting completion forecast

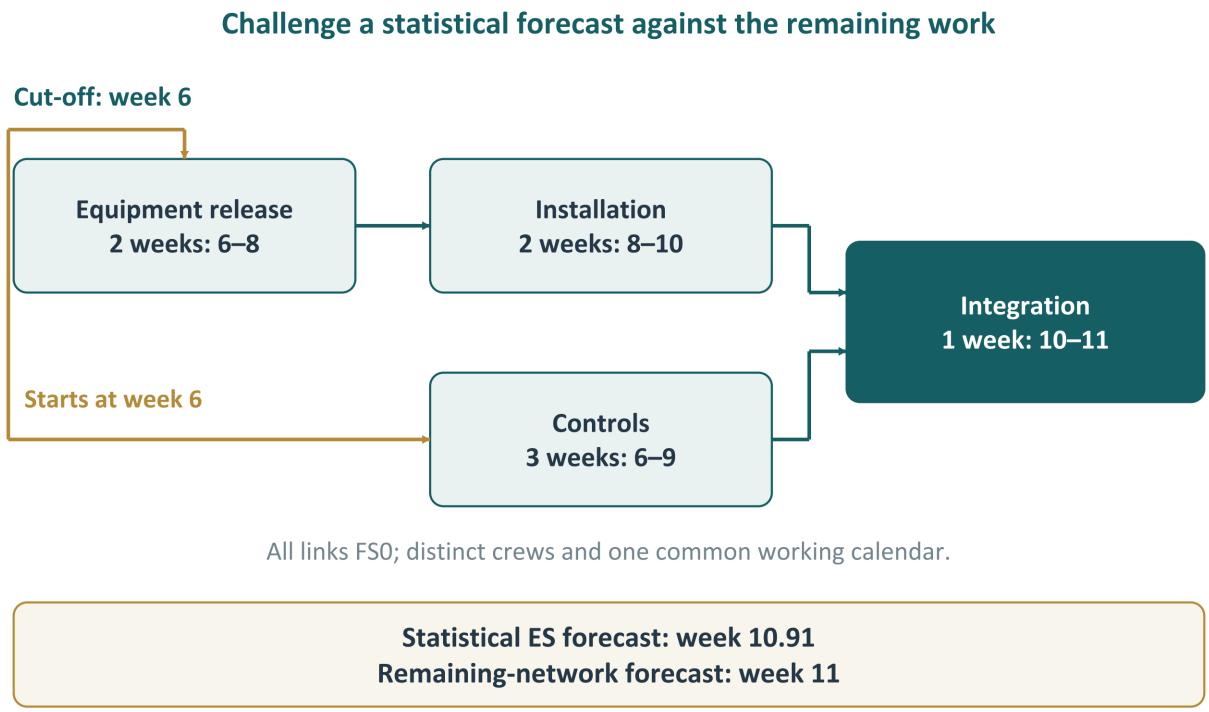


Figure 10.9. The original remaining network. The equipment-release and installation branch takes four weeks, controls takes three, and the common integration activity takes one. Remaining duration is five weeks, producing an eleven-week total forecast.

Table 10.6 | The remaining network and its forecast cost

Remaining activity	Duration: weeks	Predecessor condition	Bottom-up remaining cost: £000
Equipment release	2	Ready to proceed at the cut-off	10
Installation	2	Equipment release complete	24
Controls	3	Ready to proceed at the cut-off	14
Integrated testing	1	Installation and controls complete	10

The remaining duration is the longer of the parallel branches, four weeks, plus one week for integration. It is five weeks, not the sum of all eight activity-weeks. Adding AT of six gives ED of eleven. Costs can be added here because the four estimates cover distinct remaining scope without duplication: ETC is £58,000 and EAC is £126,750. The resulting time forecast is close to the earned-schedule estimate of 10.91 weeks, but their closeness does not independently validate either. They use different methods and need separate checks of their assumptions.

Use the forecast to identify an effective response

Reducing controls from three weeks to two would not improve completion in the stated network, because equipment release and installation still take four. Reducing installation from two weeks to one could reduce the longer branch to three weeks, matching controls; the common integration week would then produce four weeks remaining and a Week 10 finish. That is a scenario to investigate, not an achieved recovery. It requires evidence that the method, resources, quality and handovers can support the reduction, together with a cost and risk assessment. Chapter 11 develops the approval and implementation of such recovery options.

A remaining-duration estimate should reflect the work left, not merely the percentage of original time unused. For a separate quantity example, 360 units remain to be completed and accepted. At a substantiated rate of 30 accepted units per working day, the production element needs twelve working days. If the relevant rate is instead 24 units per day, it needs fifteen. The calculation must then account for working calendars, access, mobilisation, inspections and successor conditions. Rates measured on easier completed work may not represent the remaining work, and additional people may not increase output proportionately if space or equipment is limiting.

England's Sellafield illustrates the importance of those assumptions. The NAO's October 2024 report recorded 23 boxes retrieved from the Magnox Swarf Storage Silo in 2023-24, while the most optimistic scenario assumed 546 annually by the mid-2030s to support a later retrieval milestone. Expected denser packing was another prospective improvement. These were conditional changes in future production, not achieved savings or grounds for a simple linear forecast. The lesson is to distinguish observed output from the technical and operational assumptions needed to sustain a future rate (NAO, 2024, pp. 31-32).

Add uncertainty without disguising it as a precise promise

The eleven-week network estimate assumes that the stated durations and enabling conditions hold. If equipment release takes an extra week, the same logic gives a twelve-week finish unless a feasible response offsets the effect. These are conditional scenarios, not P50 and P80 dates. A probability label requires a suitable uncertainty model and evidence about duration variation, events and dependence. Where quantitative risk analysis is used, start from the updated remaining network and retain known actuals rather than resampling events that have already occurred.

The report should state the proposed commitment separately from the current calculated outcome. A target can remain Week 10 while the present forecast is Week 11, provided the difference and required decision are made visible. Automatically resetting the baseline to Week 11 would remove the comparison before the organisation has agreed what to do. Conversely, keeping the forecast at Week 10 merely because it is the contractual date prevents early action. A credible scheduler preserves the distinction and explains the assumptions under which each alternative could become achievable.

Compare completion counts with baseline execution index

Baseline execution index (BEI) provides a count-based view of delivery. Using the cumulative convention presented by the US Department of Energy, divide the number of detailed activities actually completed by the number of detailed activities scheduled to be complete by the same status date in the selected baseline (DOE, 2014, p. 14). State the eligible activity population and baseline version, including how milestones, support activities and approved scope changes are treated. The numerator and denominator must relate to that same controlled population.

BEI = cumulative actual completions / cumulative baseline completions due.

In an original example, 12 eligible activities were due by Friday and 10 have been completed. BEI is 10/12, or approximately 0.83. If the team also finishes two activities whose baseline dates fall next month, the cumulative numerator becomes 12 and BEI becomes 1.00, even though two activities due this week remain incomplete. Early completions can therefore compensate numerically for overdue work. A ratio above one is possible; it indicates a greater completion count than was due, rather than a guaranteed early project finish. If no eligible activities are yet due, the denominator is zero and the ratio is undefined.

BEI gives each included activity one count. It does not weight an activity by duration, cost, resource effort or influence on the completion milestone. In the example, one overdue activity could control testing while the two early completions are minor administrative tasks. Read the index alongside the overdue-activity list, critical and near-critical paths, resource feasibility and risk-adjusted milestone forecast. Once all eligible activities are complete and all their baseline completion dates have passed, the cumulative count ratio is one, including on a late project. This is why the indicator supports diagnosis and discussion rather than establishing delivery confidence by itself.

Table 10.7 | Comparing schedule performance measures

Measure	What is compared	What needs a separate check
BEI	Counts of actual completions and baseline completions due	Which due activities remain open and whether they drive delivery
SPI	Budgeted value earned and budgeted value planned	Cost weighting, earning rules and the remaining network
SPI(t)	Earned time and elapsed time	Calendar basis, future performance assumptions and network feasibility

10.9 Communicating a decision rather than a collection of indicators

The audience determines the level of detail, but the evidence should remain consistent across views. A sponsor may need the changed completion outlook, principal cause and decision required. A work-package manager may need the affected activities, resources and acceptance conditions. The cost team may need the ETC basis and accounting reconciliation. These are different presentations of connected information, rather than separate versions of the truth. PMI's reporting guidance emphasises stakeholder needs and schedule presentations at appropriate levels (PMI, 2019, pp. 88-91).

A useful performance narrative connects the reporting position, observed change, cause, consequence, response and required decision. It should distinguish established facts from estimates and assumptions. A red indicator with no explanation does not identify what action would help; a favourable index with no

scope or period can create misplaced confidence. Thresholds should reflect the project and the importance of the affected milestone. A small variance on a controlling acceptance event may deserve more attention than a larger variance on non-critical work with substantial flexibility.

A worked performance narrative

For the illustrative project, a concise account would state: at the Week 6 cut-off, earned value is £55,000 against £62,000 planned, with £68,750 incurred. The remaining network forecasts completion at Week 11, one week beyond baseline and half a week later than the previous forecast. Equipment release and installation control the finish. The bottom-up remaining estimate is £58,000, giving EAC of £126,750. The team should validate the possibility of a one-week installation reduction, including resources and acceptance consequences, before proposing recovery. The Week 10 target remains unchanged pending that assessment and the authorised decision.

This narrative identifies both the result and the action that could change it. It does not suggest that CPI of 0.80 is a direct measure of time delay or that the 10.91-week earned-schedule estimate overrides the network. Supporting records would include the current instance, previous comparison, source progress evidence, resource assumptions and forecast basis. The report should also identify any missing or provisional data whose resolution could materially change the conclusion. Transparency about such limits improves the decision; hiding them behind a precise number does not.

Australia's 2026 Snowy 2.0 audit illustrates the difference between aggregate progress and completion outlook. ANAO distinguished weighted S-curve progress from risk-adjusted and acceleration-adjusted forecasts. It reported that public figures of 67% completion in October 2025 and 70% in February 2026 did not adequately reflect recognised delay risk because the measure was not linked to work criticality or project risk. ANAO recommended regular schedule reporting against published targets; Snowy Hydro partly agreed. The lesson is to explain the percentage basis alongside the milestone outlook, rather than treat the percentage as a duration forecast (ANAO, 2026, paragraphs 4.34-4.45).

What recent research adds to professional judgement

De Andrade, Vanhoucke and Martens examined forecasting accuracy using a database of 100 projects. Their regularity indicator, based on the planned-value profile, improved categorisation of expected forecasting accuracy compared with the approaches studied, although sector and size affected performance. The implication is to inspect the shape of the baseline and relevant historical evidence before assuming that an index-based forecast will be dependable. The study does not establish one universally superior formula (de Andrade, Vanhoucke and Martens, 2024).

Aramali and colleagues studied the environment in which EVMS operates, testing a framework on 35 completed US projects and programmes. Stronger assessed environments were associated with some cost outcomes, but the study did not establish significant schedule-growth differences or causality. Its practical contribution is to direct attention to people, practices and resources alongside calculations. Reliable reporting requires an operating environment in which evidence is collected, challenged and acted upon; installing an EVM dashboard alone does not establish that capability (Aramali et al., 2024).

Thiele, Abbasi and Ryan tested a proposed normalised baseline representation on six completed projects, reporting useful schedule indications while identifying further work on cost results. Their approach combined earned-value and earned-duration methods to examine variation in forecasting signals. This is a small retrospective demonstration, not a general accuracy guarantee. It supports questioning how the baseline's shape affects an indicator. The paper's Earned Duration Management method is distinct from this chapter's ED abbreviation for Estimated Duration (Thiele, Abbasi and Ryan, 2025).

Preserve the record and the decision trail

Archive the issued schedule instance with its data date, calculation settings, baseline reference and supporting narrative. Retain the changes to remaining durations, logic, calendars and resource assumptions, together with their reasons and approval status. The next update can then distinguish continuing trends from reporting corrections or model changes. GAO's Schedule Assessment Guide similarly connects actuals, remaining work, out-of-sequence review, versioned schedules and explanatory narratives (GAO, 2015, Best Practice 9). The quality of the record determines whether later analysis can reconstruct what was known at the time.

Routine updating, a revised forecast and an authorised change are related but different events. This chapter has focused on measuring and explaining the position. Chapter 11 examines change control, recovery and delay analysis in greater depth. For PMI-SP preparation, practise identifying the evidence required, applying the correct formula and then deciding what the result does and does not establish. The strongest answer usually connects the metric to the work and the decision, rather than selecting a familiar calculation without considering its assumptions.

PMI's current certification resources continue to link the 2012 Examination Content Outline. This chapter particularly supports Schedule Monitoring and Controlling and stakeholder communication; the published 35% weight belongs to the monitoring and controlling domain, not to this chapter alone (PMI, 2012; PMI, n.d.). The following original practice questions use the chapter's assumptions and are not official PMI examination items.

Knowledge check and examination practice

Select the best answer in each case. Monetary values in the calculation questions use the same scope, baseline and reporting cut-off. Retain the distinction between budget units, elapsed time and dimensionless indices when explaining the result.

Question 1: validating the reporting cut-off

A Friday close-of-business update includes an actual finish dated the following Tuesday because the package manager is confident the work will be complete then. What should the scheduler do?

A Retain the actual because the package manager accepts responsibility.
B Record Friday as the finish so the activity does not remain in the past.
C Treat Tuesday as a forecast, obtain Friday's actual status and retain an actual finish only when the event has occurred.
D Move the baseline finish to Tuesday.

Question 2: interpreting three completion percentages

An activity has four elapsed working days, six days remaining, 60 accepted units out of 100, and 400 hours used with 100 hours remaining. Which statement is best?

A The three percentages must be averaged to obtain the true completion.
B Duration is 40%, physical completion is 60%, and the stated effort convention gives 80%; each describes a different basis.
C The activity is 80% physically complete because actual hours are objective.
D Remaining duration must be reduced to four days because physical completion is 60%.

Question 3: out-of-sequence progress

At day 6, A has four days remaining. Its finish-to-start successor B actually began at day 4 and has three days remaining. Under the chapter's retained-logic assumptions, what is B's forecast finish and the appropriate treatment of its actual start?

A Day 9; move B's actual start to day 6.
B Day 10; delete the dependency without investigation.
C Day 13; move B's actual start to day 10.
D Day 13; preserve the verified actual start and investigate the dependency and remaining work.

Question 4: interpreting earned-value results

At Week 6, PV is £62,000, EV £55,000 and AC £68,750. Which statement is correct?

A CPI is 0.80 and SV is -£7,000; the latter does not directly establish days of delay.
B CPI is 1.25 and the project is seven weeks late.
C SPI is 0.80 and physical progress is 68.75%.
D CV is -£7,000 and the project has spent less than the earned value.

Question 5: the numerator in a required-efficiency calculation

Using BAC of £100,000, EV £55,000, AC £68,750 and a selected EAC of £125,000, which calculation correctly gives TCPI to that EAC?

A (£125,000 - £55,000) / (£125,000 - £68,750).
B £55,000 / £68,750 because every TCPI equals historical CPI.
C (£100,000 - £55,000) / (£125,000 - £68,750), giving 0.80.
D (£100,000 - £68,750) / (£125,000 - £55,000).

Question 6: deriving earned schedule

Baseline PV is £48,000 at Week 5 and £62,000 at Week 6. At actual time six weeks, EV is £55,000. Assuming linear interpolation, what are ES and SV(t)?

A ES is six weeks and SV(t) is zero.
B ES is 5.5 weeks and SV(t) is -0.5 weeks.
C ES is £55,000 and SV(t) is -£7,000.
D ES is 6.5 weeks and SV(t) is +0.5 weeks.

Question 7: completion after the baseline finish

Unchanged authorised scope with a ten-week baseline is fully completed at Week 12. EV and PV both equal BAC. Which interpretation is correct?

A SPI of one proves that the project finished on time.
B The remaining duration must be two weeks because SV(t) is -2 weeks.
C The baseline should be deleted because conventional SV is zero.
D Conventional SPI is one, while SPI(t) is 10/12 and SV(t) is -2 weeks; actual remaining duration is zero.

Question 8: choosing an effective recovery investigation

At Week 6, equipment release takes two weeks followed by two weeks of installation. Controls takes three weeks in parallel, and one week of integration follows both branches. Which statement is best?

A Completion forecasts Week 11; reducing installation by one feasible week could achieve Week 10, whereas reducing controls alone from three to two weeks would not improve the finish.
B All durations should be added, giving completion at Week 14.
C Completion is guaranteed at Week 10.91 because the earned-schedule calculation gives that result.
D Reducing any one activity by one week always improves project completion by one week.

Answer explanations

1: C. An actual finish records an event that has occurred by the cut-off. Confidence in a future event makes it a forecast, not an actual. The scheduler should establish the package's Friday position and its remaining work, then preserve the forecast separately. Neither changing the historical cut-off nor moving the baseline resolves the underlying evidence issue.

2: B. The three calculations are 4/(4 + 6), 60/100 and 400/(400 + 100). Their denominators concern duration, accepted units and the current effort estimate respectively. They cannot be averaged into a meaningful universal percentage. Remaining duration requires its own assessment of work, capacity, calendars and constraints; it is not automatically determined by the physical percentage.

3: D. A finishes at day 10 under the stated remaining estimate. Retained logic then allows B's three remaining days to proceed to day 13. Its genuine day 4 start remains part of the history. The team should investigate why B began before A finished and whether the original activity definitions and dependency adequately represent the remaining work.

4: A. CPI is 55/68.75 = 0.80. Schedule variance is 55 - 62 = -7 in £000. It compares earned and planned budgeted work, so its unit is currency rather than time. Actual cost exceeds earned value by £13,750, giving an adverse CV. The network is still needed to establish the effect on completion.

5: C. Remaining budgeted work is BAC minus EV, or £45,000. The cost allowance remaining to the selected EAC is £56,250, producing TCPI of 0.80. EAC changes the denominator, not the authorised budgeted value of unfinished scope. The equality with cumulative CPI occurs here because the selected EAC is the CPI-persistence forecast; it is not a universal identity for every target.

6: B. Earned value is £7,000 above Week 5's PV within an interval whose planned increase is £14,000. The interpolation fraction is 0.5, making ES 5.5 weeks. Subtracting AT of six gives SV(t) of -0.5 weeks. These values describe the aggregate earned-time position, not an independently established half-week delay to every milestone.

7: D. At this late completion point, EV and PV have both reached BAC, so ordinary SPI is one and ordinary SV zero. Earned schedule reaches PD of ten weeks, compared with twelve actual weeks, preserving the two-week difference. All required work is complete, so remaining duration is zero; a historical variance is not unfinished work.

8: A. The two branches take four and three weeks respectively, followed by one common integration week. Remaining duration is five weeks, giving Week 11 completion. Reducing the shorter branch does not change that result. A feasible one-week installation reduction would make both branches three weeks and produce four weeks remaining. Its feasibility, cost and acceptance consequences must be established before it becomes an approved recovery plan.

References and further reading

PMI citations use printed pages in the third edition. Dated case statements describe the reporting position of their sources. All diagrams, worked datasets, scenarios and examination questions in this chapter are original teaching material.

Aramali, V., Gibson, G.E., Jr., El Asmar, M. and Sanboskani, H. (2024). 'An Effective Earned Value Management System (EVMS) is a Team Sport'. *Project Management Journal*, 55(4), pp. 389-405. https://doi.org/10.1177/87569728231226226.

Australian National Audit Office (ANAO) (2026). *Delivery of Snowy 2.0*. Auditor-General Report No. 39 of 2025-26, 18 June. Especially paragraphs 4.34-4.45. Official audit.

Cour des comptes (2025). *Le Grand Port Maritime de Nantes Saint-Nazaire*. Report S2025-0963, published 2 September. Especially section 3.3.2, pp. 94-96. Official audit.

de Andrade, P.A., Vanhoucke, M. and Martens, A. (2024). 'An empirical project forecasting accuracy framework using project regularity'. *Annals of Operations Research*, 337(2), pp. 501-521. https://doi.org/10.1007/s10479-023-05269-7.

Deutsche Bahn (2026a). *Nach Korridorsanierung: DB nimmt Nordabschnitt der Strecke Hamburg-Berlin wieder in Betrieb*. 15 May. Operator announcement.

Deutsche Bahn (2026b). *Bahnstrecke Hamburg-Berlin nach Korridorsanierung wieder in Betrieb*. 14 June. Operator announcement.

National Audit Office (NAO) (2024). *Decommissioning Sellafield: managing risks from the nuclear legacy*. HC 233, 23 October. Especially Figure 10.9, p. 31, and paragraph 2.15, p. 32. Official audit.

Project Management Institute (PMI) (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Especially pp. 5-6, 9 and 10. Official outline.

Project Management Institute (PMI) (2019). *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: PMI. Core coverage: sections 3.3.1-3.3.3, 3.4.6, 3.4.12, relevant section 3.5 reporting guidance, and progress/EVM/earned-schedule components in section 4. Formal definitions cite their printed pages individually.

Project Management Institute (PMI) (n.d.). *PMI Scheduling Professional (PMI-SP)*. Current certification resources. Official certification page.

Roads and Transport Authority, Dubai (RTA) (2026). *Mohammed bin Rashid launches tunnelling works for Dubai Metro Blue Line*. 3 May. Official announcement.

State Information Service, Egypt (2026). *State continues integrated urban projects to improve citizens' quality of life*. 11 April. Official report.

Thiele, B., Abbasi, A. and Ryan, M.J. (2025). 'Improving project forecasting accuracy by developing the Normalised Project Management Baseline'. *KSCE Journal of Civil Engineering*, 29(4), 100066. https://doi.org/10.1016/j.kscej.2024.100066.

US Department of Energy (DOE) (2014). *EVMS Training Snippet Library: IMS Monthly Review*. Snippet 3.1B, July, p. 14. Official training material.

US Department of Energy (DOE) (2019). *DOE EVMS Gold Card*. Version 20190710, 10 July. Single-sheet equations and terminology. Official resource.

US Department of Energy (DOE) (2020). *Earned Value Management System (EVMS) and Project Analysis Standard Operating Procedure*. DOE-PM-SOP-05-2020, 14 January. Especially section 2.4.1.1, pp. 15-17, and forecast analysis, pp. 22-25. Official procedure.

US Department of Energy (DOE) (2022). *Integrated Project Management Using the Earned Value Management System*. DOE G 413.3-10B, 20 April. Especially pp. 44-46 and 51. Official guide.

US Government Accountability Office (GAO) (2015). *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, 22 December. Especially Best Practice 9, pp. 121-132. Official guide.

US Government Accountability Office (GAO) (2025). *Modernizing the Nuclear Security Enterprise: Opportunities Exist to Better Prepare for Delay in New Uranium Processing Facility*. GAO-25-107330, 18 September. Especially pp. 16-19. Official audit.

CHAPTER 11

Controlling Change, Recovering Delivery and Analysing Delay

From a changed forecast to a defensible decision

A project rarely proceeds exactly as first planned. A revised requirement may introduce new work, an approval may arrive late, a supplier may offer an alternative sequence, or a team may discover that its original productivity assumption was optimistic. Each situation can change the schedule, but each calls for a different decision. Reporting a later forecast does not itself authorise additional scope. Recovering a milestone does not remove the need to record what caused the pressure. Approving a revised baseline does not erase earlier performance. Professional scheduling connects these distinctions so that a credible model supports a controlled response.

This chapter develops the judgement needed to evaluate change, compare recovery options and investigate delay. A single independent worked example follows a proposed technical review through a logic-linked network and then tests the cost of recovering its effect. A second example explains why the effects of two events cannot always be added. The calculations are deliberately transparent: learners can see the assumptions, reproduce the arithmetic and challenge the conclusions. They are original teaching examples, rather than accounts of a named project's performance or contractual responsibility.

The chapter develops sections 3.1.2.12 and 3.3.4-3.3.8 of PMI's scheduling standard, the Change Request Identifier component in section 4, and all five forensic approaches in Appendix X5. Its professional emphasis is on proportionate evidence, traceable decisions and realistic delivery. Learners preparing for the PMI-SP examination should be able to select the next appropriate control action, distinguish compression techniques and recognise the limitations of a delay analysis. At Level 6, they should also be able to defend a recommendation when several technically possible responses compete for limited money, access, capacity and management attention.

The chapter framework: recognise, preserve, model, compare, authorise and monitor

The original framework in Figure 11.1 treats change control as a connected decision process. Recognise what has changed and classify the decision required. Preserve the evidence and the relevant schedule versions before testing alternatives. Model the effect on the work and its interfaces. Compare feasible responses against delivery objectives, cost and uncertainty. Obtain the necessary authority for the chosen response. Finally, monitor whether the response achieves its intended effect and retain the record. These stages can repeat: new evidence may alter the model, and an unachievable recovery proposal should return for reconsideration rather than pass through approval unchanged.

Six stages connecting a changed situation to controlled delivery

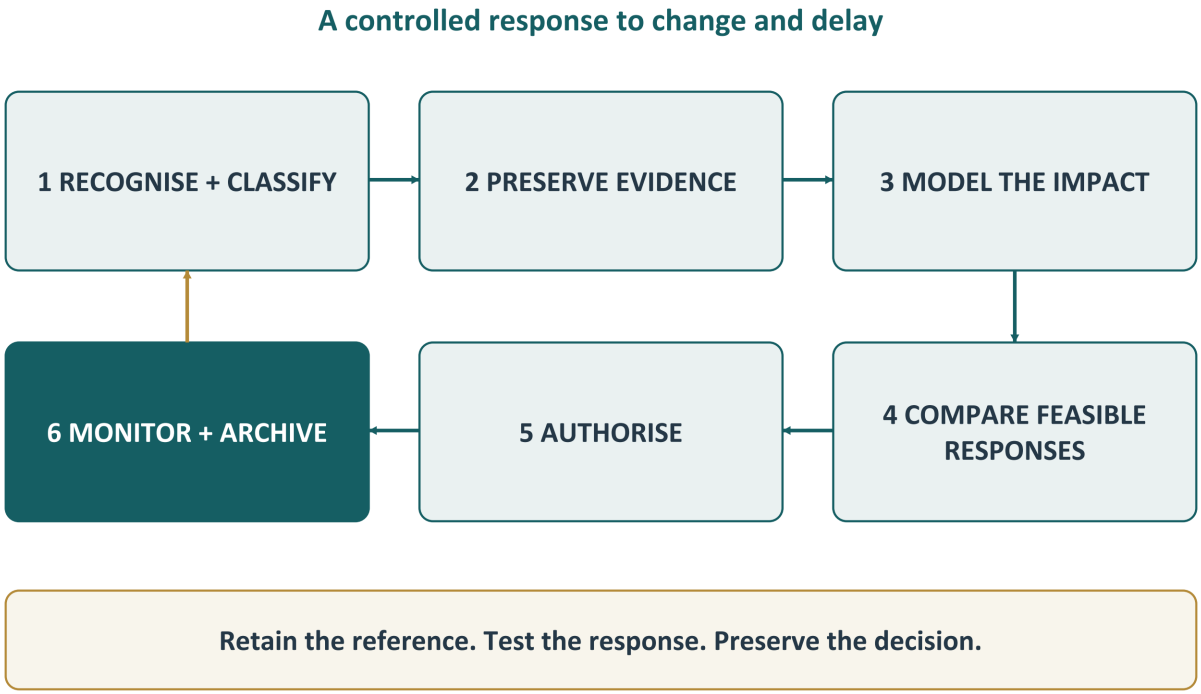


Figure 11.1. An original change-to-decision framework. The control loop preserves the distinction between evidence, analysis, authority and the subsequent outcome.

11.1 Classifying what has changed

Change Control. 'A process whereby modifications to documents, deliverables, or baselines associated with the project are identified, documented, approved, or rejected.' (PMI, 2019, p. 177)

A scheduler should begin by identifying the nature of the information received. A verified actual finish belongs in the routine update. A revised estimate of remaining duration changes the forecast. A proposal to add another operational capability may change scope. An extra crew intended to restore planned performance is a corrective response, subject to the organisation's authority and commercial arrangements. A new approved reference plan is a rebaseline. These categories interact, but treating them as interchangeable allows a routine data entry to acquire the appearance of an approval that nobody actually gave.

Consider an installation activity that needs three additional days because access was more restricted than expected. The current forecast should represent that position honestly once the evidence is validated. Whether the event constitutes a compensable change is a separate assessment. Whether recovery should be purchased is another decision. Whether the baseline should change depends on the applicable governance and approval, rather than on the embarrassment of reporting an adverse variance. A useful schedule therefore holds the present prediction alongside the relevant approved references, instead of forcing every date to tell the same story.

Table 11.1 | Distinguishing changes in the control record

Control situation	What changes in the schedule record	Decision that remains separate
Routine update	Verified actuals, progress and remaining work at an agreed cut-off	Acceptance of the data does not authorise new scope
Forecast revision	The current prediction changes because assumptions or evidence change	Approval of a new contractual date or baseline
Proposed scope change	A controlled scenario shows added, removed or modified work	Authority to implement the proposal and its consequences
Corrective action	A feasible response changes the remaining delivery plan	Spending, resource, technical and commercial approvals
Authorised rebaseline	A new numbered reference reflects an approved basis	Preservation and explanation of earlier commitments and performance

Honest forecasts and controlled commitments

If a change is pending, the team still needs a realistic view of likely delivery. The reporting arrangement may use a current authorised-scope forecast with a separately identified pending-change scenario, or another explicitly agreed convention. What matters is that the scope and approval status of each view are clear. A pending item should not disappear merely because it has not been approved; equally, inclusion in a risk scenario should not imply an instruction to execute it. The schedule narrative should identify which view informs immediate operations and which informs a prospective decision.

PMI's incorporation and maintenance guidance requires the schedule to reflect approved changes and remain useful for the remaining work (PMI, 2019, pp. 69-70). A proposed response must therefore be distinguished from the accepted plan. A supervisor's suggestion to overlap work may be valuable input, but it is not evidence that design releases, resources, access and acceptance arrangements are available. The scheduler's contribution is to make the consequences visible and testable before the organisation commits itself.

Rebaselining is a governed decision

> **Schedule Baseline.** 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and performance measurement baseline.' (PMI, 2019, p. 189)

A baseline is a reference against which performance can be understood. Rebaselining can be appropriate after an authorised material change to scope, delivery strategy or the approved control basis. It should state what is being approved, the effective date, the approving authority and how the new reference relates to earlier ones. It is not an automatic remedy for a poor performance indicator. A team may need a credible remaining plan while still reporting the variance against the original commitment. Those two requirements can coexist.

PMI discusses rebaselining and retaining earlier baselines on printed page 69. For responsible implementation, any reset of the active performance reference must be accompanied by a reconciliation of prior performance. The original baseline, intervening approved versions and historical updates remain available. The report should explain the movement between them so that a reader can distinguish authorised scope growth from execution deterioration, changed assumptions and correction of an earlier modelling error. A favourable new variance is meaningful only when the change in its reference is visible.

UK government guidance reinforces this distinction. GovS 002 requires identifiable change requests, assessment of their implications and an implementation plan before authorisation. It also addresses traceability and the identification of controlled versions. These requirements support a clear connection between an agreed reference, continuing forecasts and approved modifications; they do not make every update a new commitment (Government Project Delivery, 2025, sections 7.2.5 and 7.7-7.9).

England: HS2 and the work behind a reset

The National Audit Office's June 2026 report on the London-Birmingham HS2 programme examined a reset begun in January 2025 while construction continued. It found that significant work remained on a robust cost and schedule baseline, commercial renegotiations, Euston plans and organisational capability. The report recorded an aim to complete the reset in spring 2027, rather than an achieved completion. Its recommendation was to establish confidence that the arrangements could deliver before implementing the reset plans. The scheduling lesson is that revising a date is only one part of rebuilding a credible control basis; scope, commercial arrangements, capability and delivery assumptions must fit together. These are findings at the report date, not a statement of the programme's eventual outcome (NAO, 2026).

11.2 Preserving the evidence and identifying the authority

> **Change Request Identifier.** 'The primary key value for items in the program change log as related to the schedule model.' (PMI, 2019, p. 177)

The identifier connects the schedule consequence to the decision record. In the component guidance, PMI treats it as an optional, manually entered alphanumeric field (PMI, 2019, p. 109). Optionality in the standard's component classification does not mean that traceability is unimportant. A project may require the field through its own controls procedure. A reference such as CR-017 can link affected activities, a technical instruction, the proposal, the impact analysis, approval conditions and the implemented revision. Where several changes affect one activity, the information structure must preserve each relationship rather than overwrite an earlier reference with the latest one.

The analysis should start from an identifiable schedule instance. Record its data date, version, scope basis, calendars, calculation settings, progress position and material assumptions. Save the unmodified instance before creating a scenario. The scenario then receives its own name and change references. A comparison between two files is only useful if the analyst can explain the differences. If calendars, duration estimates and resource settings change at the same time as the proposed event, the resulting movement cannot confidently be attributed to that event alone.

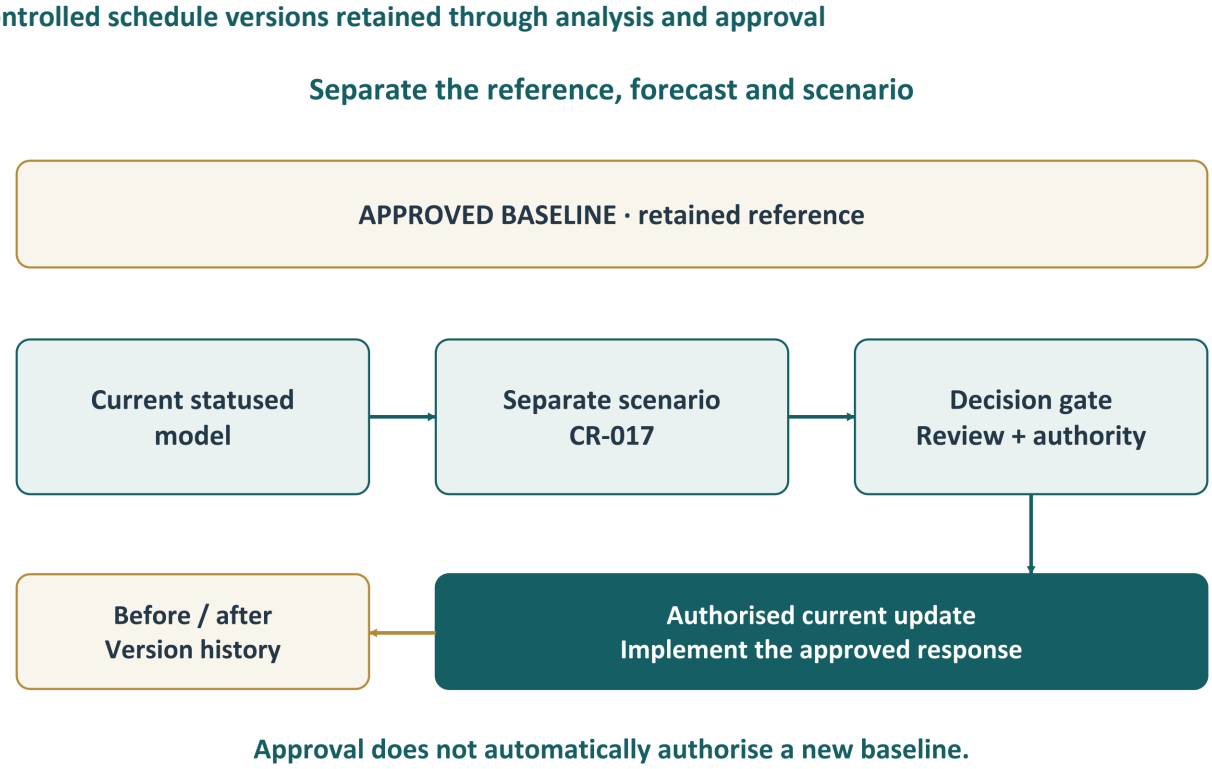


Figure 11.2. Scenario analysis creates a controlled branch from an identified model. Approval may authorise an update, a recovery action, a baseline revision or a combination; these are distinct decisions, and earlier versions remain available.

Records that establish a usable chronology

A reliable chronology distinguishes when an event occurred, when it was discovered, when it was communicated, when a decision was required and when it was made. An email date is not necessarily the start of the physical effect. A drawing revision can exist before it reaches the people using it. An instruction can be issued while access remains unavailable for an unrelated reason. Recording these distinctions helps the analyst connect documentary events with actual work rather than assuming that a sequence of messages is a sequence of delay.

PMI's forensic guidance identifies schedule records alongside correspondence, daily reports, meeting minutes, instructions, requests for information, change records and other supporting material (PMI, 2019, pp. 166-168). Their value lies in their connection. A daily report describing an idle crew becomes more informative when it identifies the location, planned task, missing prerequisite and alternative work considered. Photographs may establish a visible condition but require a reliable date, location and interpretation. Interviews can clarify gaps, but recollection should be tested against contemporaneous records rather than silently treated as equivalent evidence.

Table 11.2 | Records that support a defensible chronology

Record group	Question it helps answer	Limitation to address
Instructions, requests and approvals	What was requested, by whom, and when?	The document alone may not establish implementation or impact
Daily records, quantities and access logs	What work could and did occur at the affected location?	Completeness, timing and consistent activity mapping
Baselines and periodic updates	What was planned and forecast at each relevant point?	Model quality, approval status and unexplained changes
Resource and cost records	What capacity was available and what expenditure occurred?	Cost or attendance does not by itself prove productive output
Decision and issue records	What options were considered and what was authorised?	Decision date, scope, conditions and follow-through

Notice, technical approval and commercial authority

Projects operate within different authority structures. Technical acceptance may permit a design to proceed without approving additional expenditure. An internal change board may approve a business decision without modifying a construction contract. A client representative may receive a report without having authority to instruct acceleration. The scheduler needs to know who can make each decision and when it is needed. The schedule can then include the necessary review and approval activities rather than hiding them in a narrative or assuming that a request will be answered immediately.

Contractual notices require the relevant clause, recipient, form, timing and particulars to be checked. A general progress report may not satisfy those requirements. Conversely, issuing a notice does not by itself establish the merit or value of a claim. As a contract-specific US example, FAR 52.243-4 addresses changes instructed by a contracting officer and associated adjustment procedures. Its provisions cannot be transplanted into every project or jurisdiction; the applicable contract and authorised roles determine the required action (US Federal Acquisition Regulation, clause 52.243-4).

The Society of Construction Law's 2017 Protocol offers guidance on records and timely assessment, but it does not replace contractual terms or governing law. Its selection of delay-analysis methods also depends on circumstances, particularly whether the assessment is contemporaneous or distant from the event. This chapter uses that distinction as a professional caution, while retaining PMI's five broad forensic families for teaching (SCL, 2017, Introduction and Guidance Part B, sections 1, 4 and 11).

11.3 Modelling a proposed change without contaminating the comparison

The first analytical question is precise: what would change in the identified schedule if this proposal were implemented under the stated assumptions? It is narrower than asking who is responsible or what compensation should be paid. The modeller identifies the affected work, represents the new or changed dependencies and recalculates the relevant milestones. The result is conditional on the model, its status and the event assumptions. A two-day activity can produce no completion movement, a two-day movement or a more complex effect through calendars, resources and interfaces.

A small logic-linked group inserted to represent an event is often called a fragment or fragnet in professional practice. It should describe real work or waiting conditions with a defensible duration and

explicit connections to the existing network. The entry point explains what must have happened before the event can occur; the exit point explains what work it prevents or releases. New resource requirements, access windows and acceptance conditions belong in the analysis. A disconnected bar labelled 'delay' does not establish how the event influences delivery.

A self-contained change example

An equipment integration package is assessed at the beginning of working day 10. All earlier work is outside this remaining-work example and remains unchanged. The model uses a single working calendar, finish-to-start relationships with zero lag and distinct available crews. Day numbers are elapsed working-day boundaries: an activity starting at day 10 with a duration of three finishes at day 13. No resource levelling, external date constraints or uncertainty allowances are included. In this deliberately simple example, the current forecast and the approved milestone both finish at day 24 before the proposed change.

The main branch consists of technical release A, fabrication B and installation C. A parallel branch consists of controls preparation D and controls verification E. Both branches must finish before integrated acceptance F can begin. Proposed change CR-017 adds a two-day technical review R after A and before B. The review is a prospective requirement known before this remaining work starts; the example does not alter an actual date or retrospectively insert work into completed history.

Table 11.3 | The effect of change CR-017 on the example

Activity	Duration and immediate predecessor	Current start-finish	With CR-017
A: Technical release	3 days; data date	10-13	10-13
R: Additional review	2 days; A; proposed only	Not present	13-15
B: Fabrication	5 days; A, replaced by R if approved	13-18	15-20
C: Installation	4 days; B	18-22	20-24
D: Controls preparation	5 days; data date	10-15	10-15
E: Controls verification	6 days; D	15-21	15-21
F: Integrated acceptance	2 days; C and E	22-24	24-26

Without the review, the two branches before F take 3 + 5 + 4 = 12 days and 5 + 6 = 11 days. Remaining duration is therefore max(12, 11) + 2 = 14 days, giving completion at day 24. With the review, the first branch becomes 3 + 2 + 5 + 4 = 14 days. Remaining duration becomes max(14, 11) + 2 = 16 days, giving day 26. The modelled movement is two working days relative to the same pre-impact position. Here the event lies on the controlling branch, so its two-day duration translates directly into two days at completion.

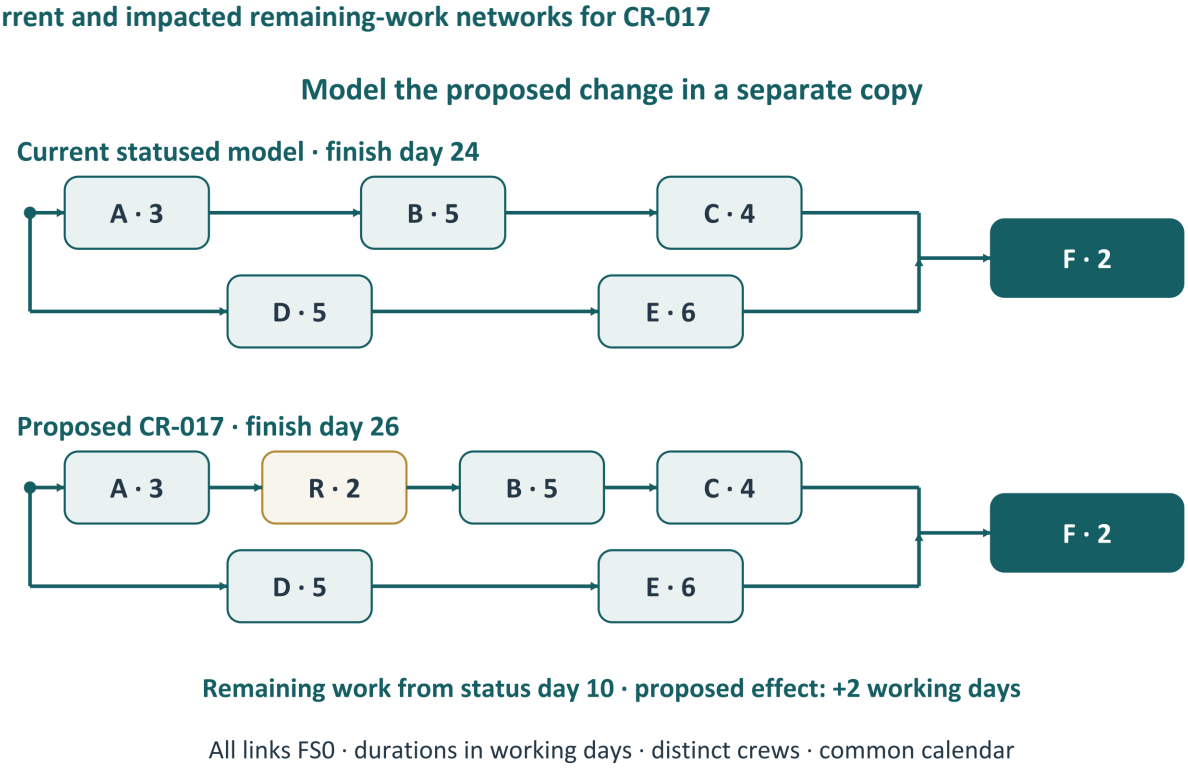


Figure 11.3. The proposed review extends the controlling branch. The comparison holds the cut-off, settings and all unaffected work constant; its result is a modelled time effect, not an allocation of contractual responsibility.

Check the basis before accepting the number

Before presenting the result, the scheduler should test whether the fragment represents the proposal adequately. Does the additional review depend only on A, or must a third party first supply information? Can fabrication begin after a partial release? Does the review change the amount of fabrication or the installation method? Are the reviewer and fabrication capacity actually available in the proposed windows? If an answer changes the model, the two-day result must change with it. Numerical precision cannot compensate for an incomplete event description.

The choice of the comparison model also matters. In this example the current statused model is used to examine a future event. If the event were inserted into an old original baseline despite intervening progress and changed dependencies, the question would be different. It would ask what the event would have done to that original plan. This distinction separates an appropriate prospective time-impact analysis from an impacted-as-planned study. Similar-looking software operations can answer different questions because their starting models and information dates differ.

Add uncertainty without obscuring the central comparison

The two-day review duration is an assumption, not a promise. If it may require rework, the analyst can test a longer duration, an additional review loop or a risk scenario. Keep the central comparison reproducible and identify the alternative assumptions separately. A range can be more useful to the decision-maker than an unsupported single date, but it should explain what causes the range. Do not attach a probability to a completion date unless an appropriate probabilistic analysis supports it.

Interactions require particular attention. A later fabrication start may lose a reserved manufacturing slot, making the effect larger than the inserted review duration. Alternatively, an existing access constraint may absorb the movement without changing installation. An expiring permit or seasonal work window

may create a discontinuity. These possibilities are reasons to inspect the actual project interfaces, not reasons to add arbitrary contingency to every change. Record the assumptions and identify the decision deadline at which the proposed response would cease to be available.

The August 2026 US federal Project Schedule guide specification provides a concrete example: it distinguishes prospective and retrospective analysis, requires fragment connections and restricts unrelated changes in prospective comparisons. Its recovery provisions also require the basis of revised logic, durations and calendars to be explained and extra resources or hours to be evidenced. Such provisions apply through the particular contract as incorporated and amended; they illustrate reviewable analysis without establishing a universal contractual procedure (USACE/NAVFAC/AFCEC, 2026, sections 3.8-3.9).

11.4 Selecting a feasible recovery approach

> **Corrective Action.** 'An intentional activity that realigns the performance of the project work with the project management plan.' (PMI, 2019, p. 177)

Recovery begins with a delivery objective and a diagnosis. The objective might be to restore an approved milestone, protect an operational opening, reduce the duration of a shutdown or limit an emerging delay. The diagnosis identifies what currently controls that objective. Increasing output somewhere else can improve local performance while leaving the relevant milestone unchanged. The scheduler therefore needs to analyse the remaining network, the resources and the decision conditions before recommending acceleration.

Four useful response families are fast tracking, crashing, resequencing and productivity improvement. Their mechanisms differ. Fast tracking overlaps work that would otherwise proceed sequentially. Crashing adds resources to shorten selected durations. Resequencing changes the order or allocation of feasible work. Productivity improvement removes impediments or changes the working method so that output per unit of input improves. A real recovery package can combine them, but the explanation should state which mechanism produces each claimed gain and what could prevent that gain from occurring.

Fast tracking: overlap with a defensible release condition

> **Fast Tracking.** 'A schedule compression technique in which activities or phases normally done in sequence are performed in parallel for at least a portion of their duration. See also crashing and schedule compression.' (PMI, 2019, p. 181)

Overlapping fabrication and installation can be credible when completed, accepted batches release independent work fronts. It is not credible merely because a software relationship is changed from finish-to-start to start-to-start. The model must represent what is released, who confirms its readiness and how the remaining fabrication connects to the remaining installation. If the original activity is too broad to express that logic, decomposing it into meaningful packages may be necessary. The resulting schedule should retain the completion conditions for all required work.

Fast tracking exposes the project to information and interface risk. Installation based on an unstable design may need rework; starting several areas can spread supervisors and inspectors too thinly; partial deliveries can increase handling and temporary storage. The analysis should compare the expected time benefit with these consequences and with the ability to stop or reverse the overlap if a release condition is not met. A genuine hold point should remain visible. Deleting it to obtain an earlier date changes the assurance strategy and requires the corresponding technical authority.

Crashing: additional capacity with a real duration response

> **Crashing.** 'A schedule compression technique used to shorten the schedule duration for the least incremental cost by adding resources. See also fast tracking and schedule compression.' (PMI, 2019, p. 178)

Adding resources can shorten a duration only where the work can use them productively. A second independent testing team may permit parallel tests, whereas doubling the people around one constrained item may add congestion. Overtime may increase available hours but also alter fatigue, supervision, productivity and quality. Specialist equipment may require mobilisation, permits or trained operators before it changes output. These enabling activities belong in the recovery model and its cost estimate. A recovery plan that starts delivering benefits before the extra capacity can arrive is internally inconsistent.

The least incremental cost is assessed against the schedule objective and the feasible alternatives. It does not mean selecting the cheapest activity-level reduction without examining the network. A £2,000 reduction on a non-controlling branch may save no project time, while a £3,000 reduction elsewhere saves a day. After that reduction, another branch may become controlling, changing the next best choice. The cost and critical-path analysis must therefore proceed together, with recalculation after each material change or through a complete search of the defined alternatives.

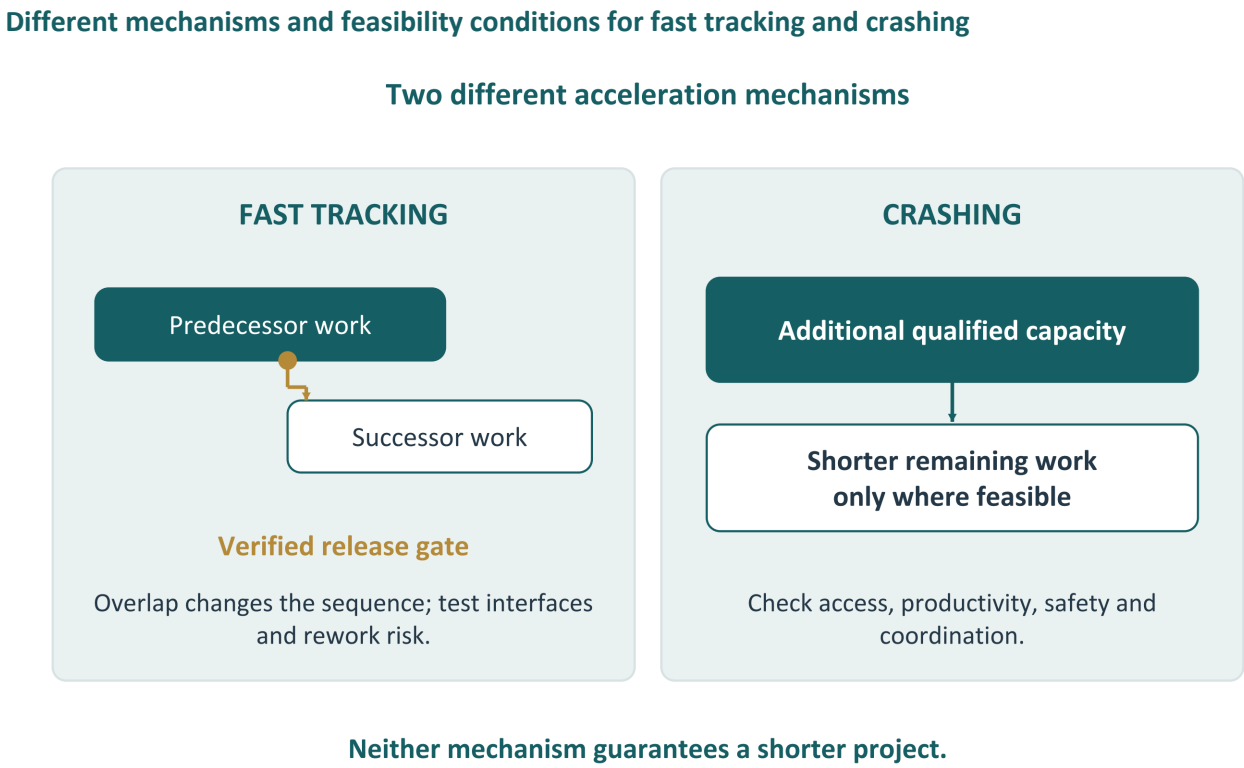


Figure 11.4. Fast tracking changes overlap and release conditions; crashing changes available capacity and achievable durations. Both require a technically credible plan and explicit treatment of their secondary effects.

Resequencing and productivity improvement

Resequencing can protect productive work when the originally planned front is unavailable. A team may complete an independent area first or bring forward an activity whose prerequisites are already satisfied. The benefit depends on access, continuity, mobilisation and downstream interfaces. Changing the order can also create temporary works, return visits or fragmented handovers. A recovery schedule should show these consequences rather than treating every moved bar as an equal unit of saved time. Mandatory physical and safety dependencies remain binding even when discretionary sequencing changes.

Productivity improvement requires an explanation of how the rate will change. Removing repeated material searches, improving workface readiness, standardising an accepted method or resolving information bottlenecks can improve output without simply adding labour. The forecast should use evidence from comparable conditions and allow for any learning or implementation period. An instruction to 'work more efficiently' is not a quantified recovery mechanism. If the current remaining-duration estimate was wrong, correcting it is an estimate revision; it should not be presented as a delivered productivity gain.

Research insight: flexibility has a recovery cost

Borgonjon and Maenhout (2024) model personnel rescheduling with eligible tasks that may pause and resume, including a setup cost for interruption. Their computational study shows benefits from this flexibility in the tested settings. However, it assumes a decision before execution with accurately known parameters. The useful lesson is conditional: interruption and resequencing can expand recovery options, but restarting work has consequences that belong in the model. The study does not establish that a particular construction operation can be interrupted safely or that every rescheduling algorithm produces a globally optimal plan.

Table 11.4 | Comparing recovery responses and their conditions

Response	Source of possible time benefit	Main feasibility question
Fast tracking	Independent portions overlap	What verified information or accepted work releases the overlap?
Crashing	Additional productive capacity shortens duration	Can the work use the capacity, and what is the incremental cost?
Resequencing	Available work is brought forward or interfaces rearranged	Are dependencies, access and return visits represented?
Productivity improvement	Better readiness or method increases effective output	What evidence supports the new rate and its adoption time?

11.5 A worked recovery decision: the cheapest reduction is not always useful

Return to CR-017, which moves the modelled finish from day 24 to day 26. For this illustration, the team identifies four discrete compression opportunities. Fabrication B can be shortened by up to two days at £4,000 per day. Installation C can be shortened by one day at £3,000. Controls verification E can be shortened by one day at £2,000. Integrated acceptance F can be shortened by one day at £6,000 through additional independent testing capacity. A and R cannot be compressed. Each option preserves the required scope and acceptance criteria.

These costs are assumed direct increments, linear only within the stated limits. The extra capabilities are assumed available and independent; no congestion, mobilisation delay or shared-resource conflict is hidden in the example. Those simplifying assumptions would need validation on a live project. Let b, c, e and f represent the selected whole-day reductions in B, C, E and F. The impacted main branch is 14 - b - c days, the controls branch is 11 - e days, and the common acceptance duration is 2 - f days.

Finish day = 10 + max(14 - b - c, 11 - e) + (2 - f). Direct incremental cost in £000 = 4b + 3c + 2e + 6f.

There are 3 × 2 × 2 × 2 = 24 possible combinations because b can be zero, one or two, while the other reductions can each be zero or one. Enumerating them produces the least direct cost for each achievable completion target in the table. This is a minimum within the stated discrete options, not a claim that no other working method could be better. It excludes wider commercial consequences, risk premiums, indirect costs and the value of earlier operation, all of which may matter to the final decision.

Table 11.5 | Least-cost recovery within the defined options

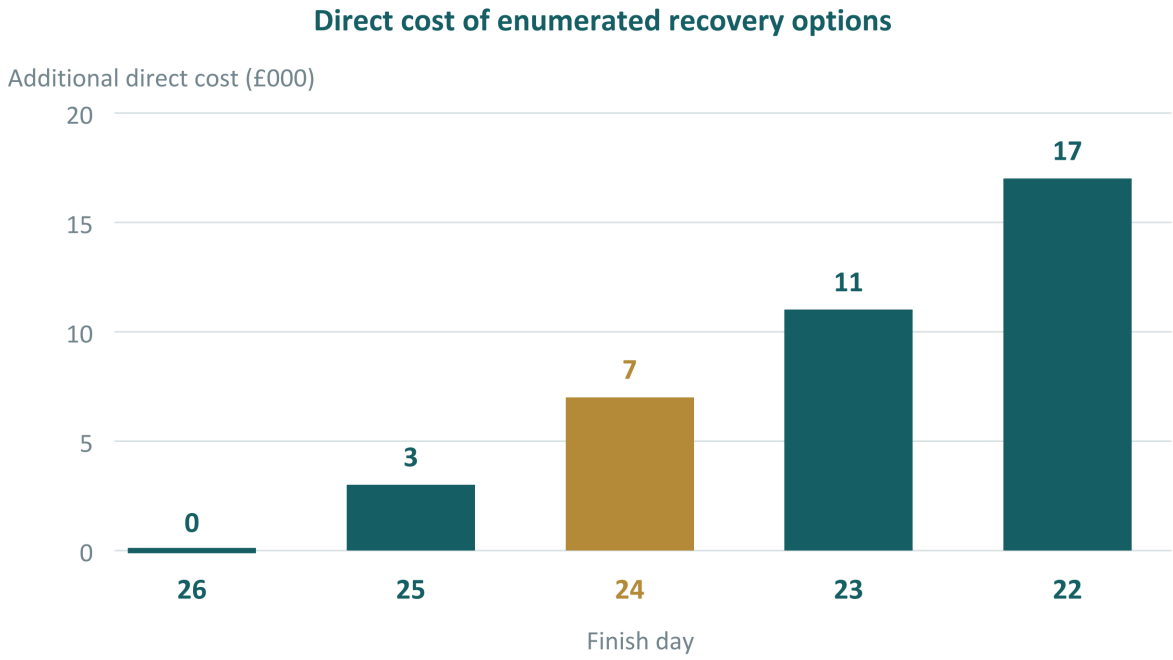
Target finish	Least-cost reductions within the defined options	Direct increment	Reasoning
Day 26	None	£0	Accepts the modelled two-day movement
Day 25	C by 1 day	£3,000	Reduces the controlling main branch by one day
Day 24	B by 1 and C by 1	£7,000	Restores the original milestone at the lowest defined direct cost
Day 23	B by 2 and C by 1	£11,000	Both upstream branches now take 11 days
Day 22	B by 2, C by 1 and F by 1	£17,000	Shortens the common successor after both branches become critical

Why the £2,000 option is not the first recovery choice

Reducing E alone changes the controls branch from eleven to ten days. The fourteen-day main branch still controls the start of F, so the finish remains day 26. The £2,000 may be justified for a different operational reason, but it buys no completion improvement in this model. By contrast, shortening C by one day moves the controlling branch from fourteen to thirteen and the finish from day 26 to day 25. The relevant comparison is the cost of changing the required milestone, not the cheapest reduction attached to any activity.

To restore day 24, shortening B by one day and C by one costs £7,000. Shortening B by two days also reaches day 24 but costs £8,000. Shortening C and the common acceptance activity F by one day each reaches day 24 at £9,000. The selected £7,000 option therefore has the lowest direct increment among the modelled alternatives for that target. If the cheaper combination had a significantly greater execution risk, the final recommendation could differ, but the reason should be explicit rather than hidden in the arithmetic.

Minimum direct cost for each completion target in the defined recovery options



Target day 24: £7,000 · minimum among the enumerated options

Figure 11.5. The recovery frontier for the 24 enumerated combinations. The increasing marginal cost reflects both available compression limits and the changing controlling structure of the network.

The critical path changes as recovery succeeds

Reducing B by two days and C by one makes the main branch eleven days long. The controls branch remains eleven days, so both now control the start of F. Completion is day 23. Reducing only E at this point leaves the main branch at eleven and therefore produces no further finish improvement. A feasible one-day reduction to the common successor F benefits the shared finish and achieves day 22. Under the stated bounds, no combination can improve on day 22 because the main branch cannot be shorter than eleven days and F cannot be shorter than one.

The professional lesson is dynamic. An activity can cease to be the sole controlling concern as recovery is implemented. New critical or near-critical paths require attention, and the apparent benefit of an additional reduction can disappear. A plan that identifies the original critical path once and then accelerates it indefinitely may spend money without gaining time. The scheduler should recalculate, inspect path sensitivity and explain where the next unit of effort would affect the delivery objective.

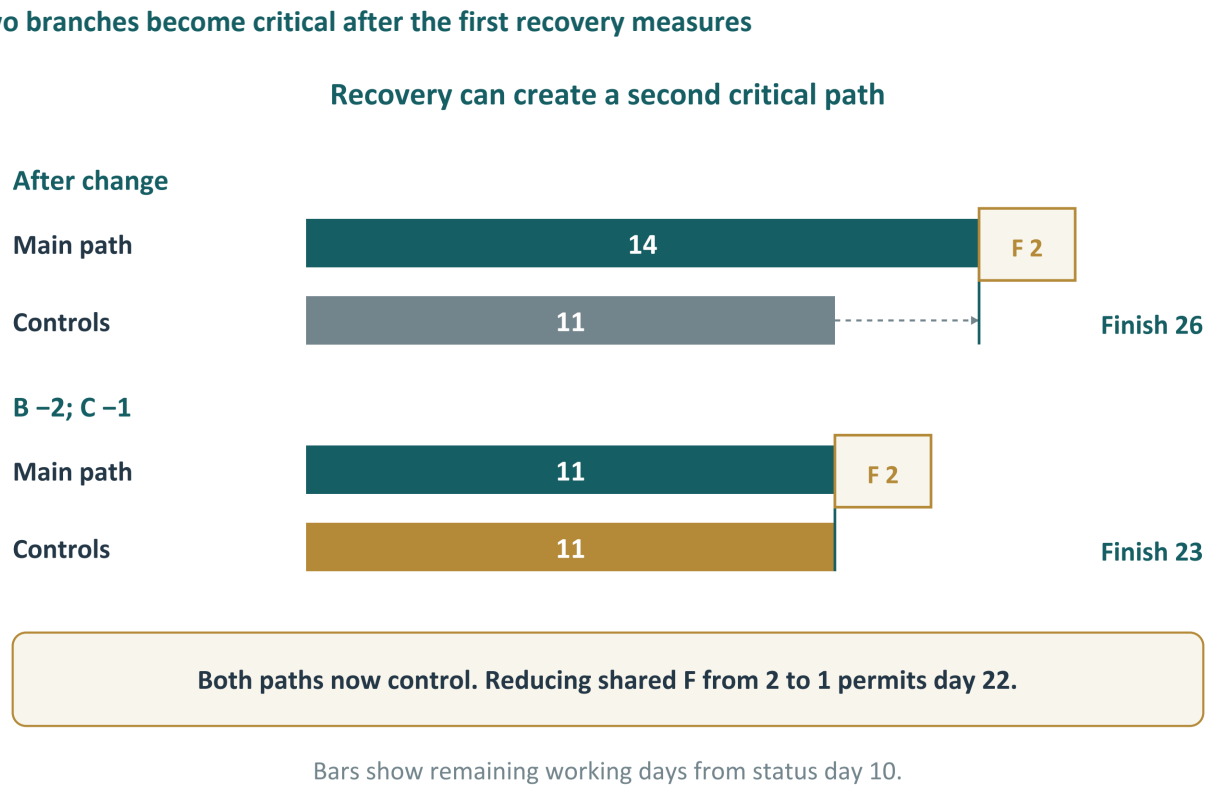


Figure 11.6. Recovery can create multiple critical branches. Once both upstream branches require eleven days, shortening only the controls branch does not move completion; the defined common-acceptance option still can.

From direct cost to a balanced recommendation

The decision-maker needs more than the frontier. A credible recommendation explains the target, the additional resources, their availability, the required approvals, the latest decision date and the residual risk. It also states what is excluded from the estimate. Avoided site overheads or earlier operating benefits may justify a more expensive direct option, but they require their own evidence and consistent time basis. Do not count a benefit twice or treat an unapproved commercial recovery as guaranteed income.

Yılmaz and Dede (2023) investigated time-cost trade-offs using optimisation algorithms on benchmark construction networks, including 18- and 63-activity problems. Their results provide multiple alternatives for balancing duration and cost. This supports comparing a set of options rather than assuming that the shortest possible plan is the preferred plan. The evidence is computational: a mathematically attractive duration still requires field validation of resources, working methods and constraints. The small enumeration in this chapter makes the same decision structure visible without implying that benchmark performance guarantees a feasible recovery on a real project.

For the example, the recommendation might be to authorise one day of B compression and one day of C compression, subject to confirmation of the additional fabrication capacity and installation arrangements, to restore day 24 for a £7,000 direct increment. The decision should also state how the forecast will be monitored and what will trigger escalation. If the capacity cannot be confirmed by the necessary date, the day-24 proposal is no longer the same feasible option. The model and recommendation must then be revised, rather than leaving an obsolete recovery promise in the report.

11.6 Implementing an approved response and preserving accountability

Approval should identify its object. It may approve the technical change, the expenditure, the recovery method, an amended contractual milestone, a revised internal target or a new schedule baseline. One approval does not automatically include all the others. The decision record should state the authorised scope and conditions, identify the affected version and assign responsibility for implementation. Where approval is conditional, the outstanding condition and its required completion date should remain visible in both the control record and the relevant schedule logic.

The scheduler then incorporates the authorised changes into the appropriate current model and verifies that the intended relationships, durations, resources and milestones have been implemented. This verification is more than checking that the finish date matches the proposal. A data import could omit a predecessor, change a calendar or apply an unintended constraint while preserving the same finish by coincidence. Compare the relevant fields and inspect the resulting paths. Record material reasons for changed logic and duration so that a later reviewer can distinguish a deliberate decision from accidental model drift.

Preserve the bridge between versions

PMI emphasises maintaining the schedule model, keeping records of adjustments and communicating approved changes (PMI, 2019, pp. 69-70). A useful version bridge states the opening forecast, verified progress changes, approved scope changes, recovery effects, other assumption changes and the resulting forecast. Where effects interact, the bridge should explain the ordering and avoid presenting dependent movements as independent additions. The original and revised baselines, previous updates and impact scenarios remain available with their effective dates and approval status.

The same discipline applies when a proposed change is rejected or deferred. Its scenario should be retained with the decision, and any resulting exposure should remain visible. Rejection does not necessarily remove the physical condition that prompted the proposal. Deferral can consume the time needed to obtain resources or preserve an access window. Monitoring therefore follows the underlying delivery issue as well as the administrative status of the change request.

France: documented change and successive Grand Palais openings

The French Budget Directorate's April 2026 account describes revised project arrangements in 2020, partial Grand Palais reopening for the 2024 Olympic and Paralympic events, and public reopening of the nave and national galleries on 6 June 2025. Palais de la Découverte works continued in 2026. The account states that deviations from forecasts were documented and identifies additional 2025 funding associated with Olympic-related acceleration and inflation. It is a participating directorate's account, not an independent audit or a calculation of days saved. For scheduling, it illustrates why management changes, acceleration decisions, financial effects and differently scoped opening milestones need separate, connected records (Direction du Budget, 2026).

Verify the recovery outcome

An approved recovery plan is an intention. The next updates should establish whether the extra capacity arrived, the release conditions were met, the expected production occurred and the relevant milestone improved. Leading indicators can reveal failure before the finish slips again: a missed drawing release, an unavailable specialist or a declining acceptance pass rate may invalidate the recovery assumption. These signals should lead to a fresh forecast and decision. They should not be suppressed because the plan has already been presented to senior management.

Recovery also needs a stopping rule. If the required milestone has been protected, continuing expensive acceleration elsewhere may provide little value. If the original target has become technically unattainable, the organisation needs a revised decision supported by evidence. The scheduler should distinguish a stretch objective from the current most credible forecast. Keeping both visible can encourage performance without presenting aspiration as established fact.

A target schedule can be a selected comparison model distinct from the baseline. Report its identity, the variance units and the direction of subtraction so that the comparison is unambiguous. For example, changed finish minus reference finish is positive for a later result and negative for a gain under that declared convention (PMI, 2019, pp. 134 and 136).

USA: Psyche's recovery assessment and later launch

NASA's independent review board assessed Psyche's recovery plan in May 2023 as credible for an October launch while identifying unfinished work. It emphasised an integrated resource-loaded schedule, verification and validation, task milestones and operations readiness; approximately one-third of the three-month margin had already been consumed. This illustrates the breadth of evidence needed to support a recovery date. A separate NASA announcement records the actual launch on 13 October 2023. That later outcome confirms a launch, but does not prove that any single recovery intervention caused it or erase the earlier missed opportunity (NASA Independent Review Board, 2023, slides 12 and 19-21; NASA, 2023).

UAE and Egypt: recovery and completion boundaries

RTA reported the first phase of Dubai's Hessa Street development open on 11 January 2026, while forecasting remaining works for the second quarter. The same announcement described overall progress as 90%. An opened section, an aggregate progress measure and a forecast for unfinished scope therefore represented different information. The source does not establish that phasing was introduced as a recovery measure. Its teaching value is the need to preserve the scope and acceptance boundary of every milestone when considering partial delivery (RTA, 2026).

Egypt's telecommunications regulator reported on 7 July 2025 that traffic had been rerouted following the Ramses Exchange fire and that operators were coordinating restoration. It expected full service restoration within the following 24 hours. The statement distinguishes an incident condition, a recovery action and a forecast at one reporting point; it does not confirm the eventual restoration time. An alternative service route can be part of recovery while repair work continues, so service restoration and full asset reinstatement should remain separate outcomes in the control narrative (NTRA, 2025).

11.7 Explaining delay: event, mechanism, outcome and responsibility

An event and a late finish do not establish a causal connection merely because both occurred. The analyst needs to identify the affected work, explain the mechanism by which it was prevented or slowed, establish its relationship to the controlling work at the relevant time and assess the resulting milestone effect. This chain can involve changing critical paths, resource constraints, access restrictions and mitigation. The analysis must also consider credible alternative explanations. A late drawing may coincide with an unavailable work front that would have prevented the same task from starting anyway.

The word delay is used loosely in everyday reporting. A late activity start, reduced productivity, an extended activity duration and a later project finish are different observations. An activity can start late and still finish within available float. Productivity can deteriorate without moving completion if another path remains longer. Conversely, a short interruption to a controlling acceptance activity can move the

project finish despite strong aggregate progress. State the unit and the affected milestone before discussing the magnitude of the effect.

Evidence chain from an event to a milestone effect and separate contractual assessment

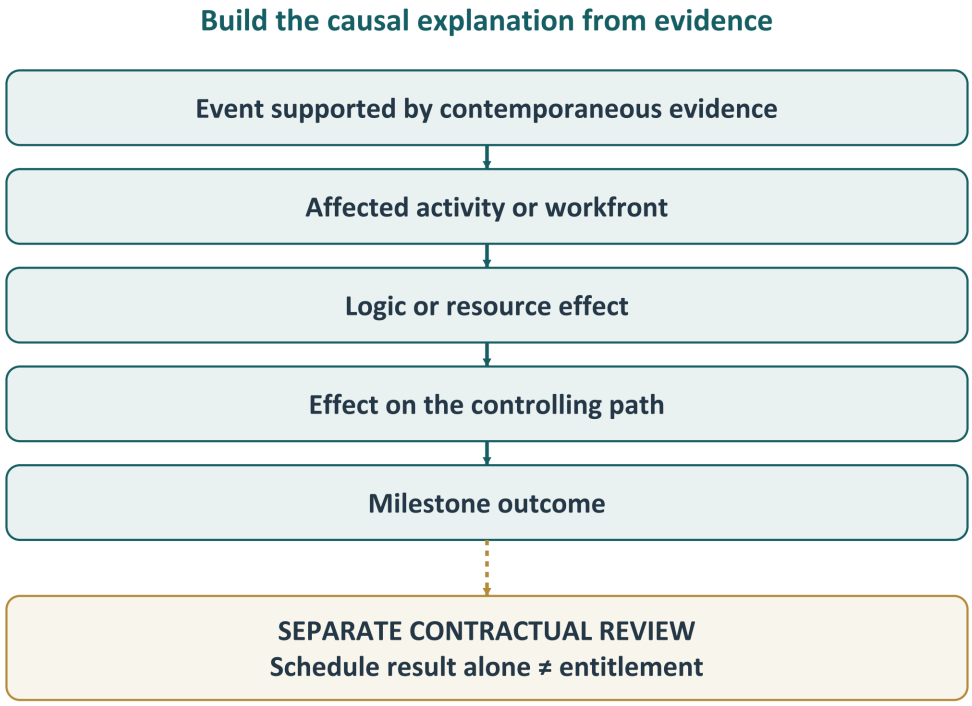


Figure 11.7. An original causal reasoning chain. Technical schedule analysis supports the factual assessment; contractual responsibility, procedural compliance and remedies require their own evaluation.

Float is an analytical quantity with a separate governance context

Available float can absorb an activity movement before the chosen milestone changes, subject to the model's logic, calendars and constraints. The analyst should use the relevant position at the time of the event rather than assuming that the original baseline float remained available throughout delivery. Float may have been consumed by progress, changed dependencies or earlier events. A later recalculation can also reveal that a constraint was creating a misleading value. The narrative should distinguish the calculated effect from assumptions about who may use float under the applicable arrangements.

Ownership of float and the consequences of its consumption are contractual and governance questions. The schedule should not silently resolve them by allocating every day to a party. Different milestones may also have different controlling paths: an event can affect a sectional completion without affecting overall completion, or the reverse. The analysis boundary must match the decision under consideration. A single project finish date is not an adequate substitute for all relevant delivery and contractual milestones.

Why event effects cannot always be added

Consider a separate simplified model with two parallel paths joining at completion. Path P takes ten days and path Q eight, so the base finish is day 10. Event X adds three days to P, producing a finish at day 13 when considered alone. Event Y adds four days to Q, producing a finish at day 12 when considered alone. If both occur, the paths take thirteen and twelve days, so completion remains day 13. The combined movement is three days, although the separate movements are three and two. Adding them would incorrectly report five days.

Order also affects a sequential comparison. Introducing X first moves completion by three days; introducing Y afterwards adds no further movement. Introducing Y first moves completion by two days; adding X then adds one. Starting from the combined model and removing X moves completion from day 13 to day 12, whereas removing Y leaves it at day 13. These are answers to different counterfactual questions. None of these arithmetic results allocates legal responsibility or establishes a rule for contractual concurrency.

Interaction of two events on parallel paths

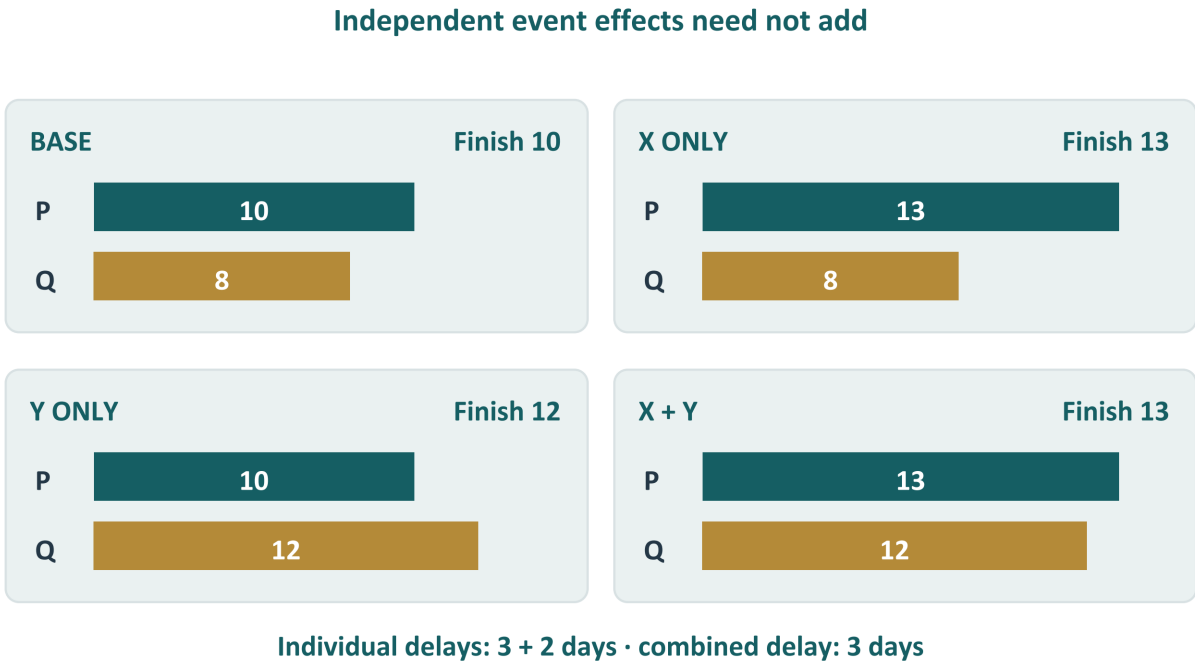


Figure 11.8. Separate event effects are not necessarily additive. The example demonstrates network interaction and the importance of the comparison basis; it does not determine legal concurrency or entitlement.

Concurrency, disruption and the limits of a schedule result

Two events occurring during the same calendar period are not automatically concurrent causes of the same completion delay. Their timing, effective influence on the controlling work and applicable contractual treatment need examination. The analyst should show which events affected which work and when, rather than using a broad label to replace the causal explanation. Where several reasonable modelling choices produce materially different results, present the sensitivity and identify what additional evidence could resolve it.

Disruption concerns the effect on working efficiency and may require quantity, labour, location and method records beyond the schedule alone. A project may suffer disruption while maintaining its finish through additional resources, or finish late for reasons unrelated to the particular productivity loss being claimed. Time and money therefore need connected but distinct analyses. This chapter does not prescribe a universal entitlement rule: the purpose is to make the scheduling evidence sufficiently clear for the authorised commercial and legal assessment to use it responsibly.

Australia: several explanations do not constitute a forensic allocation

The NSW Audit Office's March 2026 report records the opening of Sydney Metro's city-tunnel section on 19 August 2024 and a then-forecast 2026 Bankstown service. It reports Sydney Metro's explanations for cost increases, including pandemic-related resequencing, weather, procurement conditions, additional scope, industrial action and legacy assets. It also identifies a gap in consolidated public reporting of cost, budget and scope changes. These are relevant issues to investigate, but a list of factors is not an event-by-event allocation of critical delay or liability. Comparable schedule versions and linked evidence are needed to examine the mechanisms (Audit Office of New South Wales, 2026, p. 19).

11.8 The five forensic approaches in PMI Appendix X5

Forensic analysis examines schedule evidence to understand the effect of events on delivery. It is not one fixed software command. PMI identifies five broad approaches: as-planned versus as-built, periodic or windows analysis, time-impact analysis, collapsed as-built and impacted as-planned (PMI, 2019, pp. 165-166). Their names signal different starting models and operations. Selecting a method requires attention to the question, the period, available records, model reliability and any applicable contractual requirements. The apparent sophistication of a calculation does not overcome weak source information.

As-planned versus as-built

This approach compares what the plan showed with what actually occurred. It can reveal differences in activity dates, sequence, duration and milestone achievement at a summary or detailed level. A clear comparison is useful for identifying where investigation should concentrate and for communicating the broad delivery history. Its credibility depends on a meaningful scope mapping: an original activity may have been split, replaced or substantially changed, so matching names alone may be misleading.

The principal caution is causation. A bar that finished ten days later than planned does not establish that a particular event caused ten days of project delay. The controlling work may have changed, other events may have intervened, or the original plan may have been unrealistic. The comparison should therefore be supported by evidence about what happened and why. It is strongest as an organised view of differences and their investigated explanations, rather than as an automatic allocation of every variance to a single cause.

Periodic or windows analysis

This family examines delivery through successive periods, using schedule updates and supporting records to understand changes in the controlling work and forecast. Dividing the history into windows can reveal a path that was important early but ceased to control later, or a recovery measure that offset an earlier movement. The periods may reflect reporting cycles or meaningful project events, but their selection should be explained. Window boundaries can affect interpretation, particularly when an event begins in one period and its consequences emerge in another.

PMI's category is broad and does not prescribe one universal calculation algorithm. The analyst should specify how each window's critical path is established, whether contemporary forecasts or reconstructed as-built information are being used, and how corrections to unreliable updates are treated. A month-to-month change in the reported finish can include progress, revised assumptions, scope change and recovery. It cannot simply be relabelled as the delay caused by one event without examining those components. Preserve both the source updates and any justified analytical corrections.

Time-impact analysis

A time-impact analysis models the effect of an event by introducing its logic-linked work into an appropriate schedule and comparing the resulting position with the pre-impact case. For a prospective assessment, a validated statused model close to the event allows the remaining work and known conditions to be represented. The CR-017 example illustrates that use. The fragment, its connections, durations and assumptions should be visible so that another competent reviewer can reproduce and challenge the result.

Time-impact analysis can also model removal of work that is no longer required, with the remaining dependencies preserved, and quantify a gain rather than a delay. A retrospective application requires additional care. If the analyst is examining a completed event, the relationship between information known at the time and information known later must be explicit. A forecast impact made before the event is not automatically the delay that ultimately occurred. Actual progress, mitigation and subsequent events may differ from the prediction. The report should state whether it answers a contemporaneous forecasting question or reconstructs an historical effect, and should not blend those perspectives without explanation.

Collapsed as-built

This approach begins with an as-built representation and removes selected delay or change effects to explore a hypothetical outcome without them. The subtraction may look simple, but constructing a defensible as-built network is demanding. Actual dates do not uniquely reveal the dependencies that governed the work. A model built backwards to fit a preferred result can produce an impressive calculation without a reliable causal basis. The network, calendars, event representation and treatment of resources all require support.

Removing an event also requires the analyst to consider the logic that would remain. Work cannot be made available before a real prerequisite merely because the selected event has been deleted. The alternative sequence must be technically possible and consistent with the counterfactual question. Interactions can make removal results differ from the event's original prospective effect, as the two-path example showed. The output should therefore be presented as a conditional modelled comparison, with sensitivity and evidential limitations, rather than as a self-proving statement of entitlement.

Impacted as-planned

This approach inserts delay or change events into the original planned model and calculates their effect on that plan. It can provide a clear illustration of how an event relates to the intended sequence. The starting baseline and its assumptions should be identified, along with any event durations and connections added by the analyst. A plan that was incomplete, unrealistic or inconsistent with the relevant scope is a weak foundation, even when the event fragment itself is carefully constructed.

Its central limitation is that delivery may have departed substantially from the original plan before the event occurred. The original critical path, available float and resource assumptions may no longer represent the situation. An impacted-as-planned result can consequently differ from an assessment based on contemporary updates or actual delivery. That difference should be explained through the different questions and evidence, rather than by declaring whichever result is more favourable to be correct. It is particularly important not to describe an original-baseline insertion as a current statused analysis.

The starting models and analytical operations of PMI's five forensic families

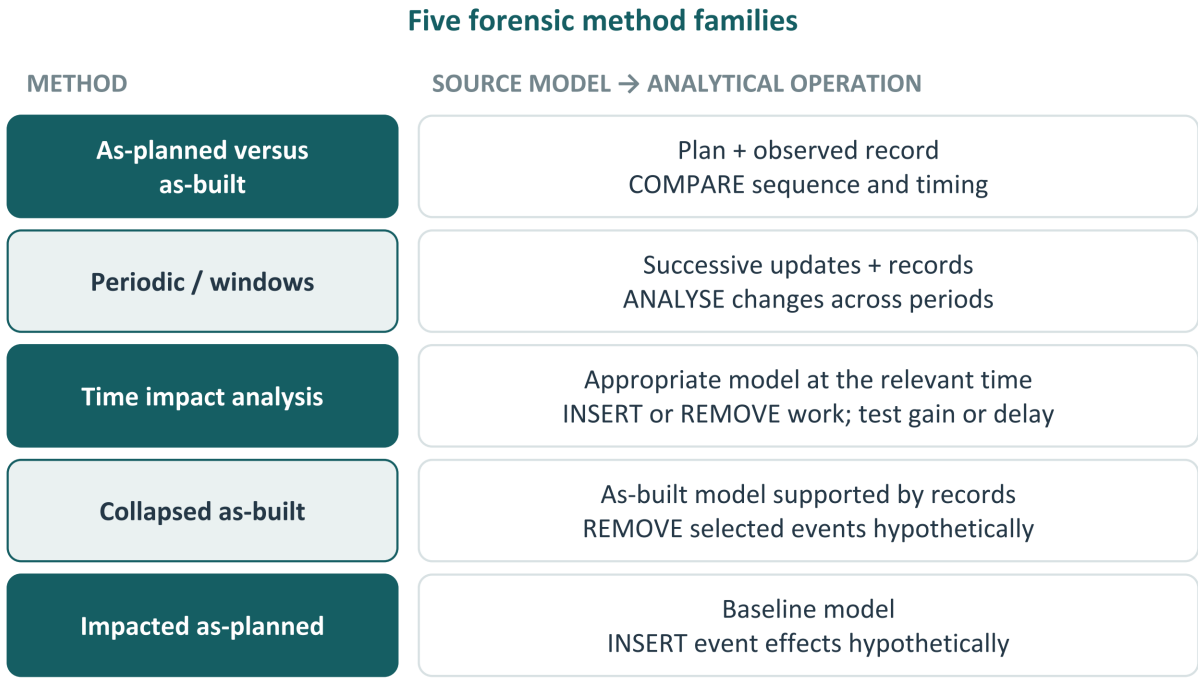


Figure 11.9. A comparison of the five broad families in PMI Appendix X5. The starting model and analytical operation determine the question being answered; named methods can contain more detailed variants.

Table 11.6 | Comparing delay-analysis method families

Method family	Starting point and principal use	Limitation requiring judgement
As-planned versus as-built	Compare the intended and actual delivery histories	A variance alone does not establish its cause or completion effect
Periodic or windows	Examine successive periods and changing controlling work	Update quality, window selection and analytical rules influence conclusions
Time-impact	Introduce or remove work in an appropriate pre-impact model	Results depend on status, event logic and the distinction between forecast and hindsight
Collapsed as-built	Remove selected effects from an as-built model	Reconstructed logic and the hypothetical alternative require evidence
Impacted as-planned	Add selected events to the original plan	The original plan may not represent conditions when the event occurred

11.9 Selecting and challenging an analysis

Method selection should begin with the decision question. A prospective approval needs a credible account of the remaining work under a proposed change. An investigation of completed delivery needs reliable history and an explanation of how control evolved. The analyst should then assess the records, the relevant model quality and the proportionality of the effort. A detailed method requiring missing updates may produce more unsupported assumptions than a simpler, candidly limited analysis. A method should be chosen because it can answer the question with the available evidence, not because its label sounds authoritative.

The source schedules need their own examination. Are the scope and milestones complete? Are durations plausible and calendars consistent? Are critical paths distorted by unexplained constraints, open ends or inappropriate lags? Does the progress record agree with the site evidence? Were resources and interfaces represented at the level needed for the question? PMI's forensic discussion places these matters alongside contractual requirements and record quality (PMI, 2019, pp. 166-168). Corrections may be necessary, but each should be disclosed with its reason and effect. An analytically repaired model must not be passed off as the untouched contemporary record.

Research insight: records influence what analysis can support

Abdela, Mengistu and Asfaw (2024) surveyed construction professionals in Ethiopia and used factor analysis and regression to examine scheduling practice and delay-claim analysis. As-built documentation showed a stronger influence in their model than the other scheduling-practice components examined. Their findings reinforce the practical value of reliable records, timely updates and preserved earlier schedules. This is context-specific survey evidence, not experimental proof that record keeping alone causes a particular claim outcome or that one forensic method is always superior. The teaching implication is to build an analysable record during delivery rather than expect a later calculation to recover missing facts.

Germany: diagnosing delivery rather than reading expenditure as progress

Germany's Federal Court of Audit reported in May 2025 that three station investment programmes were behind their plans. It criticised preparation and oversight, including reliance on expenditure information that did not reveal problems early enough for corrective action. The ministry described external funding difficulties and its assessment of causes when amending agreements; the auditors maintained their criticism and called for realistic planning and binding milestones. The case supports investigating obstacles before promising recovery. Expenditure is not physical completion or earned value, and an amended agreement does not itself remove the causes of slippage (Bundesrechnungshof, 2025, sections 26.1-26.4).

Sensitivity, uncertainty and independent challenge

A strong analysis tests the assumptions that could change its conclusion. Alternative reasonable event durations, window boundaries, logic interpretations or resource treatments may produce different effects. This does not make analysis pointless; it identifies where confidence rests on evidence and where judgement remains material. Report the central result, the tested alternatives and the unresolved information. Avoid false precision when the records support only an interval or a qualified conclusion.

Independent challenge should follow the reasoning chain rather than focus only on the final number. A reviewer should be able to trace a material statement to its record, follow the activity mapping, reproduce the comparison and understand the choice of method. The review should also look for selective treatment: an event favourable to one explanation should not be included while an equally relevant

competing event is omitted. The objective is a defensible account of delivery, with limitations visible to the people making the decision.

11.10 Communicating a recovery or change recommendation

A useful recommendation starts with the decision needed and its timing. It then explains the verified situation, the modelled effect, the feasible alternatives and the preferred response. The narrative should distinguish facts from estimates and assumptions, identify which version supports each conclusion and state the approval conditions. If the analysis has not established contractual responsibility, the report should not imply that it has. Clear separation of technical effect and commercial treatment improves the usefulness of both discussions.

For CR-017, the concise technical conclusion is that the proposed two-day review moves the forecast from day 24 to day 26 under the stated current-model assumptions. Among the 24 defined compression combinations, one day from B and one from C restores day 24 for a £7,000 direct increment. The recommendation remains conditional on the stated capacity and acceptance arrangements. Earlier versions are retained, the change is linked through CR-017, and subsequent updates test whether the approved response is delivering its expected effect. This tells the decision-maker what is known, what is proposed and what still needs control.

PMI-SP examination judgement

The examination perspective rewards understanding of the control sequence. When presented with a late forecast, first establish the data and cause before choosing a response. When asked to compress a schedule, examine the controlling work and recalculate after changes. When a proposed scope modification affects the finish, analyse it in a controlled model and follow the approval process. When a baseline no longer reflects approved scope, evaluate a governed revision while preserving history. A question about a delay-analysis method usually turns on its starting model, the operation performed and the evidence available.

PMI's published examination outline includes schedule monitoring and controlling and stakeholder communication, alongside strategy, planning and closeout. This chapter primarily supports the monitoring, control and communication judgements involved in changes, corrective action and explaining their consequences (PMI, 2012; PMI, n.d.). The practice questions below are original teaching questions, not reproduced examination items. Chapter 12 builds on this foundation by examining schedule quality, component conformance and evidence-based assurance in greater depth.

Knowledge check and examination practice

Question 1

A validated update shows that an activity needs four additional working days. No scope change has been approved. The sponsor asks the scheduler to move the baseline so that the report no longer shows an adverse variance. What is the most appropriate response?

A Move the baseline because a forecast should always equal it.
B Retain the outdated forecast until a new baseline is approved.
C Report the credible forecast, investigate the cause and use the formal process for any baseline change.
D Delete the activity's remaining duration to protect the milestone.

Question 2

The scheduler evaluates a future change by inserting a logic-linked event into a validated current model at the appropriate data date. The comparison model is retained unchanged. Which approach best describes this analysis?

A Prospective time-impact analysis.
B Collapsed as-built analysis.
C As-planned versus as-built comparison.
D Automatic rebaselining.

Question 3

In the CR-017 example, the impacted branches before acceptance take fourteen and eleven days. Acceptance takes two days. Controls verification on the eleven-day branch can be shortened by one day for £2,000. What is the effect of selecting only this option?

A Completion improves by one day because every duration reduction saves time.
B Completion improves by two days because float is doubled.
C The controlling branch changes to controls verification.
D The finish remains day 26 because the fourteen-day branch still controls acceptance.

Question 4

For CR-017, the permitted reductions are B by up to two days at £4,000 per day, C by one at £3,000, E by one at £2,000 and F by one at £6,000. What is the least direct cost among these options to restore the finish from day 26 to day 24?

A £4,000 by reducing B by one day.
B £7,000 by reducing B and C by one day each.
C £8,000 by reducing B by two days.
D £9,000 by reducing C and F by one day each.

Question 5

A manager proposes starting installation before all fabrication is complete. Which evidence most directly supports a credible fast-tracking proposal?

A A new start-to-start relationship that produces the desired date.
B A reduced baseline duration with no change to working arrangements.
C Defined accepted batches, release criteria and dependencies for the remaining work.
D A statement that all teams will work harder.

Question 6

An analyst begins with a reconstructed as-built network and removes selected event effects to calculate a hypothetical finish without them. Which method family is being used?

A Impacted as-planned.
B Periodic update comparison only.
C Prospective time-impact analysis.
D Collapsed as-built.

Question 7

Parallel paths P and Q take ten and eight days. Event X adds three days to P and event Y adds four days to Q. Both paths join at completion with no further work. What does the combined model establish?

A Completion is day 13, a three-day movement, without itself determining contractual entitlement.
B Completion is day 15 because the separate completion effects must be added.
C Each party is automatically responsible for half the combined delay.
D Event Y has no possible effect because it was initially on the shorter path.

Question 8

A major authorised scope change justifies a new baseline under the project governance process. What should the scheduler do with the original baseline and previous updates?

A Delete them to prevent confusion with the new commitment.
B Retain them with approval records and a reconciliation explaining the change in reference.
C Modify their actual dates so that all versions agree.
D Retain only the latest bar chart because the detailed models are no longer relevant.

Answer explanations

1: C. A forecast should reflect validated evidence, even when it is unfavourable. A baseline change requires the applicable authority and a justified purpose; it is not a cosmetic response to variance. The current situation may require corrective action, further investigation or a change proposal. Keeping the old forecast or deleting remaining work would misrepresent delivery.

2: A. The analysis inserts a future event into an appropriate statused model and compares it with the preserved pre-impact position. Collapsed as-built removes effects from an as-built model. An as-planned/as-built comparison examines intended and actual histories. Calculating a scenario neither changes the approved baseline nor authorises implementation.

3: D. The remaining duration stays max(14, 10) + 2 = 16 days after reducing E. From day 10, completion is still day 26. The option may have another operational benefit, but it does not improve this completion objective. Recovery selection must follow the network and not simply rank activity reductions by price.

4: B. Reducing B and C by one day each changes the main branch from fourteen to twelve days. Remaining duration is max(12, 11) + 2 = 14 days, giving day 24 for £7,000. Options C and D also reach day 24 but cost more; option A saves only one day. The conclusion applies to the defined feasible options and their direct incremental costs.

5: C. The proposal needs a real mechanism for releasing installation work while fabrication continues. Accepted batches and explicit remaining dependencies provide a basis for that mechanism. A relationship edit alone proves only that a model can calculate an earlier date. It does not establish design stability, available access or a technically valid sequence.

6: D. Collapsed as-built starts with an as-built representation and removes selected effects to test a counterfactual. Its credibility depends on the reconstructed logic and on the feasibility of the resulting alternative. Impacted as-planned instead adds effects to the original plan. A method's name does not guarantee that its assumptions or legal conclusions are valid.

7: A. With both events, the paths take thirteen and twelve days, so the finish is day 13. The three-day combined movement differs from the sum of the separate movements because the paths interact through their common finish. The calculation does not identify contractual responsibility, prove legal concurrency or determine a remedy.

8: B. Retaining the history allows performance and authorised changes to be understood across versions. The reconciliation should explain what changed, why it was approved and when the new reference applies. A new baseline does not alter genuine actuals or remove the need to understand earlier commitments. Detailed models and supporting records may remain essential for later review.

References and further reading

PMI citations use printed pages in the third edition. Dated case statements describe the reporting position of their sources. All diagrams, worked datasets, frameworks and examination questions are original teaching material. Numerical recovery examples assume the stated calendars, logic, capacities and cost limits.

Abdela, S.A., Mengistu, D.G. and Asfaw, D.A. (2024). 'Impact of Construction Scheduling Practice on Delay Claim Analysis'. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 16(4). https://doi.org/10.1061/JLADAH.LADR-1010.

Audit Office of New South Wales (2026). *Capital projects 2025*. 18 March. Sydney Metro City & Southwest case, p. 19. Official audit.

Borgonjon, T. and Maenhout, B. (2024). 'A genetic algorithm for the personnel task rescheduling problem with time preemption'. *Expert Systems with Applications*, 238, Part B, 121868. https://doi.org/10.1016/j.eswa.2023.121868.

Bundesrechnungshof (2025). *Bemerkungen 2024 zur Haushalts- und Wirtschaftsführung des Bundes: Ergänzungsband*. 5 May. No. 26, 'BMDV verschleppt Investitionen in Bahnhöfe', sections 26.1-26.4. Bundestag Drucksache 21/100, pp. 24-30. Official parliamentary publication.

Direction du Budget (2026). *Le chantier du Nouveau Grand Palais a mobilisé la direction du Budget au long cours*. 1 April. Government account.

Government Project Delivery (2025). *Government Functional Standard GovS 002: Project delivery*. Version 2.1, 1 September. Sections 7.2.5 and 7.7-7.9. Official standard.

National Audit Office (NAO) (2026). *High Speed Two reset*. HC 52, 29 June. Especially the report conclusions. Official audit.

National Telecommunications Regulatory Authority, Egypt (NTRA) (2025). *Containment of Ramses Exchange Fire and Gradual Restoration of Services*. 7 July. Official statement.

NASA Independent Review Board (2023). *Psyche Independent Review Board Assessment Report*. 30 May, published with NASA's response. Especially slides 12 and 19-21. Official review.

NASA (2023). *Signal Acquired - Psyche Begins Its Journey of Discovery*. 13 October. Official launch account.

Project Management Institute (PMI) (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Especially schedule monitoring and controlling and stakeholder communications. Official outline.

Project Management Institute (PMI) (2019). *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: PMI. Core coverage: section 3.1.2.12; sections 3.3.4-3.3.8; Change Request Identifier, p. 109; Appendix X5, pp. 165-168. Formal definitions cite their printed pages individually.

Project Management Institute (PMI) (n.d.). *PMI Scheduling Professional (PMI-SP)*. Current certification resources. Official certification page.

Roads and Transport Authority, Dubai (RTA) (2026). *Opening of the first phase of Hessa Street Development Project*. 11 January. Official announcement.

Society of Construction Law (SCL) (2017). *Delay and Disruption Protocol*. 2nd edn, February. Especially Introduction and Guidance Part B, sections 1, 4 and 11. Official protocol.

US Federal Acquisition Regulation (FAR). *52.243-4 Changes*. Clause dated June 2007; current official text consulted. Its application depends on the relevant contract and procedures. Official clause.

USACE/NAVFAC/AFCEC (2026). *Unified Facilities Guide Specifications: Section 01 32 01.00 10, Project Schedule*. August. Sections 3.8-3.9, pp. 21-23. Official guide specification.

Yılmaz, M. and Dede, T. (2023). 'Multi-objective time-cost trade-off optimization for the construction scheduling with Rao algorithms'. *Structures*, 48, pp. 798-808. https://doi.org/10.1016/j.istruc.2023.01.006.

CHAPTER 12

Assuring Schedule Quality and Assessing Conformance

Turning a schedule review into justified confidence

A schedule can contain thousands of activities, produce attractive reports and pass a collection of automated checks while still making an unsupported promise. Essential work may be missing, a supplier's programme may be disconnected, a calendar may permit work when the site is closed, or two activities may depend on the same unavailable specialist. Conversely, a diagnostic warning may have a legitimate explanation. The professional task is to establish what the model represents, how it behaves and whether the evidence supports the decision for which it will be used.

Schedule assurance therefore combines requirements, technical examination and delivery judgement. It asks whether the right things have been tested, whether the tests were applied correctly and whether unresolved weaknesses matter to the proposed commitment. Conformance is a more specific question: does the model use the components required by the applicable assessment method, and how well does it incorporate the additional components that are relevant? A conformance result contributes to assurance, but it does not replace a judgement about scope, resources, uncertainty, interfaces and acceptance.

This chapter brings together the full component catalogue in section 4 of PMI's scheduling standard, the conformance process in section 5, the scoring table in Appendix X3 and all five worksheet illustrations in Appendix X4. It reinforces the model-analysis and evidence principles developed earlier, while remaining self-contained. The worked examples distinguish an eligible conformance index from a diagnostic count and demonstrate how a logically connected schedule can still be infeasible. Learners preparing for PMI-SP should understand the assessment sequence and its limitations; at Level 6, they should also be able to defend a milestone recommendation and follow material findings through to verified closure.

The chapter framework: agree, preserve, test, challenge, recommend and verify

The original framework in Figure 12.1 links six responsibilities. Agree the decision and criteria before reviewing. Preserve the schedule version and supporting evidence. Test the components and calculations. Challenge whether the plan can be delivered under the stated conditions. Recommend an appropriate decision with any limitations or conditions. Finally, verify that agreed actions have resolved the findings and preserve the resulting record. A review that stops when a report is issued has completed only part of this cycle. A review that changes the model without preserving its starting position cannot clearly explain what its intervention achieved.

A six-stage schedule-assurance cycle

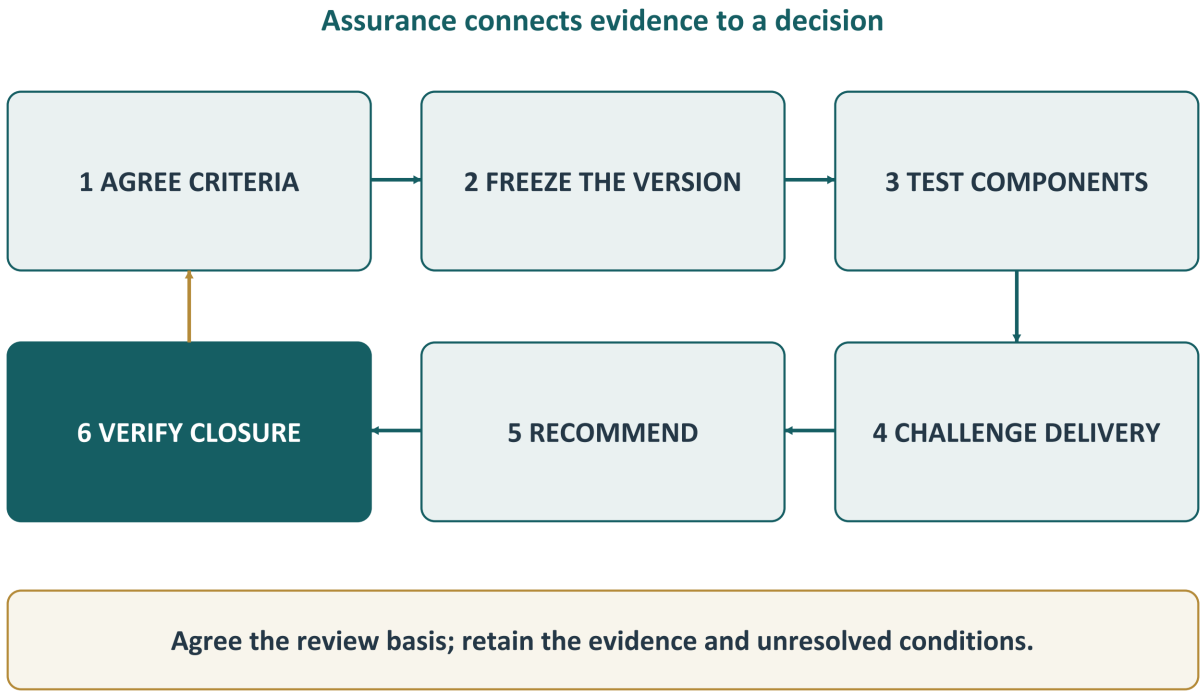


Figure 12.1. An original assurance framework connecting the review question to evidence, technical challenge, a decision and verified follow-through. The cycle applies to internal schedules and supplied contractor models.

12.1 Agreeing what the review must establish

Criteria. 'Standards, rules, or tests on which a judgment or decision can be based, or by which a product, service, result, or process can be evaluated.' (PMI, 2019, p. 178)

The review should begin with its intended use. A baseline approval, a funding decision, a monthly forecast, a recovery proposal and a readiness decision require related but different evidence. A baseline review examines whether the agreed work and delivery strategy are represented adequately. A forecast review also needs reliable actuals and remaining estimates. A recovery review tests whether additional capacity and changed methods can produce the claimed gain. A readiness review examines the conditions for a specific transition, such as entering trials or handing an asset to its operator. Calling every review a schedule check conceals these differences.

The criteria should identify the applicable contract, schedule management plan, organisational procedures, standards and decision requirements. Record the version and effective date of the criteria, including any agreed diagnostic rules. A supplier cannot be assessed fairly against an undisclosed software preference introduced after submission. Equally, contractual acceptance of a particular report format does not prove that the delivery model is complete or feasible. Where requirements conflict, the reviewer should identify the conflict and obtain an authorised resolution rather than silently choose the easier test.

Independence, competence and proportionate coverage

Independence should be appropriate to the significance of the decision. A scheduler's self-check is valuable but differs from a challenge by someone who did not create the model. A specialist can examine technical logic while a delivery manager tests access and productivity assumptions. The reviewer needs sufficient competence to understand how the selected tool handles calendars, constraints, resources and progress. Independence without relevant knowledge may produce superficial findings; detailed knowledge without freedom to challenge may leave an optimistic assumption untested.

UK GovS 002 places assurance in an integrated plan, distinguishes levels of independence and says recommendations should be documented, agreed and acted on. It also addresses reviews before significant decisions and decisions with conditions. These principles support a review whose timing, evidence and follow-through are designed around the decision, rather than an isolated report produced after the commitment has already been made (Government Project Delivery, 2025, sections 4.2-4.3).

Proportionate coverage combines comprehensive automated interrogation with targeted examination of the most consequential work. The reviewer may inspect all activities for inconsistent dates, then investigate selected critical paths, external interfaces and unusual assumptions in depth. Sampling should be explicit: identify the population, why items were selected and what the sample can support. A valid sample can reveal a systemic weakness, but an unexplained small sample cannot establish that every required component is correctly used throughout a large model. Material limitations belong in the conclusion.

England: a favourable inspection has a defined boundary

ONR's Hinkley Point C inspection of 3-4 November 2025, published in February 2026, examined construction assurance and records in selected Unit 1 buildings. It sampled non-conformance corrections and supporting arrangements, found no significant regulatory shortfalls and assigned green ratings to the inspected licence-condition areas. It nevertheless recorded observations, actions and planned follow-up on documentation. This illustrates a bounded conclusion based on sampled evidence: a favourable result can coexist with further actions. It does not establish that every future construction activity, the whole schedule or the eventual completion date has been assured (ONR, 2026).

12.2 Preserving the model and the evidence before testing

> **Schedule Model.** 'A representation of the plan for executing the project’s activities, including durations, dependencies, and other planning information, used to produce a project schedule along with other scheduling artifacts. See also schedule model analysis.' (PMI, 2019, p. 190)

Review the model that generated the reported dates, not merely its printed bars. Preserve the native file, its identity, data date, baseline references and calculation settings. Obtain the basis of schedule, relevant scope information, approval records, change history, resource assumptions and interface agreements. Record any linked external files, calendars or resource libraries that affect recalculation. If a reviewer opens a file in a different software version or with different settings, a changed result may reflect the review environment rather than a changed delivery plan.

The initial calculation should reproduce the submitted position or identify why it does not. Reconcile key milestones, activity counts, durations and relevant resource totals before making analytical changes. Keep the unmodified submission and use a separate review copy for tests. A reviewer may need to correct an error to understand its consequences, but the correction, reason and resulting movement should be visible. Otherwise, later discussion can become confused about whether a weakness existed in the submitted model or was introduced during review.

Data Date (DD). 'A point in time when the status of the project is recorded.' (PMI, 2019, p. 179)

The data date anchors the distinction between historical status and future prediction. Actual starts and finishes need evidence that the events occurred by the cut-off under the agreed criteria. Remaining work should lie on the forecast side of the update process, subject to the tool's calculation rules. Information collected later may still describe the earlier cut-off, but the report should identify that relationship. A late correction to an actual can be valid if supported and traceable; moving a genuine actual simply to improve the model's appearance is not a correction.

Evidence should answer the question being tested

Different records establish different things. A purchase order may demonstrate an order placed, but not manufacture complete. A delivery note may demonstrate arrival, but not installation acceptance. A timesheet may establish attendance, but not productive output. A signed test record can demonstrate completion of its specified test scope, while leaving integration or operational approval outstanding. The reviewer should map the record to the precise activity or milestone criterion rather than infer a broader achievement from a convenient document.

The evidence chain needs a stable connection between scope, model fields, source records and conclusions. Activity identifiers, WBS references and change identifiers help maintain that connection. Where names have changed or packages have been split, preserve the mapping rather than relying on a visual comparison of labels. The same discipline supports later forensic analysis: a finding about an incorrect actual date, changed relationship or omitted interface should be understandable after the people involved have moved to other work (PMI, 2019, pp. 70 and 166-168).

12.3 Using the component catalogue as a system of checks

Component. 'A constituent part, element, or piece of a complex whole.' (PMI, 2019, p. 177)

Section 4 is more than a list of available software fields. Its entries describe the component name, required or optional use, whether the value is manual or calculated, data format, behaviour, good practices, conditional notes or associations, and definition. A field with the right name may behave differently between tools or settings. The reviewer therefore examines the actual implementation and its relationship to other fields. Correctly formatted data are necessary for reliable calculation, but they do not establish that the data describe real work.

The eight lenses for reviewing a PMI component entry

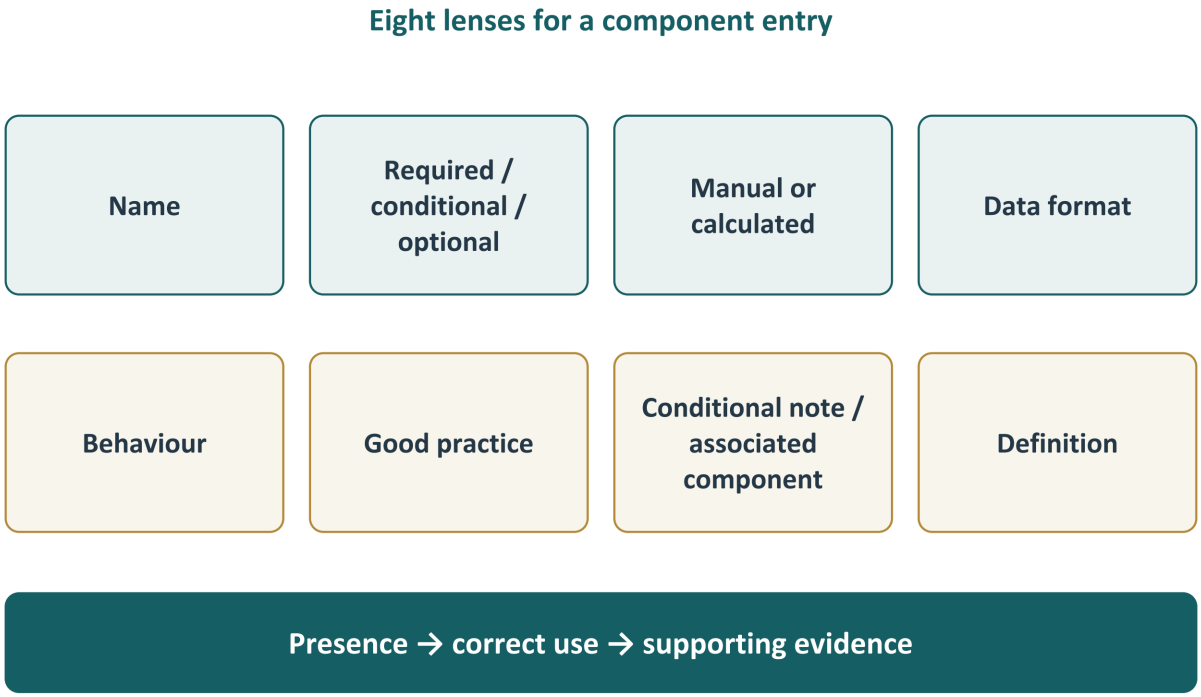


Figure 12.2. Section 4's eight types of component information provide a structured review. Presence, correct use and supporting evidence are different tests; software availability alone does not earn a conformance point.

A manually entered field requires a credible source and a controlled update process. A calculated field requires valid inputs, settings and interpretation. For example, an early finish date can be calculated correctly from an unrealistic duration and still be an unreliable forecast. A total-float value may reflect a constraint that the user did not understand. A resource quantity may be numerically valid but expressed in a different unit from the associated rate. The review should trace the important outputs back through these relationships rather than checking each cell in isolation.

A complete catalogue review, organised by purpose

The following table groups the catalogue into practical review families. These are teaching groupings, not replacements for PMI's official scoring categories. Use the individual entries in section 4 to decide what each field means and Appendix X3 to determine how it is scored. The groupings connect the components covered throughout the book so that a review addresses the whole model rather than the handful of fields exposed by a default software report (PMI, 2019, pp. 93-136).

Table 12.1 | Reviewing component families by purpose

Component family	Fields and relationships to examine	Evidence of appropriate use
Identity and structure	Activity ID, label, code, scope definition, WBS ID; project name and description; model ID and level	Stable scope mapping and an appropriate level of detail
Versions and change	Baseline, target and model instances; change identifiers; notes, comments, logs and variance	Approved references, reasons for revisions, and the two compared attributes and units for each variance
Calendars and units	Project, activity and resource calendars; units of measure	Working periods, exceptions and unit conversions match delivery conditions
Relationships	Finish-to-start, start-to-start, finish-to-finish, start-to-finish; lead and lag	Physical, information and contractual dependencies are represented and justified
Constraints	Activity start/finish constraints, expected finish, as-soon/as-late settings; project constraints	The source and calculation effect of each imposed date are understood
Durations and effort	Original, actual, remaining and total activity/project durations; activity effort	Estimates and actuals use the correct calendar, scope and quantity basis
Dates	Actual, early and late starts/finishes; activity and project resource-levelled dates	Dates reconcile with status, logic, resources and settings
Paths and float	Critical path, total float and free float	A credible controlling chain reaches each relevant milestone
Progress	Activity/project physical or duration percentages; activity work percentage	The measure matches the work and does not substitute elapsed time for output
Resources	Assignments, availability, calendar, ID, description, type, library, rates, lag and driving resource; actual, remaining and total quantities	Capacity, units and allocation can support the planned work
Cost and accountability	Activity cost category and estimate, project cost category, actual cost, BAC, control account ID/manager and work-package identifier	Scope, responsibility and budget/cost records reconcile
Earned-value performance	PV, EV, earning type/weight, EAC, ETC, CPI, CV/CV%, SPI, SV/SV% and TCPI	Progress credit, reference budgets and forecasts have consistent bases
Earned-time performance	Actual time, earned schedule, estimated duration, ETC(t), SPI(t), SV(t) and TSPI	Time units and the underlying planned-value profile are consistent
Risk	Optimistic, most likely and pessimistic durations; distributions, cumulative probability, criticality and risk ID	Inputs reflect evidence, interactions and the stated uncertainty model
Summary and presentation	Milestones, summary activities, hammock and level-of-effort representations; model presentations	Aggregation preserves the meaning of the underlying work and acceptance boundaries

The catalogue contains alternatives that must not be double-counted. Appendix X3 requires one of activity physical percentage complete or activity duration percentage complete, and one of the corresponding project-level measures. Using both can help different reporting purposes, but it does not create an additional scored point for each alternative. The 126 catalogue entries therefore become 124 assessment units after combining the two alternative pairs; excluding the thirteen not-scored units leaves 111 scoreable units. The reviewer should also distinguish a component's classification from its name. A field called Mandatory Finish Date is not thereby a core-required component; Appendix X3 lists it as not scored. Its potential effect on the model still requires examination.

Appropriate use is sensitive to the stage of the project. An unstarted activity should not receive a fictitious actual finish merely to fill a column. The relevant actual-date component must be implemented and used correctly when actual events exist. At initial planning, blank actuals may accurately reflect the absence of history. The assessor should distinguish a valid empty value from an absent capability, an incorrectly configured field or missing evidence for a claimed event. Populating fields indiscriminately can make the model less truthful while making a superficial completeness report look better.

Check scope before admiring the network

A schedule cannot calculate the consequence of work that has been omitted. Trace the deliverables through design, procurement, manufacture, access, installation, testing, integration, approval and handover as applicable. Examine enabling and external work as well as visible production. A supplier's delivery milestone may need upstream design approval and downstream receipt inspection. A station opening may depend on training, operating procedures and emergency exercises. These examples do not mean every project needs the same activity list; they show why the scope boundary must drive the review.

The WBS and schedule should support each other without being treated as interchangeable. A WBS can confirm the scope structure but does not establish the delivery sequence. A schedule can contain well-linked activities that still miss a required deliverable. Reviewers should reconcile the two and examine interfaces between packages. Where a high-level planning package is appropriate, its future decomposition and integration conditions should be understood. Hiding unresolved detail inside a long bar does not make the uncertainty disappear.

Research insight: investigate the causes of non-conformance

Srinath and Varghese (2023) examined thirty construction baseline schedules using three assessment mechanisms, document review and interviews with twenty-three experts. They analysed underlying causes of schedule non-conformance and used a separate modified Delphi process for verification. Their research design connects the condition of the model with the practices that produced it. For assurance, the implication is to investigate why a weakness recurs, rather than repeatedly correcting its visible symptom. The study does not validate PMI's 111-point index as a delivery-probability measure, and its findings should not be turned into a universal ranking of causes for every sector.

USA: review findings can change the work represented

GAO's February 2026 assessment of NNSA major projects reports that an external independent review of Surplus Plutonium Disposition found its schedule unreliable for identifying the critical path and inconsistent with GAO scheduling practices. Responses included adding risk-mitigation work and extending operational-readiness activities, with adjustments reflected in the October 2024 approved baselines alongside other estimate issues. This is a substantive assurance intervention: work content and assumptions changed, rather than a metric merely being made more favourable. The report does not establish that every weakness was eliminated or that baseline approval guaranteed completion (GAO, 2026, pp. 58-59).

The complete entry-by-entry reference is part of this book in Appendix B. Its 126 entries make the component attributes available for detailed checking, while this chapter develops the judgement needed to assess their correct use. A field's presence, permissible format and conformance category should be checked separately from the credibility of the assumption or evidence it contains.

12.4 Establishing the applicable conformance requirements

PMI's conformance index assesses the presence and proper use of the schedule components described in section 4. Section 5 divides the assessment into required and optional contributions. The essential rule is that every applicable required component must be properly used before an index can be recorded on the conformance continuum. If that condition is not met, the assessor may stop or continue diagnostically to identify improvements, but the model does not meet the minimum conformance requirements (PMI, 2019, pp. 137-141).

There are 36 core-required components, abbreviated CRC, which apply regardless of project complexity. Three additional groups become required when the project documents require their associated practices: 13 resource-required components, RRC; nine earned-value-required components, ERC; and seven risk-required components, KRC. The documents may include organisational procedures, the contract and the schedule management plan. The assessor establishes these requirements before counting points. Selecting fewer groups because the submitted model would otherwise fail reverses the proper sequence.

Required-group selection and the conformance eligibility gate

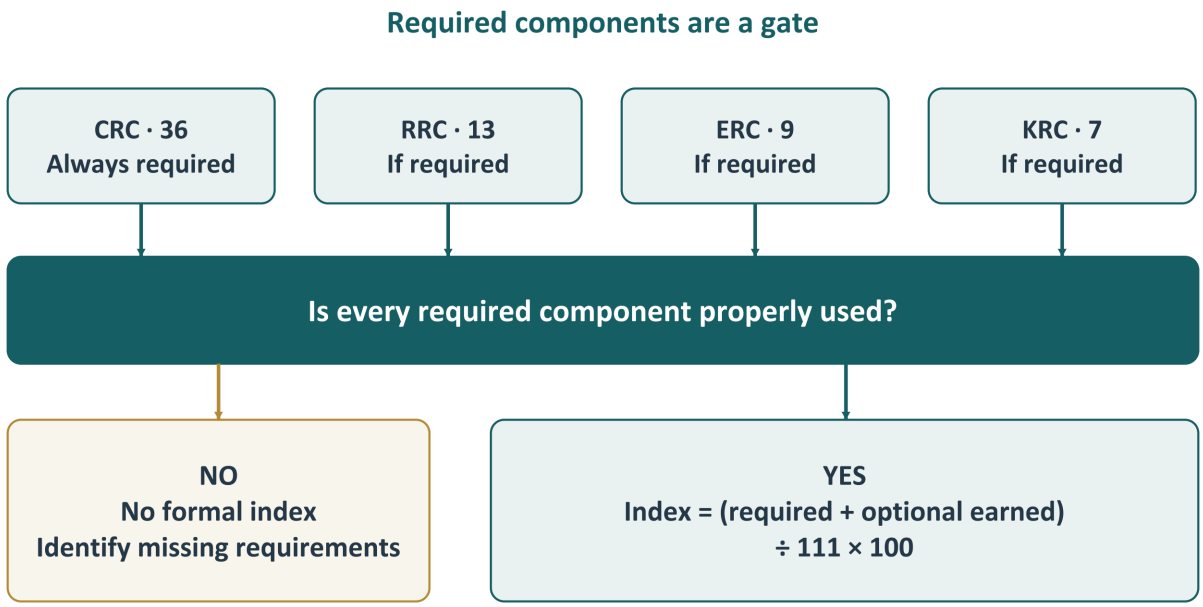


Figure 12.3. The required-component gate precedes the index. A missing or improperly used required component cannot be offset by additional optional points.

The denominator remains 111

Appendix X3 provides 111 scoreable component units: 36 CRC, 13 RRC, nine ERC, seven KRC and 46 in the general optional pool. It also identifies 13 not-scored components, which do not enter the denominator. When a conditional group is not required for the project, its components become optional rather than disappearing from the available score. Consequently, changing the combination of required groups changes the minimum requirement and the optional pool, but the total possible score remains 111 (PMI, 2019, pp. 140-141 and 151-157).

Let r, e and k each be either one or zero according to whether resource loading, EVM and schedule-based risk management are required. The required total is 36 + 13r + 9e + 7k. The available optional total is 111 minus that required total. These equations restate the source's component counts; they do not introduce a new weighting system. Each eligible component earns one point when it is present and properly used. A component that is merely available in the software does not qualify on that basis alone.

Table 12.2 | Required and optional conformance positions

Project requirements beyond CRC	Required points available	Optional points available
None of the three conditional groups	36	75
Resources only	49	62
EVM only	45	66
Risk only	43	68
Resources and EVM	58	53
Resources and risk	56	55
EVM and risk	52	59
Resources, EVM and risk	65	46

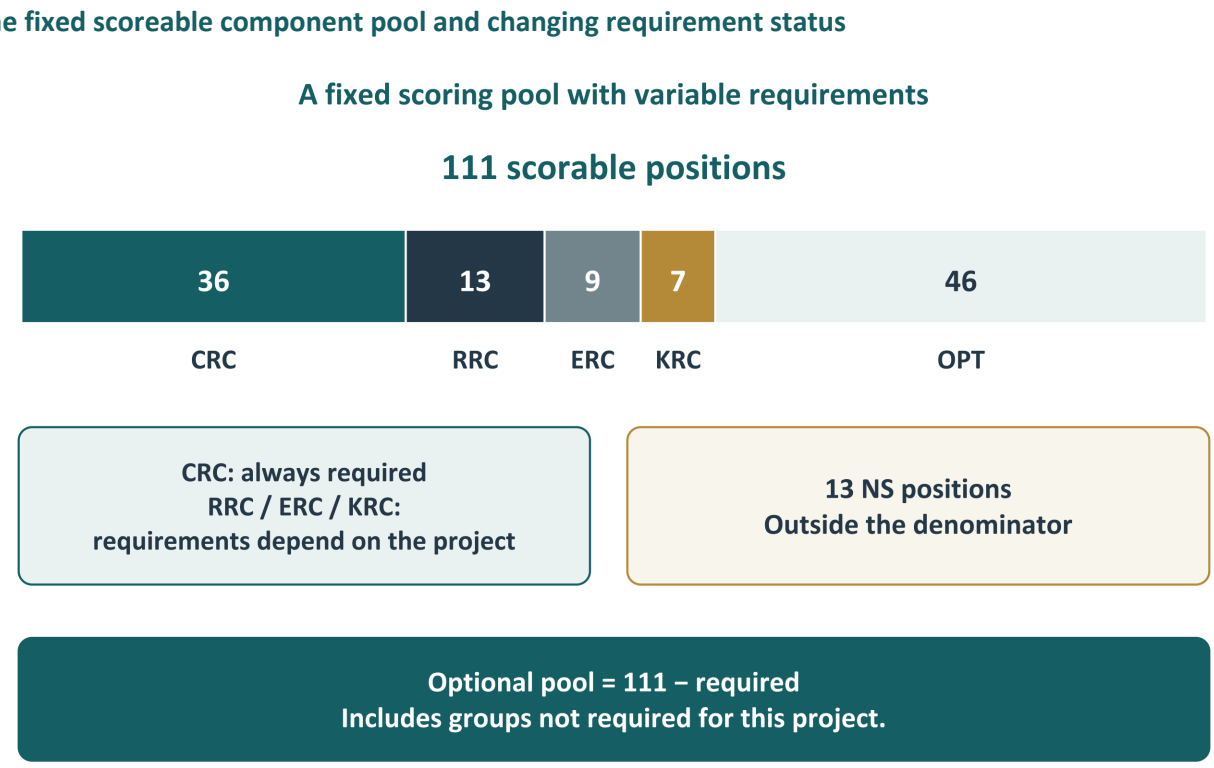


Figure 12.4. Requirement status changes the allocation between required and optional components, not the fixed pool of 111. The 13 not-scored components remain outside the calculation.

The absence of a requirement for resource loading does not imply unlimited real-world resources. It changes the formal classification of the RRC group for this assessment. The reviewer must still consider whether the delivery commitment depends on a capacity assumption that has not been established. Similarly, a lower formal requirement for risk components does not remove uncertainty from the project. Conformance criteria and the wider professional judgement about deliverability should be stated separately so that neither is mistaken for the other.

Awarding points for use, not decoration

Evidence of correct use should be proportionate to the component and its consequence. A model may contain a resource calendar while assignments use an unintended default calendar. It may contain a baseline while the reported variance refers to a different target. It may display a risk identifier without linking the risk to any affected work or assumption. In each case, checking that a column exists is insufficient. The assessor should examine the behaviour, associated components and good-practice guidance before awarding the point. Points concern component use, not the number of activities: a field used across ten thousand activities still contributes at most its one eligible point.

Optional components should serve the project. Adding an unused field, a meaningless code or an unnecessary calculated indicator solely to increase the index defeats the purpose of the assessment. Nor should all optional components be treated as equally useful for every decision merely because each eligible item contributes one point. A well-justified optional resource view can materially improve a capacity decision; an irrelevant extra report may add no practical insight. The score records component use under the method, while the reviewer explains its significance.

Calculating and reporting an eligible index

Once all required points have been earned, add the eligible optional points and divide the total earned by 111, then multiply by 100. Report the required points earned against those required, the optional contribution and the resulting index. This makes the gate visible rather than leaving the reader to infer it from a percentage. State the rounding convention and retain the unrounded calculation for verification. The examples in this chapter calculate from the integer point totals and round the final percentage to one decimal place.

Eligible conformance index = 100 × (required points earned + optional points earned) / 111, only when required points earned equal all applicable required points.

The source describes a continuous index, not named bronze, silver or gold maturity bands. It does not define the index as the percentage of activities that are correct, the probability of meeting the finish date or the percentage of work complete. A core-only model earning exactly 36 points would have an eligible index of approximately 32.4%, provided all required components are correctly used. Its relatively low number does not mean it has failed a universal 50% pass mark; the eligibility condition and project requirements determine the minimum, not an invented threshold.

12.5 Reading every Appendix X4 scenario correctly

Appendix X4 explains the scoring through a base worksheet and four completed illustrations. The purpose here is to understand every scenario and reconcile the arithmetic, rather than reproduce an assessment form. Use the official counts in Table 5-1 and Appendix X3 when interpreting the illustrations. The underlying distinction is consistent: first establish the required groups and verify all required points, then consider optional points and calculate an eligible index (PMI, 2019, pp. 159-164).

Figure X4-1: establish the structure before entering a result

The base worksheet on printed page 160 is blank in its earned-point and final-score fields. It lists the potential component groups before the three requirement questions have been answered. Conditional groups appear in both the required and optional sections because their placement has not yet been determined. They must not be counted in both places. The assessor identifies the project requirements, assigns each conditional group to the appropriate side and ensures that required plus optional availability still equals 111.

This example also illustrates why visual examination can matter when extracting evidence. A text extraction from a PDF can expose hidden or displaced values that are not part of the visible completed record. The visible worksheet and the governing explanation should therefore be checked together. In a real review, the same caution applies to exported reports, hidden spreadsheet cells and software views that contain stale values. Data extraction is a useful aid, but the reviewer remains responsible for interpreting what the source actually presents.

Figure X4-2: resources are required, EVM and risk are optional

The resource-required example on printed page 161 requires 36 CRC plus 13 RRC points, giving 49. All 49 are earned. The optional pool consists of the general 46 plus nine ERC and seven KRC points, giving 62 available. The illustration earns ten optional points: five from the general optional pool and five from the otherwise conditional EVM group. Total earned is 49 + 10 = 59, so the calculation is 59/111 × 100 = 53.153…%, reported here as 53.2%.

The presence of some EVM components does not, by itself, make EVM a project requirement. Requirement status comes from the applicable documents. Conversely, if those documents did require

EVM, the assessor could not leave the ERC group optional merely because only five of its nine points had been earned. The example therefore teaches both arithmetic and governance: identify the requirement first, then assess whether the implementation satisfies it.

Figure X4-3: all three conditional groups are required

The example on printed page 162 requires 36 + 13 + 9 + 7 = 65 points, all of which are earned. Only the general pool of 46 remains optional, and nine optional points are earned. Total earned is 74. Dividing by 111 gives exactly two-thirds, so the percentage is 66.666…%, reported here as 66.7%. The completed illustration displays 66, while its introductory description on page 159 gives 67. Calculating from the point totals avoids carrying forward that difference in displayed rounding.

The professional interpretation is that all required groups have passed the component-use gate. It does not mean the project has a two-thirds probability of success. Nor does a nine-point optional contribution necessarily justify a recommendation to add all the remaining optional features. Improvements should address the needs and weaknesses of the model. A higher score obtained through relevant, properly used components may help, but the schedule still needs substantive delivery challenge.

Figure X4-4: resources and risk are required, EVM remains optional

The resource-and-risk example on printed page 163 requires 36 + 13 + 7 = 56 points, all earned. Its optional availability is 46 + 9 = 55 because the ERC group is not required. It earns 30 general optional points and all nine ERC points, giving 39 optional and 95 total. The verified calculation is 95/111 × 100 = 85.585…%, reported here as 85.6%. The page-159 description gives 86, whereas the displayed worksheet gives 85. Again, use the point totals and a declared rounding convention.

This example shows that a conditional group can contribute its full set of points as optional when the practice is not mandated by the project documents. The same nine ERC points must not also be counted as required. A fully populated optional group does not change the denominator or create a second allocation. The reason for using those components should still be evident in the project controls approach and the associated records.

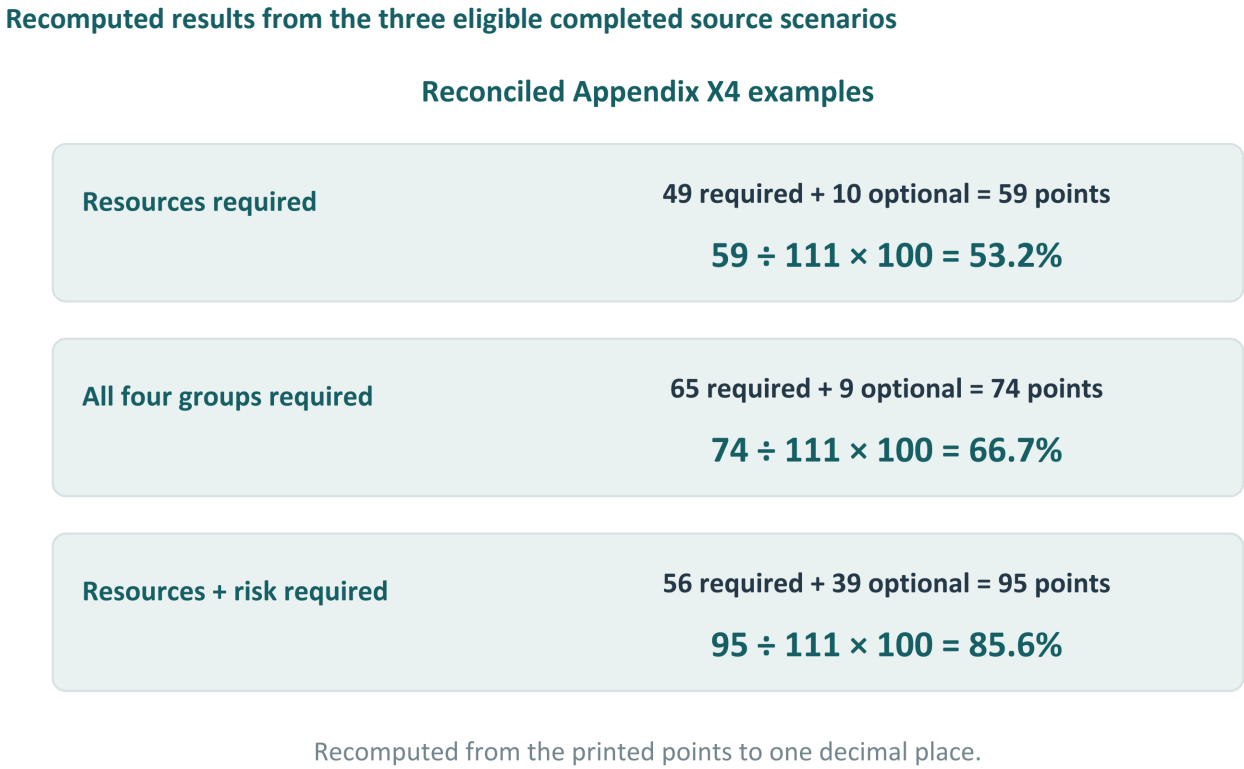


Figure 12.5. Calculations reconstructed from the source's earned-point totals, with percentages rounded once at the end to one decimal place. These are conformance indices, not delivery probabilities.

Figure X4-5: optional points cannot cure failed minimum requirements

The non-scored example on printed page 164 requires resources and risk, giving 56 required points. The visible worksheet earns 33 CRC, seven RRC and seven KRC points: 47 required points in total. It also earns 25 general optional points and nine optional ERC points, giving 34 optional points. Although these sum to 81 diagnostic raw points, the model has not earned all 56 required points. Its final-score fields are correctly left blank. The appropriate conclusion is that it does not meet the minimum conformance requirements; the raw counts may still guide improvement.

The introductory text on page 159 describes three missing resource components, but the visible resource row earns seven of thirteen, leaving six missing. Alongside three missing CRC points, that gives nine missing required points and agrees with 47 earned against 56 required. This chapter follows the visible earned-point rows and the governing gate. It does not convert 81/111 into an official index or award a provisional passing score because optional components are present.

A careful source-reading convention

Some worksheet labels and potential-count cells also require care. The lower optional section labels its 46-point general pool as core required, although Table 5-1 and Appendix X3 classify those 46 points as optional. Several completed lower tables display a resource potential of eleven, while the governing table and worksheet header give thirteen. The reconciled examples above use the authoritative category totals and visible earned rows. These are observations about the third edition, not a claim that PMI has issued an official correction. The assessment method remains clear when requirements, counts, earned points and rounding are kept separate.

There is also a classification difference to recognise: the detailed WBS ID entry on page 136 is labelled required, whereas the Appendix X3 scoring inventory places WBS ID in the ERC column on page 157.

Appendix X3 is identified on page 151 as the basis for the official category counts, so use that allocation when scoring rather than moving the point or changing the totals. This does not remove the professional need for scope and WBS traceability when EVM is not mandated.

Table 12.3 | Interpreting the source conformance scenarios

Source scenario	Required points earned/needed	Optional earned and diagnostic total	Reported result in this chapter
X4-1: base	Not yet assessed	Allocation follows the requirement questions	No result entered
X4-2: resources	49/49	10 optional; 59 total	Eligible index 53.2%
X4-3: all groups	65/65	9 optional; 74 total	Eligible index 66.7%
X4-4: resources and risk	56/56	39 optional; 95 total	Eligible index 85.6%
X4-5: failed minimum	47/56	34 optional; 81 diagnostic raw points	No conformance index recorded

12.6 Why a larger number may support a weaker conclusion

Consider two original teaching models assessed against the same requirement for resources and risk. Both therefore need 56 required points and have 55 optional points available. Model A earns 55 of the 56 required points and all 55 optional points, giving 110 raw points. Model B earns all 56 required points and fourteen optional points, giving 70. Model A has the larger raw count but fails the minimum requirement and receives no formal index. Model B is eligible for $70/111 \times 100 = 63.1\%$.

The comparison is not a declaration that Model B is superior in every respect. It demonstrates that Model A cannot use optional features to compensate for a required failure. The report should identify the failed component and its consequences, while still examining both models' delivery assumptions. If Model A's failure is corrected and the other points remain valid, its eligibility changes. If Model B contains unsupported durations, its eligible index does not make those durations credible. A useful assurance conclusion needs the gate, the component evidence and the practical implications.

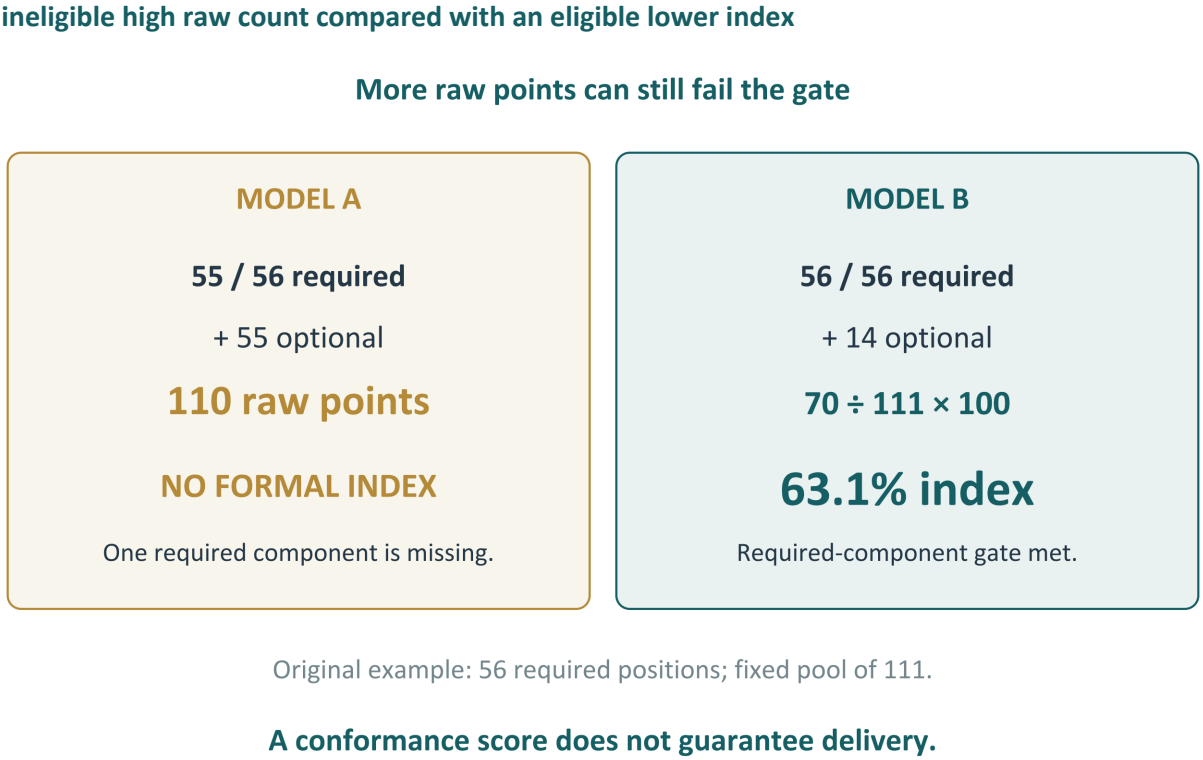


Figure 12.6. An original comparison showing the effect of the required-component gate. Raw points from an ineligible model must not be displayed as a conformance index.

Keep four different measures separate

Field completeness records whether specified data are present. Component conformance examines whether components are present and properly used under the selected method. Diagnostic metrics describe particular patterns, such as missing logic among eligible activities. Delivery confidence concerns the evidence supporting a milestone under its scope, resources, assumptions and uncertainty. The same word percentage can appear in all four discussions, but the numerators, denominators and interpretations are different. Reports should name the measure rather than display an unexplained green percentage.

For example, suppose a local review rule examines forty incomplete activities after excluding explicitly justified boundary items. Four lack a required predecessor under that rule. The diagnostic rate is 4/40 × 100 = 10%. It is not PMI's 111-component index, and it does not prove that the other 90% of activities are feasible or correct. The review must disclose the population and exclusions, inspect the four cases and determine whether they are genuine defects. Changing the denominator between reports can change the percentage without improving a single relationship.

Germany: the indicator must answer the intended question

Germany's Federal Court of Audit reported in July 2025 that an indicator of active use of central IT had been replaced with technical rollout counts. It argued that the revised measure no longer demonstrated intended uptake; the ministries responded that active use was impractical and rollout more suitable. The audit also identified unfulfilled network user obligations among connected bodies. The lesson is to examine whether a measure supports the conclusion being drawn and whether known requirements have actually been met. These findings concern IT governance, not a PMI schedule score or a quantified delay assessment (Bundesrechnungshof, 2025, pp. 18-22).

12.7 Testing network integrity and delivery feasibility

Constraint. 'A factor that limits the options for managing a project, program, portfolio, or process.' (PMI, 2019, p. 177)

Network examination starts with the actual prerequisites for the work. Check for missing predecessors or successors, circular logic, disconnected networks and relationships that do not express the intended release conditions. Legitimate start and finish boundaries should be identified explicitly. An activity can have both a predecessor and a successor while still being linked to the wrong work. A rule that counts open ends therefore identifies only one type of possible defect. Interviews, drawings, method statements and interface agreements help determine whether the connections represent a valid execution sequence.

Review leads and lags by asking what they represent. A fixed waiting period may be appropriate in a particular model, while an active approval or procurement process may need its own activity, responsibility and progress evidence. A negative lag that appears to save time should not conceal an unsupported overlap. The reviewer should preserve a genuine dependency rather than delete it to satisfy a preferred date. Where work can proceed in accepted batches, the model may need more meaningful decomposition so that partial release and final completion are both represented.

Calendars, constraints and dates can change the apparent answer

The same nominal duration can occupy different elapsed dates under different calendars. Check working days, shifts, holidays, resource availability and local exceptions, particularly at interfaces between organisations. A five-day activity on a seven-day calendar is not necessarily equivalent to five working days under the project's normal pattern. Resource lag and relationship lag may also be calculated under tool-specific conventions. The review should establish the convention that actually applies, rather than infer it from a label.

A date constraint can represent a genuine external restriction or a contractual target, but it can also suppress the model's natural response or distort float. Establish the source of the date, its approval status and its calculation effect. Keep commitments distinct from the current forecast. A required finish does not become physically achievable because a software setting displays it. If a constraint creates negative float, investigate the relationship between the imposed date and the calculated plan rather than remove the warning without resolving the underlying issue.

A credible critical path must respond sensibly

Trace the controlling chain to each relevant milestone and examine its continuity, scope and plausibility. The critical path to sectional acceptance may differ from the path to overall completion. Constraints, calendars and resources can also affect which work controls the result. In a preserved test copy, a carefully chosen duration or relationship change can help test whether the model responds as expected. Explain the test conditions and restore the original inputs afterwards. An unexpected result is a reason to investigate settings and logic, not immediate proof that the software is wrong.

Review near-critical paths and shared resources as well as the displayed longest path. A small change can cause control to move to another branch. An apparently generous float value may reflect missing downstream work or a disconnected interface. The review should therefore examine why float exists, not merely whether it is positive. PMI's model-analysis guidance links critical paths, float, durations, constraints, progress and risk; assurance uses those connected concepts to test the meaning of the result (PMI, 2019, section 3.4).

Australia: an accepted schedule can still contain an unresolved interface

The ANAO's March 2026 Land 400 Phase 3 audit reports that a May 2024 review identified deficient schedule structure and logic. Approval was initially withheld while comments remained unresolved, and a later version was approved in January 2025. Subsequent milestone changes were followed by contractor statements that driving work and the turret schedule were disconnected. For a later reporting period, the master schedule showed no final-acceptance delay while the full remote-weapon-system effect was not reflected. These attributed findings show why review must follow integration and acceptance boundaries after approval; a favourable milestone display is not sufficient evidence by itself (ANAO, 2026, paragraphs 3.59-3.65).

A worked example: complete logic, insufficient capacity

An independent equipment example starts at working-day boundary zero. Release activity A takes two days. Panel Alpha configuration B takes four days and Panel Beta configuration C takes three; both depend on A. Integration D takes two days and depends on both configurations. The panels are physically independent, the calendar is common, all links are finish-to-start with zero lag, and A and D use other available teams. B and C each require one specialist engineer at full capacity throughout their duration, but only one engineer is available.

Ignoring the shared resource, A runs from day 0 to day 2, B from day 2 to day 6, C from day 2 to day 5, and D from day 6 to day 8. The logical calculation is 2 + max(4, 3) + 2 = 8 days. Every activity can have the expected links and the arithmetic can be correct, yet B and C overlap while both require the same full-time engineer. The eight-day result relies on capacity that the stated plan does not possess.

> **Resource Availability.** 'The dates and number of work periods, in calendar units, that a given resource is available according to the appropriate resource calendar.' (PMI, 2019, p. 188)

A feasible sequence with the single engineer places B from day 2 to day 6, C from day 6 to day 9 and D from day 9 to day 11. Reversing B and C also gives eleven days under these assumptions. The calculation is 2 + 4 + 3 + 2 = 11. A second qualified engineer could change the capacity assumption, but their availability and any mobilisation or supervision consequences would need evidence. The reviewer should not silently add them simply to protect the earlier finish.

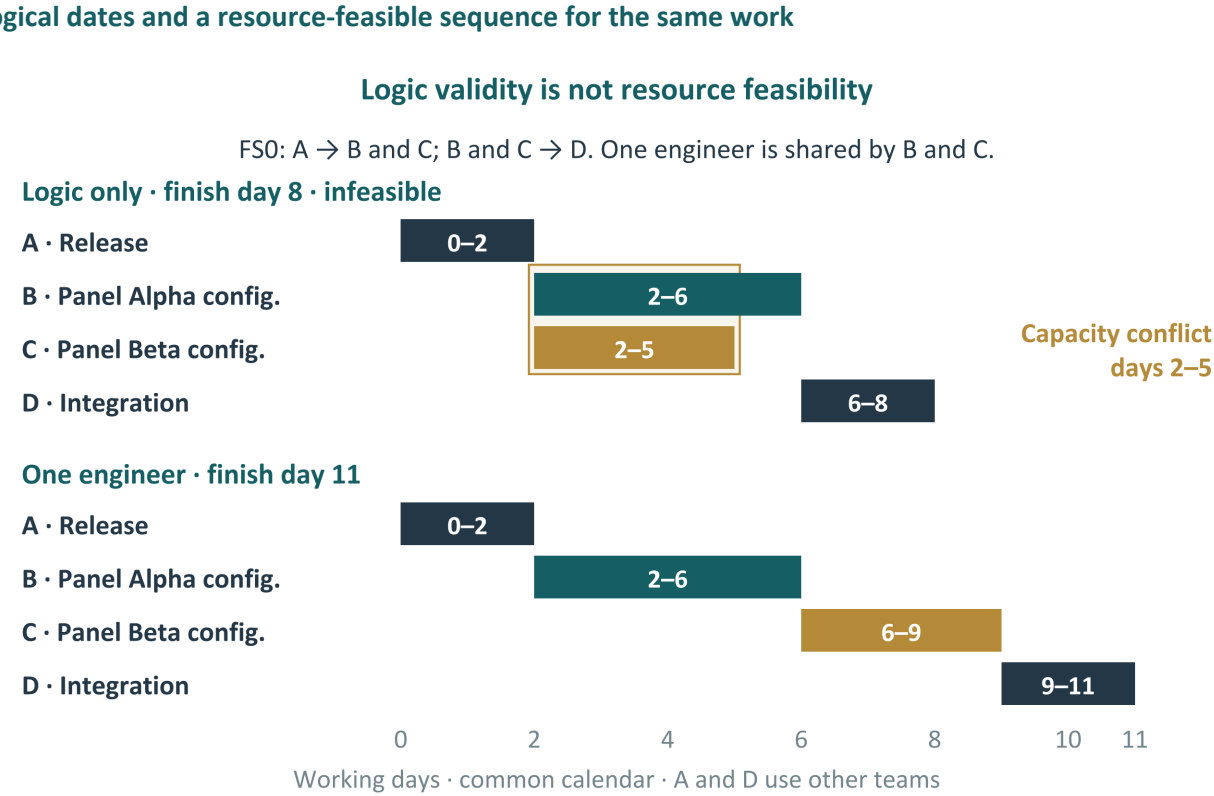


Figure 12.7. An original capacity example. The eight-day logical plan requires overlapping use of one full-time specialist; the stated single-engineer capacity supports an eleven-day sequence.

The finding should identify the two assignments, their overlap, the capacity limit and the milestone consequence. Its correction could be an evidenced second resource, a different feasible method, a revised sequence or an authorised change to the delivery commitment. The chosen response must be reflected in the model and its basis. Closing the finding because a resource report has been hidden, or because the engineer has been given a larger numerical availability without approval, would remove the warning while preserving the problem.

12.8 Reviewing uncertainty, progress and readiness assumptions

Duration estimates should connect quantities, rates, working methods and available conditions. An estimate copied from an earlier project may be useful evidence, but comparability needs examination: access, scope, location, design maturity, crew composition and acceptance criteria may differ. Remaining duration should reflect the work still to be completed, not merely the original duration minus elapsed time. When the evidence is weak, the reviewer should identify the uncertainty and its decision effect rather than convert an optimistic estimate into an assured fact.

Where risk analysis is required, review the input model before interpreting the probability output. Optimistic, most likely and pessimistic durations need a defensible basis; distributions and dependencies should reflect the assumptions being made. Check whether a risk event has already been included in a duration range before adding a separate effect. Resource restrictions, path changes and common causes can alter the result. A simulation can process an incomplete network precisely without making its answer credible. A conformance index and a probability of meeting a date describe different quantities and should never be substituted for one another.

Progress information requires similar care. Physical percentage, elapsed duration and effort consumed answer different questions. A high percentage may leave a small but controlling acceptance activity unfinished. An actual finish needs the agreed completion criterion, while a forecast finish remains a prediction. Review out-of-sequence work to establish what occurred and what dependencies still govern the remaining work. Retaining genuine actuals and explaining a revised remaining sequence produces a more useful record than adjusting history until it resembles the original plan.

Readiness is a set of conditions, not a single visual impression

Completion milestones should identify what is being accepted and by whom. Installation complete, testing complete, operational readiness and public opening can occur at different times. The model should represent the necessary evidence and decision work, including review periods and the handling of test exceptions where applicable. A demonstration can be valuable evidence for a specific function without proving that every required operating condition has been tested. A management visit may confirm attention to delivery without constituting technical acceptance.

MBRSC reported on 9 January 2025 that MBZ-SAT had completed environmental testing, including thermal-vacuum, vibration, acoustic and mass-property tests, and had been transported for launch preparation. Its account describes completed tests within a defined scope followed by further activities. It does not mean launch or operational commissioning was already complete. The transferable scheduling lesson is to identify precisely which acceptance boundary has been crossed and which prerequisites remain before the next milestone (MBRSC, 2025).

SIS's 13 September 2026 account of Egypt's West Nile Monorail records an inspection of the workshop and control centre, a train journey between two stations and briefings on planned passenger-free trials. These are reported events and future arrangements, rather than a published confirmation of final operational acceptance. A schedule reviewer would need evidence matched to the relevant readiness criterion before treating it as achieved. This does not imply that project records were absent; the short public account simply does not establish every acceptance condition (SIS, 2026).

12.9 Combining automated diagnostics with professional challenge

Automated checks can examine large populations consistently and reveal patterns that are difficult to see manually. They can identify missing links, unusual durations, negative float, inconsistent dates, excessive constraints or suspect progress entries. Their usefulness depends on the data supplied, the tool settings and the definition of each test. Preserve the test version, population, exclusions and calculation basis. A report from a commercial checking tool is evidence of what that tool tested, not automatically a certificate of conformance with PMI or any government organisation's requirements.



Figure 12.8. An original diagnostic workflow. Investigate an alert, determine whether it is a defect or a justified exception, and verify the effect of any correction. A clean report is only one part of assurance.

GAO's 2015 account of the historical DCMA 14-point assessment states that its thresholds are starting points for analysis rather than automatic compliance triggers. More recent DCMA procedures inspected for this chapter use EVMS Compliance Metrics as indicators requiring further investigation. The November 2025 surveillance procedure states that an out-of-threshold result does not automatically create a finding; the compliance-review procedure identifies the applicable metric version at review notification. These are specific US EVMS practices, not PMI's 111-component calculation or universal schedule-acceptance rules (GAO, 2015, p. 190; DCMA, 2025a, p. 8; 2025b, p. 8).

Investigate both false alarms and missed defects

A legitimate project start may have no predecessor. A justified external milestone may require a particular date treatment. A long activity may represent an appropriate future planning package, while a much shorter activity may conceal several incompatible work fronts. These possibilities do not excuse weak modelling; they show why the reviewer needs the criterion, context and supporting evidence. An exception should have a reason and an effect assessment, not simply a tick that removes it from the report.

The absence of an alert also needs interpretation. A missing commissioning package may not trigger a link check because the omitted activities are not present to be tested. Incorrect but well-formed dependencies can pass a structural rule. A resource name can be present while its owner has not committed the capacity. Professional challenge therefore asks questions outside the diagnostic report. The aim is to understand whether the plan represents delivery, rather than optimise the model to satisfy a limited set of numerical tests.

Research insight: machine learning can support relationship review

Amer, Hockenmaier and Golparvar-Fard (2022) investigated automated critique of activity relationships using natural-language processing and information from activity descriptions and the WBS. Their study used 3,387 activities from three hospitality projects and reported an F1 result of 88.3% for its relationship-classification work. That performance measure concerns the tested classification task; it is not the proportion of an entire schedule known to be correct, a PMI conformance index or a delivery probability. The research supports using automated suggestions to focus review while retaining domain judgement about physical dependencies, interfaces and the consequences of a proposed correction.

Benchmark with comparable conditions

Historical data and peer schedules can help challenge unusually short durations, low allowances or exceptional productivity assumptions. The comparison needs a defensible basis: scope, quantity, complexity, location, access, calendar and maturity may differ. A benchmark range is more informative when the reviewer can explain these differences. Treating an industry average as a mandatory duration can be as misleading as accepting a project's unsupported optimism. Where the proposed performance is better than the reference, ask what specific method, capability or condition accounts for it.

Assurance should also recognise behavioural effects. A target that rewards fewer alerts can encourage deletion of genuine constraints or unjustified splitting of activities. A target that rewards a higher index can encourage irrelevant optional fields. A more useful discussion connects each finding to a decision risk and a credible improvement. The scheduler should be able to explain how the model became more truthful or useful, not merely how its dashboard became greener.

12.10 Recording findings and verifying closure

A finding should connect the applicable criterion, the evidence observed, the weakness and its consequence. For example, the capacity example is stronger when it identifies B and C, the overlapping dates and the single-engineer limit than when it merely says resources are unrealistic. The consequence explains why the issue matters: the current eight-day forecast depends on unavailable capacity. The action then addresses the cause and the decision, such as confirming an additional qualified resource or revising the sequence and commitment.

Prioritise findings by their effect on the review decision. A missing controlling interface, false actual completion or unsupported critical resource may invalidate a milestone recommendation. A minor naming inconsistency may still need correction but need not carry the same urgency. The severity system should be defined for the review and not confused with PMI's equal one-point component contributions. One component point can expose a major delivery weakness, while several lower-consequence presentation issues may have little effect on the forecast.

Ownership, due points and closure evidence

An action needs an accountable owner, the required correction or evidence, and a due point linked to the decision it supports. A generic end-of-month deadline may be too late if the commitment is made next week. Identify whether the finding blocks approval, permits a conditional decision or can be addressed through routine improvement. If an action cannot be completed in time, the decision-maker needs the consequence and available alternatives, rather than an unexplained overdue status.

Reported completion is not verified closure. The owner provides the changed model and supporting evidence; the reviewer retests the relevant criterion and examines wider consequences. Adding a missing predecessor may resolve a structural defect while moving the finish, changing the critical path or exposing a resource conflict. The review should capture those consequences before the finding is closed.

Closure does not require pretending that the corrected forecast is favourable; it requires demonstrating that the identified weakness has been addressed and the resulting position is understood.

From a recorded finding to verified closure and an archived record

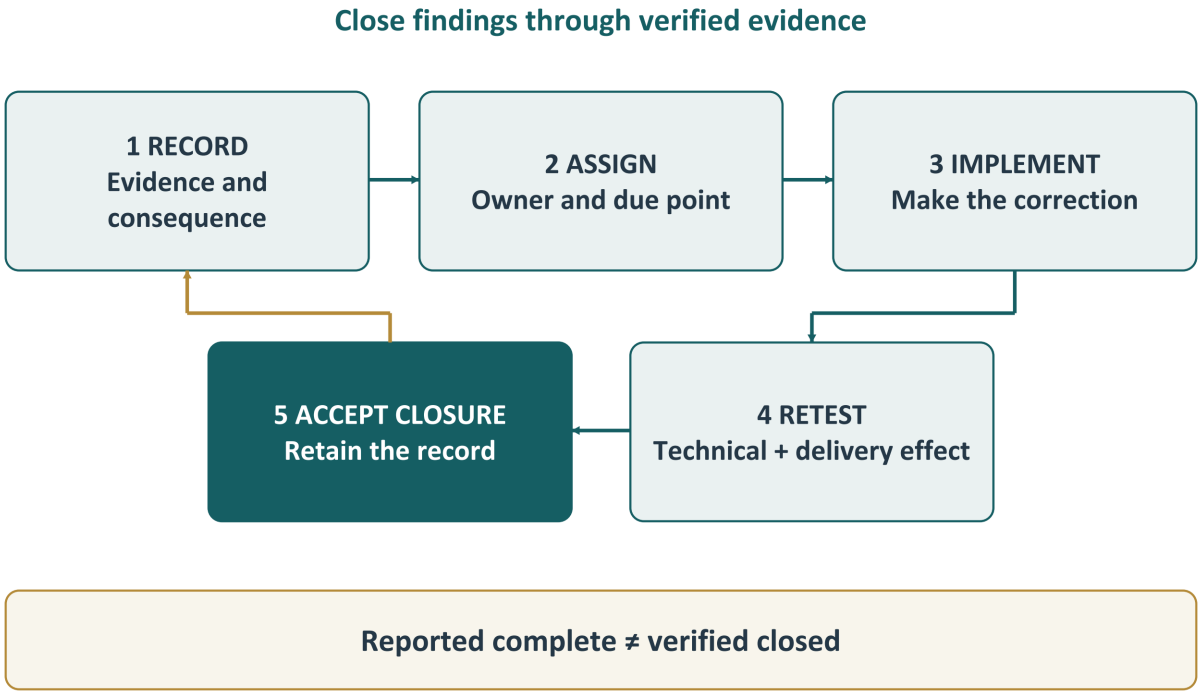


Figure 12.9. An original finding-closure workflow. A change is retested for both technical correctness and delivery effect before closure is accepted.

UK: Ajax and the difference between scrutiny and follow-through

The Sheldon review of Ajax, signed in May and published in June 2023, found that external scrutiny had identified important programme problems, including through schedule and Gateway reviews. Follow-through was limited and selective, and reviewers did not consistently establish whether recommendations had been enacted. Recommendation 13 called for monitoring and challenge about implementation and reasons for non-implementation. The case demonstrates that identifying a weakness and resolving it are different achievements. It does not establish a quantified delay that would have been avoided by any individual recommendation, nor a current assessment of the programme (Sheldon, 2023, pp. 131-133).

Retest the current position without losing the original finding

Finding records should preserve the original evidence, the response, the revised model identity, the retest and the closure decision. If a later change recreates the same weakness, the issue may need to be reopened. If an action is superseded by an authorised scope change, record why and assess any remaining effect. Deleting superseded findings removes the ability to explain how the assurance position evolved. The history also helps identify recurring process weaknesses, such as repeated calendar imports or poorly controlled external interfaces.

A disagreement about a finding should be resolved through evidence and the applicable criterion. The model author may have a valid reason that the reviewer initially missed. Equally, a senior stakeholder's preference for an earlier date does not invalidate a demonstrated capacity conflict. Record the issue, the competing interpretations, the additional evidence considered and the authorised disposition. Where

uncertainty remains material, the assurance conclusion should retain it instead of converting disagreement into an unqualified pass.

12.11 Making an assurance-backed milestone recommendation

The final recommendation should identify the model and data date, the decision reviewed, the criteria applied, the extent of testing and the material findings. Report the required-component gate and any eligible index separately from diagnostic metrics and delivery judgement. Explain whether the milestone is supported by the reviewed evidence, depends on outstanding conditions, is unsupported because of material weaknesses, or cannot yet be assessed because evidence is insufficient. These are decision descriptions used in this chapter, not official PMI maturity bands.

Table 12.4 | Communicating an assurance-backed milestone

Decision description	What the evidence supports	What the communication must make clear
Supported within the review scope	The reviewed plan and assumptions support the specified decision	Version, boundary, assumptions and residual uncertainty
Supported subject to conditions	Identified conditions must be met at specified points	Owners, evidence, due points and consequences if conditions fail
Not supported	Material weaknesses prevent a defensible commitment	Required corrections, affected milestones and feasible next steps
Unable to conclude	Missing or unreliable evidence prevents assessment	Information needed and limits on decisions before it is available

Update the basis of schedule as the explanation of the model

Material review outcomes should flow into the basis of schedule. Record corrected scope boundaries, changed calendars, duration bases, resource assumptions, interfaces, constraints, risk treatments and milestone criteria. Identify the approvals and unresolved limitations. The basis should explain why the current model is credible under its stated conditions, not reproduce an obsolete description of the original plan. The narrative, native file and presented milestone dates should refer to the same controlled position.

For the single-engineer example, an appropriate conclusion would state that the eight-day logical finish is not supported by the confirmed capacity. An eleven-day sequence is feasible under the stated working pattern and dependencies, while an eight-day option would require evidence of additional capability or a different valid method. If a second engineer is proposed but not yet committed, the shorter date remains conditional. This is more useful than reporting that the network passed a missing-logic test or that most fields were correctly populated.

France: stage-specific assurance with explicit future conditions

ASNR's November 2025 opinion on Cigéo judged the safety case satisfactory at the stage of an application for authorisation to create the facility, while identifying further evidence for later stages. It considered the development schedule realistic on the information available, envisaged technical requirements or hold points and made pilot commissioning conditional on additional evidence and conformity demonstrations. This was a stage-specific regulatory judgement, not the creation-authorisation decree or final acceptance of a completed facility. Its relevance is the explicit connection between a favourable current assessment, future conditions and the milestone at which those conditions matter (ASNR, 2025, pp. 4-8).

PMI-SP examination judgement

For examination purposes, keep the assessment sequence clear. Establish the requirements before allocating conditional groups. Check proper use before awarding points. Apply the required-component gate before calculating an eligible index. Keep the denominator at 111 and exclude not-scored components. Interpret a diagnostic result through evidence, and distinguish a model that conforms from a delivery commitment that has been justified. When a required component fails, optional points cannot repair the gate; when an alert appears, investigate before deciding whether it is a defect.

PMI's published examination outline includes validation, schedule analysis, maintenance, stakeholder communication and the application of appropriate controls. This chapter supports those professional judgements without implying that Appendix X4 arithmetic is the whole examination or that memorising a checklist is sufficient preparation (PMI, 2012; PMI, n.d.). Chapter 13 develops how to communicate schedule decisions to different audiences, confirm completion and preserve the records and lessons needed at closeout.

Knowledge check and examination practice

Question 1

A project requires resource loading and schedule-based risk management but does not require EVM. Under PMI's conformance method, what are the required and optional point totals?

A 36 required and 46 optional, with a denominator of 82.
B 56 required and 55 optional, with a denominator of 111.
C 65 required and 46 optional, because all groups are always required.
D 56 required and nine optional, with a denominator of 65.

Question 2

A model requiring resources and risk earns 55 of its 56 required points and all 55 optional points. What should the assessor report?

A A passing index of 99.1%, because only one point is missing.
B An eligible index of 100%, because optional points compensate.
C An index based on the required points alone.
D No recorded conformance index; the raw counts can support diagnostic improvement.

Question 3

A model earns all 65 required points when resources, EVM and risk are mandated, plus nine optional points. What is its index rounded once at the end to one decimal place?

A 66.7%.
B 74.0%.
C 90.0%.
D 65.0%.

Question 4

A local diagnostic checks forty eligible incomplete activities and identifies four without the predecessor required by its rule. Which interpretation is correct?

A The PMI conformance index is 90%.
B There is a 90% probability of achieving completion.
C The missing-predecessor rate is 10%, and the four alerts need examination against the rule and evidence.
D Every activity with a predecessor is known to be feasible.

Question 5

Release A takes two days. Independent configurations B and C then take four and three days, followed by two-day integration D after both. B and C each need the same single engineer at full capacity; A and D use other teams. What is the earliest feasible finish under these assumptions?

A Day 8, because the logical network is complete.
B Day 11, because B and C must use the engineer sequentially.
C Day 9, because resource limits add only one day.
D Day 7, because parallel durations should be averaged.

Question 6

A commercial checking tool reports that a schedule passes all its selected diagnostics. The supplier requests unconditional acceptance of the completion milestone. What should the reviewer do next?

A Accept, because automated checks replace delivery judgement.
B Require every optional component solely to maximise the index.
C Remove all constraints so no further warnings can appear.
D Examine scope, assumptions, interfaces, resources and supporting evidence against the agreed review criteria.

Question 7

An action owner reports that a missing relationship has been added. The corrected model calculates a later finish. What is the appropriate closure approach?

A Retest the relationship and its wider effects, record the revised forecast and decide closure against the original finding.
B Delete the new relationship because it worsens the date.
C Close the action on the owner's statement without examining the model.
D Reset the baseline automatically so the variance disappears.

Question 8

A milestone is achievable only if an additional qualified engineer is confirmed before the planned configuration start. No commitment has yet been evidenced. Which assurance conclusion is most defensible?

A The milestone is guaranteed because the resource field exists.
B The resource can be assumed because the conformance index is high.
C The shorter plan is conditional on evidenced capacity by the required point, with the alternative forecast and consequences stated.
D The missing evidence should be omitted until the milestone is missed.

Answer explanations

1: B. The required total is CRC 36 + RRC 13 + KRC 7 = 56. The optional pool is the general 46 plus nine ERC points, giving 55. Together they remain 111. Conditional groups that are not required become optional; they do not disappear from the denominator or become universally required.

2: D. The required-component gate has failed. The 110 raw points can help explain the model's position and identify improvement, but they cannot be recorded as an eligible conformance index. Optional points do not compensate for a missing required point. The finding and its effect must be addressed before eligibility is reassessed.

3: A. Total earned is 65 + 9 = 74. The calculation is 74/111 × 100 = 66.666...%, which rounds to 66.7%. The denominator remains 111 even when all conditional groups are required. Rounding intermediate values or treating the point total as a percentage gives the wrong result.

4: C. The metric is 4/40 × 100 = 10%. It concerns a defined population and rule, not PMI's component index or a probability of completion. The reviewer must establish whether each alert is a genuine missing dependency or a justified exception. The absence of this particular alert does not prove that other logic, scope or resource assumptions are correct.

5: B. With one engineer, the two configurations require seven sequential working days after the two-day release. Integration then adds two days, giving 2 + 4 + 3 + 2 = 11. The eight-day logical calculation assumes overlap that the stated capacity cannot support. Either configuration order gives the same finish in this simplified example.

6: D. A clean diagnostic report shows that the selected rules did not identify exceptions under their settings. It does not establish complete scope, valid assumptions or available capacity. The assurance conclusion requires the agreed criteria and relevant evidence. Arbitrary component additions or removal of genuine constraints can improve appearances while weakening the model.

7: A. Closure requires verification that the original weakness has been corrected and its consequences understood. A later forecast may be the truthful result of restoring missing logic. Removing the relationship or automatically changing the baseline would conceal the issue. The revised model, retest and decision should remain traceable to the finding.

8: C. The evidence supports a conditional option, not an unconditional promise. State who must confirm the resource, the required timing and what happens if the condition is not met. A numerical resource entry and an eligible component index cannot supply an unavailable person. The confirmed-capacity forecast should remain visible alongside the conditional shorter option.

References and further reading

PMI page references are the printed pages of the third edition. The worksheet calculations use visible earned-point rows and the governing category totals, with final percentages rounded to one decimal place. Dated cases describe their sources' reporting positions. Frameworks, diagrams, independent examples and examination questions are original teaching material.

Amer, F., Hockenmaier, J. and Golparvar-Fard, M. (2022). 'Learning and critiquing pairwise activity relationships for schedule quality control via deep learning-based natural language processing'. *Automation in Construction*, 134, 104036. https://doi.org/10.1016/j.autcon.2021.104036.

Australian National Audit Office (ANAO) (2026). *Defence's Procurement of Infantry Fighting Vehicles (Land 400 Phase 3)*. 30 March. Especially paragraphs 3.59-3.65. Official audit.

Autorité de sûreté nucléaire et de radioprotection (ASNR) (2025). *Avis n° 2025-AV-016 relatif à la demande d'autorisation de création de l'installation nucléaire de base dénommée Cigéo déposée par l'Andra*. 25 November. Especially pp. 4-8. Official opinion.

Bundesrechnungshof (2025). *Zentrale IT des Bundes: 10 Jahre IT-Konsolidierung Bund und Netze des Bundes*. 8 July. Especially pp. 18-22. Official audit.

Defense Contract Management Agency (DCMA) (2025a). *Business Practice 4: EVMS Surveillance*. Revised 4 November. Especially p. 8. Official procedure.

Defense Contract Management Agency (DCMA) (2025b). *Business Practice 6: EVMS Compliance Review*. Revised 18 November. Especially p. 8, steps 10-12. Official procedure.

Government Project Delivery (2025). *Government Functional Standard GovS 002: Project delivery*. Version 2.1, 1 September; official HTML modified 29 March 2026. Sections 4.2-4.3. Official standard.

Mohammed Bin Rashid Space Centre (MBRSC) (2025). *MBRSC Announces Final Preparations Under Way for Launch of MBZ-Sat*. 9 January. Official account.

Office for Nuclear Regulation (ONR) (2026). *Hinkley Point C: Inspection ID 53847*. Published 10 February; inspection 3-4 November 2025. Official inspection record.

Project Management Institute (PMI) (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Official outline.

Project Management Institute (PMI) (2019). *Practice Standard for Scheduling*. 3rd edn. Newtown Square, PA: PMI. Core coverage: section 4, pp. 93-136; section 5, pp. 137-141; Appendix X3, pp. 151-157; Appendix X4, pp. 159-164. Reinforcement: section 3.4 and Appendix X5. Formal definitions cite printed pages individually.

Project Management Institute (PMI) (n.d.). *PMI Scheduling Professional (PMI-SP)*. Current certification resources. Official certification page.

Sheldon, C. (2023). *Report of the Armoured Cavalry Programme (Ajax) Lessons Learned Review*. Signed 19 May; published by the Ministry of Defence 15 June. Especially pp. 131-133, sections 7.7.2.1-7.7.2.5 and Recommendation 13. Official review.

Srinath, P. and Varghese, K. (2023). 'Identifying and Analysing the Root Causes of Quality Non-Conformance in Construction Project Baseline Schedules'. *Journal of The Institution of Engineers (India): Series A*, 104(2), pp. 397-416. https://doi.org/10.1007/s40030-023-00713-0.

State Information Service, Egypt (SIS) (2026). *PM: Egypt pushes green transport projects to ease congestion, cut emissions*. 13 September. West Nile Monorail inspection and trial-readiness account. Official report.

US Government Accountability Office (GAO) (2015). *Schedule Assessment Guide: Best Practices for Project Schedules*. GAO-16-89G, 22 December. Especially pp. 148-165 and 190. Official guide.

US Government Accountability Office (GAO) (2026). *Nuclear Security Enterprise: Assessments of NNSA Major Projects*. GAO-26-107777, 26 February. Surplus Plutonium Disposition, pp. 58-59. Official audit.

CHAPTER 13

Communicating Schedule Decisions and Closing Out

A technically sound schedule does not make decisions by itself. People must understand what its dates mean, recognise the choices available and accept responsibility for what happens next. Near the end of a project, the same difficulty appears in a different form: a system can be operating while documentation remains incomplete, a contractual obligation can remain open after physical work has finished, and a project can close while an operational team continues to measure benefits. The scheduling professional makes these distinctions visible. The purpose of this chapter is to connect reliable schedule information with decisions, and then to preserve an honest account of delivery when the project hands over and closes.

The chapter develops a decision-to-learning cycle: establish the audience and decision, release controlled information, explain the consequence, secure and record a response, confirm the transition, and preserve evidence and learning. This is an original teaching framework, not an additional PMI standard or a scoring system. It joins communication and closeout because both depend on shared understanding of the same questions: what has happened, what is still expected, what has been authorised and what evidence supports that position? The cycle applies to engineering, construction, digital and organisational change projects. It does not assume previous study of risk management or another optional module.

The decision-to-learning cycle

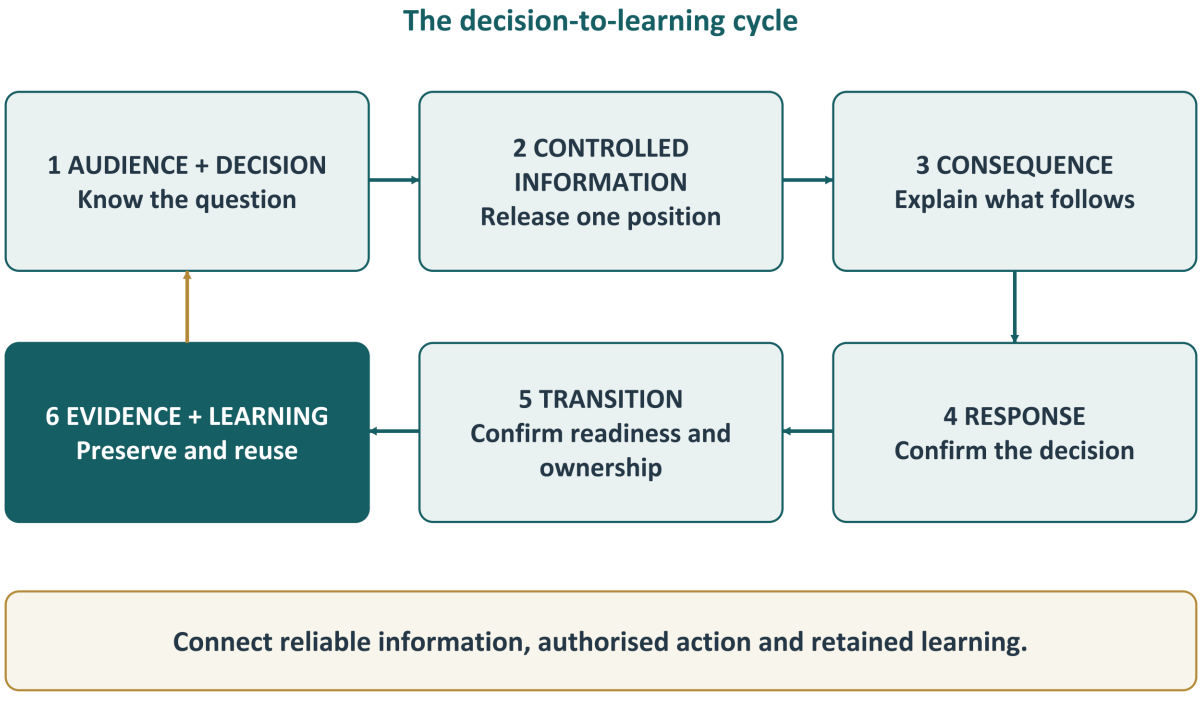


Figure 13.1. Communication creates a decision; closeout preserves what was decided, delivered and learned. Original teaching framework.

By the end of the chapter, the learner should be able to select presentations for different audiences without changing the underlying facts; explain baseline, forecast and actual dates consistently; facilitate disagreements and escalation using evidence; distinguish physical completion, acceptance, operational readiness and project closure; prepare an intelligible final schedule account; and preserve records that another competent person can reconstruct. These capabilities require judgement as well as software competence. The Level 6 occupational standard emphasises the reliability of controls information, interpretation in context and authoritative recommendations to decision-makers. The professional remains accountable for the recommendation even when another person holds the authority to approve it (Skills England, n.d.).

13.1 Start with the decision, the audience and the evidence

> **Stakeholder.** 'An individual, group, or organization that may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio. See also sponsor.' (PMI, 2019, p. 191)

A useful schedule conversation begins with the decision that the recipient can make. A sponsor may need to approve additional expenditure, an operations manager may need to release staff for training, and a contractor may need to confirm the date at which another party can enter its work area. Sending all three people the same thousand-line printout is unlikely to serve these purposes. The common starting point is a controlled model; the difference lies in the question, the level of explanation and the action requested. A report should therefore have a purpose beyond its place in the monthly reporting cycle. Even a routine report needs to make clear whether it records an agreed position, seeks a decision, requests validation or provides an early warning.

Communication should be designed while the schedule management arrangements are established. Agree which information is required, who provides it, who checks it, who can approve its release and who receives it. Specify the normal reporting cycle and the conditions that require communication between cycles. A material change to a handover milestone cannot sensibly wait three weeks merely because the next formal dashboard is due then. Equally, every minor movement should not become a sponsor-level escalation. The distinction depends on agreed tolerances, the consequence for other parties and the remaining time to act. A scheduler who understands those arrangements can communicate promptly without bypassing the project's decision structure.

The communication plan and the schedule management plan have related but different purposes. The first establishes how information moves between people; the second establishes how the schedule is developed, maintained, analysed and controlled. Their requirements should agree about reporting dates, review responsibilities, approved presentations and change notifications. PMI links distribution of a completed update to both plans in Section 3.3.6 and develops stakeholder information needs in Section 3.5. The professional should check this relationship in practice: if contractors submit progress on Friday but the programme extract is frozen on Thursday, a nominally consistent reporting cycle may repeatedly publish incomplete information (PMI, 2019, pp. 69, 88-91).

Tailoring means changing the explanation

The UK Government Functional Standard GovS 002 connects reporting with current status, future outlook and comparison against the baseline. It says reports should address recipients' needs, identify the effective period and publication date, and explain decisions and confidence in forecasts. Its communication guidance also addresses feedback and effectiveness. Within its government scope, this supports a practical distinction: publishing information is an activity, while enabling an informed response is the intended result (Government Project Delivery, 2025, sections 7.5 and 7.13).

Audience analysis should consider decision authority, technical knowledge, exposure to the consequences and opportunity to respond. A senior recipient is not automatically interested only in a single date; an executive deciding whether to commit major expenditure may need a clear account of the assumptions behind that date. A supervisor may require detailed sequences but little discussion of the portfolio business case. An external client may need a formally issued contractual presentation as well as a shorter discussion paper. Tailoring changes the depth, terminology and form of communication. It does not permit the scheduler to show a favourable forecast to one audience and a different, undisclosed forecast to another.

Table 13.1 | Tailoring communication to the decision-maker

Audience and decision	Useful schedule information	Communication and response
Sponsor or investment board: approve a response	Key milestone movement, consequences for objectives, feasible options, cost and uncertainty	Short decision paper supported by the controlled model; named authority, decision deadline and recorded outcome
Programme leadership: protect interfaces	Deliverable dates, external dependencies, shared resources and effects on other projects	Integrated milestone and interface discussion; explicit confirmation from both sides of each material interface
Client or contract manager: review obligations	Contract milestones, current forecast, notices and evidence required by agreed procedures	Formally issued report with references; distinguish forecast information from contractual agreement
Delivery team and contractors: coordinate work	Logic, access, resources, prerequisites, quantities and the near-term work sequence	Look-ahead and coordination meeting; resolve constraints and confirm who will act by when
Operations and maintenance: accept a usable outcome	Test status, training, operating arrangements, records, residual work and support availability	Readiness review and handover discussion; acceptance and outstanding responsibilities recorded explicitly

The comparison also exposes an important limit of a distribution list: receipt is not understanding. A recipient may have opened a report but interpreted a forecast as an approved promise, or assumed that an amber milestone requires no action. Close the communication loop by asking the recipient to confirm the decision, assumption or dependency that matters. For a significant handover, this may require a formal review. For a short-term interface, it may be a documented coordination exchange. Confirmation should be proportionate, but silence should not be treated as approval unless a valid project procedure explicitly provides for that outcome.

Documented cases: a date is an input to someone else's plan

The National Audit Office's May 2024 report on the UK trade border recorded that business and port representatives considered late announcements and timetable uncertainty obstacles to preparation for the April 2024 import controls. Readiness extended beyond government systems to the organisations expected to use them. This is a historical account of implementation, not a description of today's border regime. Its scheduling lesson is to consider recipients' preparation time: a technically correct announcement can arrive too late to support recruitment, facilities or operating arrangements (NAO, 2024, p. 36, paragraph 2.18).

In the USA, GAO found communication weaknesses during the 2024-25 FAFSA student-aid rollout. Colleges expected student records by the end of January 2024; on 30 January, Education announced that delivery would instead begin in mid-March. Colleges had to adjust dependent aid-offer work, and

associations described disruption to previously arranged IT support. GAO recommended reliable, timely communication of milestones. The case illustrates why an update needs to explain changed expectations and affected dependencies, rather than simply replace a date on a website. It does not establish that every subsequent difficulty was caused by communication alone (GAO, 2024, pp. 29-31).

Analyse who is affected and when engagement can change the outcome

Stakeholder-impact analysis connects the schedule decision to the people affected by it. Identify who can influence the decision, who experiences its consequences, what matters to them, and when their contribution or approval is needed. Record the consequence of a missed engagement and agree the owner, channel and response date. Power and interest mapping can help prioritise contact; UK Government Analysis Function guidance also emphasises keeping the map current and connecting it to an engagement plan (2026). Extend that view to affected groups with little formal influence. An operator who will inherit unfinished commissioning work may have less organisational power than a sponsor, but excluding the operator can undermine the handover.

Use the book's original **impact-to-action sequence: affected interest, delivery consequence, decision window, engagement action, checked understanding**. For example, moving a hospital equipment handover forward changes the operator's training window. Consult the operational lead before approving the date, identify the necessary training and acceptance activities, and confirm the revised arrangement in a form both parties understand. Revisit the analysis after scope, leadership or milestone changes. Sending a report demonstrates transmission; a response that correctly explains the consequence provides stronger evidence of understanding.

Make participation accessible and culturally sensitive

International and diverse teams can differ in language fluency, working calendars, communication preferences and confidence in challenging authority. Ask about individual needs rather than infer behaviour from nationality. Use unambiguous dates and time zones, accessible materials, a shared terminology list and advance reading where useful. Provide written and spoken ways to raise concerns, allow interpretation where needed, and check understanding without treating silence as agreement. A facilitator can invite a junior specialist to explain a technical dependency before senior participants propose a date. These arrangements improve the quality of scheduling evidence as well as the fairness of participation.

13.2 Produce several views from one controlled position

> **Schedule Model Presentation.** 'An output from schedule model instances used to communicate project-specific data for reporting, analysis, and decision making.' (PMI, 2019, p. 130)

PMI distinguishes the data held within the scheduling tool from the presentations produced from that data. A schedule model instance can support milestone lists, network diagrams, resource profiles, activity lists, time-phased costs and other outputs. These views answer different questions about a common position. A bar chart is therefore not the whole model, and a spreadsheet copied from a report is not automatically an independent source of scheduling truth. Section 2.5 describes this relationship, while the Schedule Model Presentation component on printed page 130 makes the communication output an explicit part of the scheduling environment (PMI, 2019, pp. 30-31, 130).

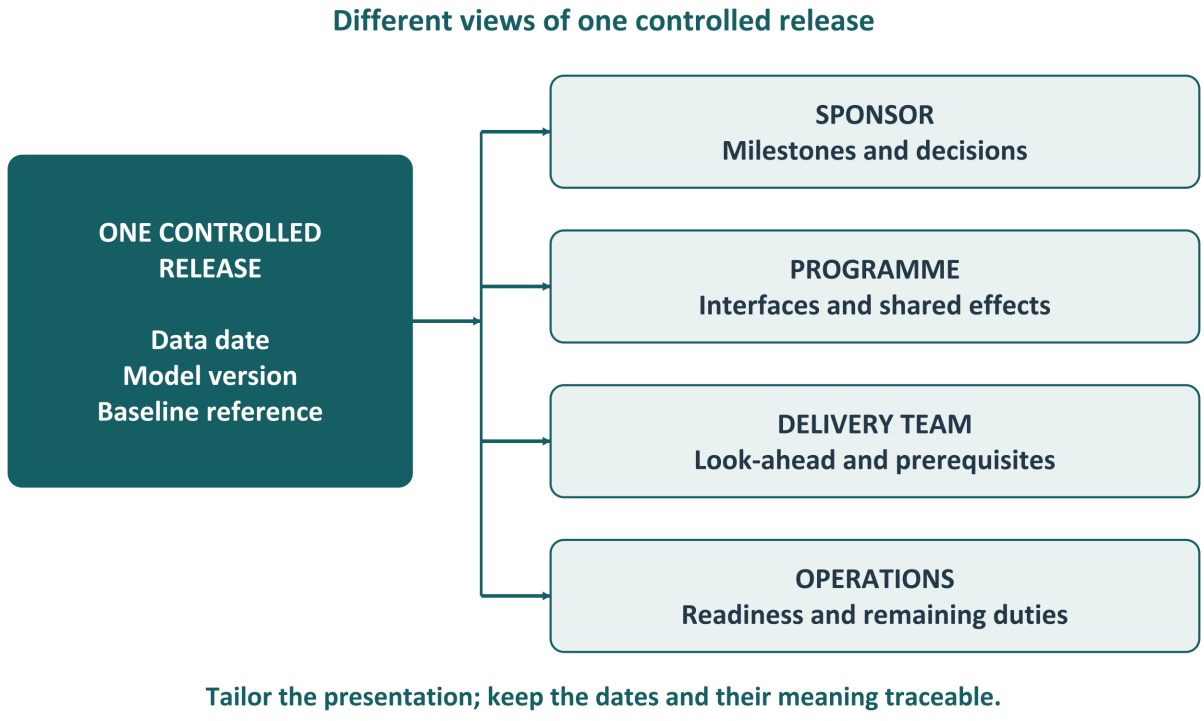


Figure 13.2. Different audiences receive different views of the same release. Filters and aggregation change the presentation, while dates and their meaning remain traceable.

Every material presentation should allow its reader to identify the project, reporting period or data date, model revision and baseline comparator. It should also state the scope of the view, units, calendar assumptions where relevant and any important exclusions. These are not decorative labels. A resource histogram without its time unit can turn weekly demand into an apparent daily requirement. A milestone table without a baseline identifier may compare an approved revision with a superseded reference. Where related systems use different cut-off dates, disclose and reconcile the difference; do not conceal it beneath a common dashboard heading. For example, actual cost may be through the previous accounting period while schedule progress is current to Friday.

The release process should make the relationship between views reproducible. Complete and validate the update, preserve the relevant model instance, generate the approved layouts and check that key dates reconcile across outputs. A dashboard should not be corrected by typing a preferred date over a formula while leaving the underlying schedule unchanged. If a late factual correction is accepted, update the controlled record and reissue the affected outputs with an intelligible revision note. Recipients who have already acted on the earlier report need to know what changed. A superseded report remains part of the history, but its status should prevent its accidental use as the current instruction.

Select the view that answers the question

The presentation component's good practices explicitly address a bar-chart visual, the output-generation date, descriptions of the output and major items, progress and the current data date, and readable network relationships with minimal unnecessary crossings. The generation date and data date are different: a report produced today may describe last Friday's accepted position. The book classifies this component as required, manual and graphical. That classification does not instruct the scheduler to type preferred dates over calculated outputs; it identifies the presentation component and the need to design its use deliberately (PMI, 2019, p. 130).

Bar Chart. 'A graphic display of schedule-related information. In the typical bar chart, schedule activities or work breakdown structure components are listed down the left side of the chart, dates are shown across the top, and activity durations are shown as date-placed horizontal bars. Also known as a Gantt chart.' (PMI, 2019, p. 176)

State whether the displayed dates represent an early-start, late-start, baseline, resource-limited or target view: those alternatives do not convey the same planning position. In adaptive work, burn charts and Kanban views can communicate remaining work and its flow, provided their scope and state rules are clear. A team work list, departmental view or master schedule should retain the relationships needed to interpret its boundary (PMI, 2019, pp. 30-31).

Milestone presentations are effective when the question concerns an event, approval or delivery promise. Network diagrams expose the sequence and the reason that a predecessor affects a successor. Bar charts communicate timing and overlap; resource profiles reveal demand and potential capacity conflicts; look-aheads organise near-term coordination; and performance plots show trends against a stated reference. None is universally superior. A network with every relationship visible may overwhelm a sponsor, while a sponsor's summary may conceal the practical dependency that a supervisor must resolve. Select the representation after identifying the decision, then provide enough supporting detail for challenge.

Table 13.2 | Selecting an appropriate schedule presentation

Presentation	What it helps the reader understand	Limitation to explain
Milestone table or trend	Original, approved, previous and current dates for significant events	A few dates do not explain the full logic or prove readiness for the event
Logic network	Dependency sequence, driving predecessors and important interfaces	Omitted activities, hidden constraints and resource assumptions can distort the apparent path
Time-scaled bar chart	Timing, duration, overlap and comparison with a baseline	Visual overlap alone does not show that resources or access can support simultaneous work
Resource profile	Time-phased demand compared with an identified capacity	Aggregated totals may conceal missing specialist skills, shifts or location restrictions
Look-ahead or work list	Near-term tasks, prerequisite releases and coordination actions	Work outside the displayed window may still control the milestone or create an interface risk
Performance or flow chart	Trends in quantities, cost, earned value or completed work	The measure, denominator and scope must be clear; a rising curve need not indicate a credible finish

Schedule levels support this selection, but the numbering convention needs to be agreed. PMI presents levels from an overall project summary to detailed planning, and illustrates audience-specific presentations in Section 3.5. A client may use different labels, however. The professional should describe the content and purpose as well as the level number. Summary dates should be derived from the relevant underlying work, and interfaces should remain visible when detail is rolled up. A milestone does not become more reliable because it is displayed at executive level. Likewise, a highly detailed chart may be precise in appearance while depending on an unverified access assumption (PMI, 2019, pp. 65-66, 90-91).

Accessible presentation improves the quality of the decision. Use legible labels, units beside values and symbols or words in addition to colour. Do not rely on red and green alone to explain a milestone's status. A reader should be able to distinguish actual work from forecast work, and understand whether a shaded band represents uncertainty, a working window or a reporting tolerance. Avoid stretched axes that exaggerate small movements and compressed axes that hide material ones. A supporting table can preserve exact values when a chart communicates the pattern. Where a digital dashboard allows filtering, show the active filters so that a partial view is not mistaken for the whole project.

Research perspective: choose a visual for the task

Tang and colleagues compared Gantt, extended Gantt and stringline visualisations in two laboratory experiments involving 93 participants. Performance varied with the question: Gantt displays could be faster for single-sequence comparisons, while stringlines helped with some dense-event comparisons and multiple-sequence patterns. These were fixed-order event-sequence tasks, not live tests of CPM accuracy or project delivery. The reasonable teaching inference is to match the visual to the reader's task and test whether the intended audience understands it. The study does not establish a universally superior scheduling chart (Tang et al., 2024).

13.3 Explain date movement without changing its meaning

> **Schedule Baseline.** 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and performance measurement baseline.' (PMI, 2019, p. 189)

Consider an independent illustrative example: a distribution centre is replacing its conveyor control system. The original approved project finish was the end of week 32. An authorised scope change created a revised baseline finish at the end of week 36. At the previous reporting point the team forecast completion at week 38; at the current data date, the end of week 24, the forecast is week 40. All week numbers refer to elapsed weeks from the same project origin. These are invented teaching data, not a documented project. Their purpose is to demonstrate how several correct numbers can produce different messages when the comparator is omitted.

A milestone bridge distinguishes four different dates

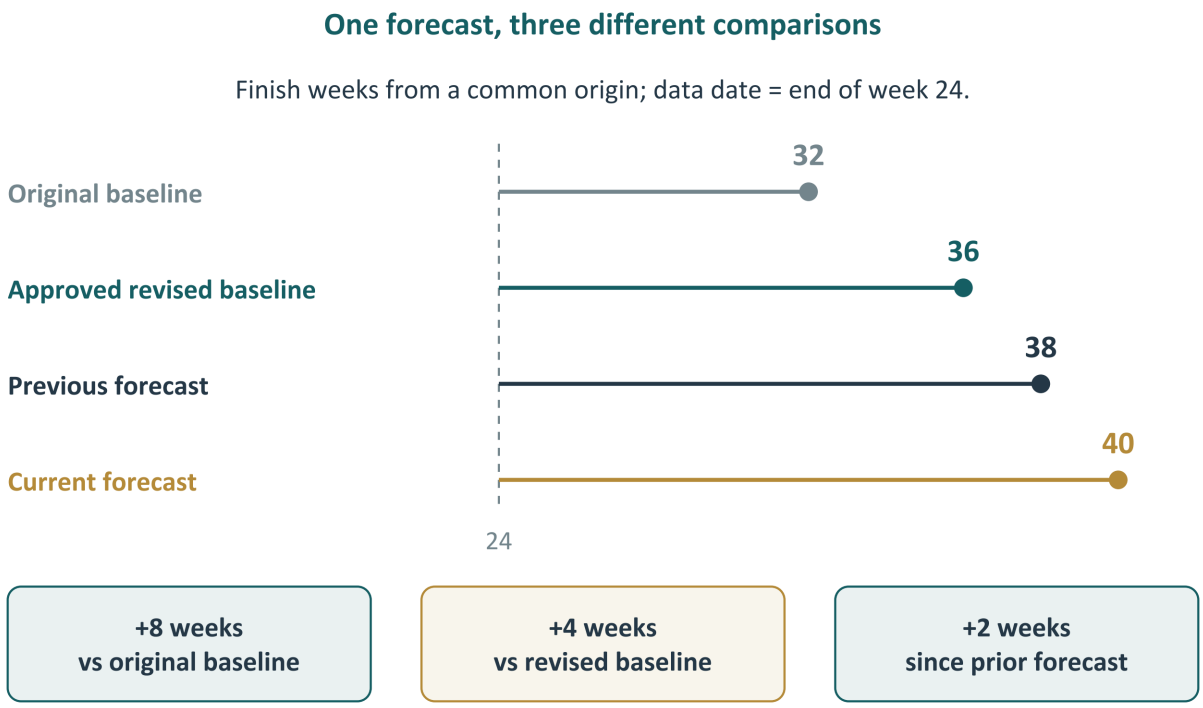


Figure 13.3. The current forecast is eight weeks after the original baseline, four weeks after the revised baseline and two weeks later than the previous forecast. These comparisons answer different questions.

The current forecast is eight weeks later than the original baseline, four weeks later than the revised baseline and two weeks later than the previous forecast. The first comparison preserves the history of the original commitment, but spans a scope change. The second describes the position against the current approved reference. The third shows deterioration since the last report. None can replace the others. In particular, the four-week authorised baseline movement is not automatically evidence of four weeks of inefficiency, and the remaining four-week difference is not, by itself, proof of contractual responsibility. Dates establish the size of a difference; the change record, actual progress and contemporaneous reasoning explain it.

A useful narrative would state that the controlled week-24 update forecasts week 40, identify the revised week-36 baseline, explain the two-week movement from the previous forecast and name the activity or interface driving it. It would then describe the consequence for operational readiness and the available response. The scheduler should distinguish an observed fact, an interpretation and a recommendation. For example, a supplier's confirmed test-slot withdrawal is an observed event; the modelled effect on completion depends on the network and alternatives; a recommendation to buy an additional test slot is a proposed decision. Combining these into a single unsupported statement such as 'the supplier has delayed the project by two weeks' may conceal the very assumptions that require review.

Keep forecasts, targets and commitments distinct

Keep the desired target visible alongside the forecast produced from current assumptions, and identify both the approved comparison baseline and any authorised undertaking. A challenging target can remain visible alongside a later forecast, provided the gap and response are explicit. It becomes misleading when the target is entered as a hard constraint solely to make the model reproduce a preferred date, then presented as an unconstrained prediction. The resulting date may conceal negative float, infeasible resources or unresolved prerequisites. A decision-maker needs to see what would have to change to achieve the target, who can authorise that change and whether the proposed response has actually been incorporated into the released forecast.

When uncertainty matters, explain the basis of the estimate before quoting confidence. An illustrative statement that a simulation places 80 per cent of modelled finishes on or before week 42 describes the output of that model and its assumptions. It does not guarantee that the real project has an 80 per cent chance of success regardless of omissions or future decisions. Specify the milestone, analysis date, important risk assumptions and whether proposed responses are already included. A reader should not have to guess whether '80 per cent confidence' concerns the project finish, an individual activity or the speaker's personal opinion. Where quantitative analysis is not justified, communicate the principal sources of uncertainty and the conditions that would change the forecast without inventing a numerical probability.

A concise status narrative can follow five connected questions: what is the controlled position, why has it changed, what consequence follows, which response is recommended, and who must decide by when? These questions are a drafting aid, not a substitute for analysis. The consequence should be expressed in terms meaningful to the audience, such as the loss of an access window, delayed revenue, additional staffing or a threatened interface. The decision deadline should be derived from the time needed to implement the response. Asking for a decision 'as soon as possible' is weaker than explaining that a supplier slot must be reserved by Friday to preserve the option. An early decision can have value even when the preferred final outcome remains uncertain.

A decision narrative connects evidence with authority

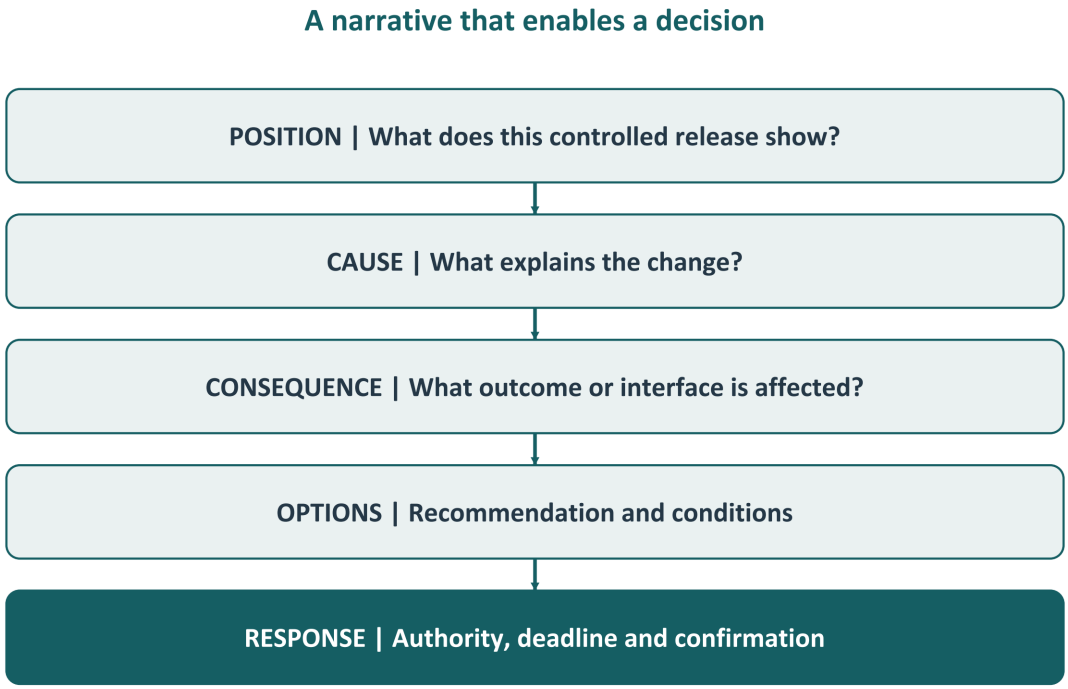


Figure 13.4. A decision narrative links the controlled position to an explicit response. Original communication model; the stages are prompts for judgement rather than a compulsory report template.

Use status colours as prompts for investigation

A red, amber or green indicator is useful only when its basis is known. One project may classify a milestone by days of variance; another may consider the likelihood of meeting it and the adequacy of the response. If the rules differ, the same colour does not mean the same thing. Report the threshold or interpretation beside the indicator, and retain the underlying forecast, variance and conditions. A milestone can remain on its baseline date while its risk increases because float has been consumed. Conversely, a late milestone can have a credible, approved response. A single colour cannot express all these dimensions, so the narrative should explain what the indicator is signalling and what action is needed.

Trend reporting is valuable because it reveals movement that an isolated snapshot hides. A finish forecast of week 40 has a different interpretation if it has remained stable for six reporting cycles than if it has slipped by two weeks every month. Stability alone is not proof of credibility: a constrained date can remain unchanged while the work behind it becomes less feasible. Pair the trend with the driving work, changes in assumptions and the status of response actions. The professional should also consider forecast error after completion. Comparing earlier predictions with the final outcome can reveal whether updates were consistently optimistic, whether uncertainty was communicated adequately and whether a particular reporting method helped decisions arrive in time.

13.4 Facilitate challenge, disagreement and escalation

Approve. 'The act of formally confirming, sanctioning, ratifying, or agreeing to something.' (PMI, 2019, p. 176)

Schedule reviews should create a shared understanding of the work, not simply collect verbal agreement with a chart. Before the meeting, identify the decisions required, distribute a controlled information set and ask the relevant owners to check facts. During the discussion, separate corrections to source data from differences about methods, assumptions or priorities. A contractor may disagree with a duration because a different crew is assumed; an operations manager may reject a handover date because training has been omitted. Both objections may be useful even if the numerical output is internally consistent. The scheduler's task is to expose the basis of the disagreement and determine what evidence or authority can resolve it.

One practical method is to compare the competing positions in a common model or a pair of controlled scenarios. Preserve the original update, state the changed assumption and show the consequence. If one scenario assumes weekend access and the other does not, obtain the access decision rather than arguing about which date looks more plausible. Where evidence is incomplete, record the uncertainty, a temporary assumption, its owner and the point at which the decision must be revisited. Do not force artificial consensus by averaging incompatible dates. An average of a feasible ten-day method and an infeasible six-day method is not automatically a feasible eight-day plan.

The meeting should finish with more than a list of actions. Record the decision, the authority that made it, the selected option, the assumptions retained, the owner responsible for implementation and the next verification point. Record material disagreement where it affects the reliability of the recommendation. A note that merely says 'schedule agreed' is inadequate if the agreement depended on receiving an unconfirmed permit or making a resource available. The released schedule and accompanying narrative should reflect the actual decision. When a decision changes scope, obligations or a baseline, apply the relevant change process rather than treating minutes as an unlimited authority to edit the model.

Escalate while an effective choice still exists

Escalation is appropriate when the consequence or decision exceeds delegated authority, when an agreed tolerance is breached, when an interface cannot be resolved at the current level, or when the time available for action is running out. The escalation should identify the decision needed, not merely advertise a problem. It should state the evidence, credible options, consequence of delay and recommended course. Urgency does not excuse inaccurate information, but incomplete information does not always justify waiting: a time-critical decision may require a clearly qualified recommendation with a planned review. The professional should distinguish the absence of certainty from the absence of a reasoned basis for action.

Ethical communication requires the same discipline under pressure. A senior manager may ask for a more positive message, and a contractor may prefer that an unresolved interface remain outside the report. The scheduler can improve clarity and avoid unnecessary alarm while preserving material facts. Removing a known threat, changing a reporting cut-off to exclude adverse progress or reclassifying incomplete work without evidence changes the substance. Explain the consequence of the proposed wording, offer an accurate alternative and use the established escalation route if necessary. A factual report can acknowledge progress and recognise uncertainty at the same time. Confidence should come from transparent reasoning and responsive management, not from concealing inconvenient information.

Germany: explain the basis of a revised commissioning message

On 26 June 2026, Deutsche Bahn announced a revised Stuttgart 21 commissioning plan following its internal review. DB reported weaknesses in planning, controls, risk management and interface coordination, and said the previous end-2026 date was not realistically achievable on the reviewed assumptions. Its new stages extended from December 2027 to 2033, with the main station planned for December 2031. The announcement also described organisational and escalation changes. These are DB's reported findings and forward plans at that date, not independent assurance or achieved milestones. The communication lesson is to explain the revised assumptions, stages and responsibilities without presenting a new forecast as a guarantee (Deutsche Bahn, 2026).

Negotiate a feasible agreement and diagnose the underlying problem

Negotiation starts by separating a requested date from the interest it serves. Establish the acceptance requirement, each party's authority and the evidence on time, resources and cost; then compare options and the consequence of failing to agree. A supplier may request a later delivery to consolidate transport, while the project needs only the first tested unit to begin integration. A staged delivery could satisfy both interests if logistics, testing and contractual arrangements permit it. Test the resulting scenario, identify any conditional commitments, and record who must approve them. Facilitation helps participants work through the discussion; negotiation seeks an agreement; formal change control authorises a change within the applicable governance.

When disagreement concerns the cause of a delay, use a structured problem-solving sequence: define the observable gap, assemble evidence, develop competing explanations, test them, select an action and verify its effect. A cause-and-effect diagram can organise possibilities under information, method, resources, access and acceptance. Repeatedly asking why can expose an underlying condition, but each link needs evidence: an assertion that a contractor is unproductive is not a causal analysis. Compare the explanations with dated records and a controlled schedule scenario, then confirm whether the chosen action removes the constraint. This connects professional judgement to a repeatable investigation rather than an exchange of opinions.

13.5 Plan completion and handover as scheduled work

Deliverable. 'Any unique and verifiable product, result, or capability to perform a service that is produced to complete a process, phase, or project.' (PMI, 2019, p. 179)

Near completion, an apparently small amount of remaining work can dominate the finish. Testing, documentation, training, approvals and defect correction may require specialist people, ordered sequences and external availability. If they are represented only by a single milestone called 'handover', the model provides little warning when readiness begins to deteriorate. Develop the necessary activities early enough to estimate, resource and coordinate them. Identify who accepts each deliverable and what evidence they require. The logic should connect physical completion to verification, release and the relevant operational or contractual milestone. A scheduler should not assume that an asset becomes usable immediately because its installation activity reaches 100 per cent.

The word 'complete' needs a stated object. Installation can be complete while testing remains open. A subsystem can be accepted while the integrated service is not yet available. An operator can take responsibility for an asset while a contractor retains defined obligations. Project governance may authorise closure after residual actions have been assigned to a continuing organisation, provided the applicable conditions permit it. These states overlap, but they are not interchangeable. Their precise meaning depends on the project's contracts, acceptance criteria and governance. The scheduling

professional communicates the distinction and checks that the model uses the appropriate event for each promise, rather than making a legal determination from a milestone label.

Distinct completion and transition states

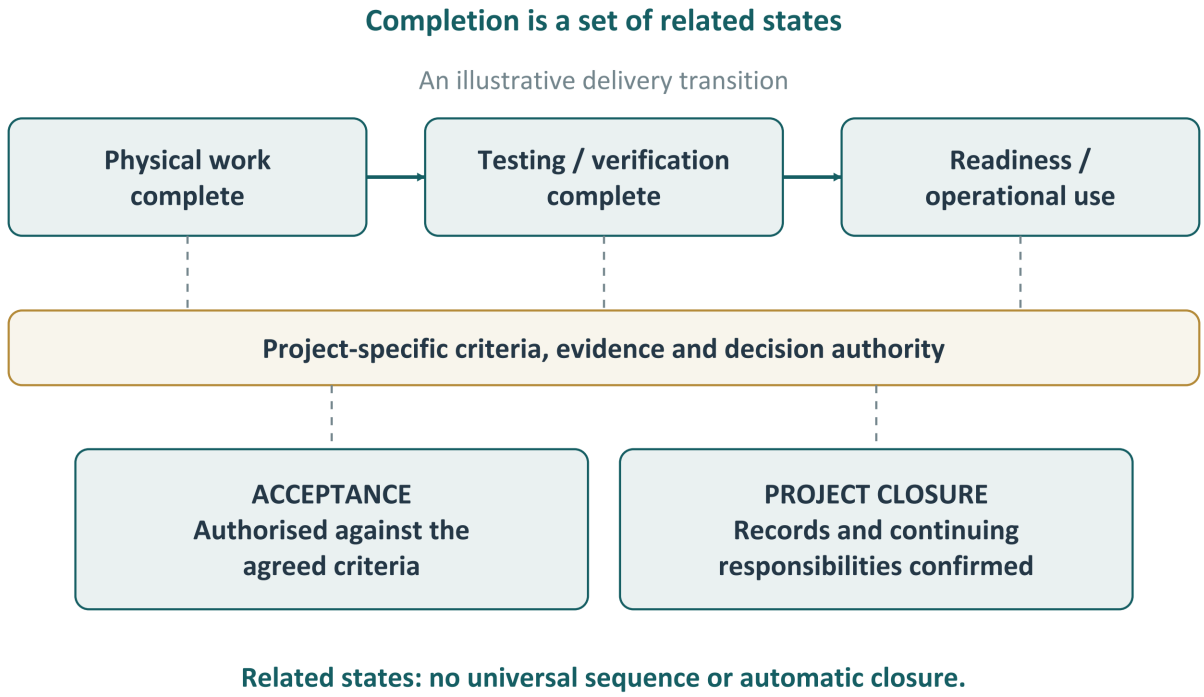


Figure 13.5. Completion is a set of related states. The connections shown are illustrative; the actual sequence and authority depend on the project. Operational use does not automatically prove contractual or project closure.

Table 13.3 | Distinguishing completion and handover states

State being reported	Evidence and authority to identify	Schedule implication
Physical work complete	Defined scope installed or delivered, with the relevant completion record	Remaining testing, correction and documentation may still control later milestones
Verification or testing complete	Agreed tests performed and results reviewed by the appropriate authority	Failed or conditional results may create further work before release
Operationally ready or in use	People, procedures, support, interfaces and permissions adequate for the stated service	Readiness can be staged; describe the extent of operation and restrictions
Accepted under the agreed arrangement	Acceptance criteria and decision satisfied by the authorised party	Acceptance may be partial or conditional where permitted; retain the associated obligations
Project closed	Closure authorised, records retained and remaining responsibilities transferred	Benefits, warranties, maintenance or residual actions may continue under named ownership

Readiness should be tested across several dimensions together. Technical equipment may be ready while trained operators are unavailable; operators may be ready while the maintenance support arrangement is

unresolved; documentation may be complete while the final integrated test fails. A readiness review should identify the evidence needed for the actual decision, rather than assemble a long checklist unrelated to the service. Trace each material condition to an owner and, where it affects time, an activity or milestone. If a condition is accepted for later resolution, record who can authorise that arrangement, the restrictions that apply and the date or event that triggers further review. A proposed concession is not an approval until the appropriate authority grants it.

Phased handover requires particular care. A project may release one area, service or function while work continues elsewhere. The schedule should identify the boundaries, shared systems, access restrictions and dependencies that make the phase usable. Report the date of the first usable release separately from the final project finish. Calling both events 'opening' invites misunderstanding. The receiving team should know the extent of its responsibility, what remains under project control and how failures or outstanding defects will be managed. The same principle applies to a digital service released to a limited user group and to a transport asset opened in stages: the advertised milestone must match the delivered scope.

England: distinguish the service stages from programme closure

TfL's June 2023 Commissioner's Report records introduction of the Elizabeth line's full peak timetable on 21 May 2023 and programme closure on 26 May, with remaining activities transferred into TfL. These were distinct milestones following the central section's passenger opening in May 2022. The report does not mean that every contract, defect or account had ceased to exist. Its scheduling lesson is to state which service stage has been achieved and who owns the work remaining after the programme structure closes (TfL, 2023, p. 18).

UAE and Egypt: specify the scope of readiness

Dubai's Government Media Office reported on 15 July 2025 that six autonomous electric baggage tractors were operating at Dubai World Central. The account distinguished the initial Level 3 deployment from a planned Level 4 upgrade in early 2026, and described the live operation as a testbed for refining later deployment. This was an achieved service stage with further development planned; the publication does not establish that the subsequent upgrade occurred. For scheduling communication, name the capability released and retain the remaining milestones rather than letting 'in operation' imply that all development and contractual work has ended (Government of Dubai Media Office, 2025).

Egypt's telecommunications regulator reported on 29 October 2025 that it had coordinated with operators and undertaken service-quality measurements around the Grand Egyptian Museum ahead of its inauguration. The Presidency subsequently recorded the opening ceremony on 1 November. These sources establish different things: readiness work for a supporting system and the occurrence of a public event. Neither is a comprehensive project-closeout record, and the ceremony should not be substituted for every operational or contractual milestone. The scheduler should make the scope and authority of each statement explicit (NTRA, 2025; Presidency of the Arab Republic of Egypt, 2025).

13.6 Transfer responsibility without losing remaining work

A closeout decision must distinguish work that is finished, work that has been formally removed from scope and work that continues under another owner. Marking every remaining activity complete to tidy the file destroys that distinction. If a package is transferred, preserve its status at transfer and link it to the receiving organisation's controlled plan. Record the boundary of the transfer, the accepting owner, the remaining obligation, the agreed due point and the means of monitoring it. Where continuing work affects an operational restriction or a later milestone, make that dependency visible. Administrative closure should not make the work disappear from the organisation's management system.

Residual items differ in importance. A minor correction to a manual is not equivalent to an unresolved test affecting safe operation, but both require an accurate disposition. The appropriate technical and commercial authorities decide whether acceptance with outstanding items is permissible. The scheduler contributes the sequence, resource implications and effect of the conditions on dates. Avoid assuming that a large percentage of completed activities outweighs one unresolved requirement that controls release. For each significant condition, establish what evidence will close it and who can confirm closure. A due date without an owner is weak; an owner without the resources or authority to act is little better.

Formal handover should also transfer usable knowledge. The receiving team needs to understand what has been delivered, what configuration is in service, what assumptions limit operation and what support remains available. Scheduling records can help explain why temporary arrangements exist and when they should end. For example, an interim operating procedure may depend on a later software release or the completion of additional training. If the project team disperses without transferring that connection, a temporary condition can become an unnoticed permanent one. Plan time for review, explanation and confirmation, rather than treating document upload as proof that the receiving organisation can manage the outcome.

Closure can be phased and may involve different authorities. A work package may close before the project, and a project may close before the programme finishes evaluating benefits. The final report should state the boundary of the closure being recommended. Where the project is cancelled or terminated early, the same discipline applies: document the work actually completed, the remaining and cancelled scope, the stopping decision and the obligations that survive it. A cancelled activity should not acquire a fictitious actual finish simply to make a completion percentage look tidy. Preserve the reason for its disposition so that later readers do not mistake a reduced scope for improved delivery performance.

Australia and France: delivery continues beyond a headline milestone

ANAO's June 2025 audit of Canberra-class ship sustainment reported that final materiel release was approved in October 2019 with 64 unresolved defects and delivery issues. Final operational capability followed in November with six significant residual deficiencies for the in-service phase. Some remaining work was subsequently assigned to upgrades or sustainment, and the acquisition project closed in July 2024 while significant deficiencies still required management. These historical findings do not determine contractual liability or the later condition of the ships. They demonstrate why the closeout account should distinguish milestone achievement from the transfer and management of residual obligations (ANAO, 2025, pp. 27-30).

France's June 2026 ministerial account of SOLIDEO distinguishes delivery of permanent works to Paris 2024 from later adaptation for legacy use. It records the sharing of experience through seminars, reports and methodologies in 2025. From January 2026, SOLIDEO used Grand Paris Aménagement's resources while retaining its own legal personality, governance, budget and completion roadmap; the supported phase was estimated to last three years. This is a ministerial account, not proof that all legacy work or settlements were finished. Its practical lesson is to preserve responsibility, resources and knowledge when the delivery organisation changes after a major event (Secrétariat général, 2026, pp. 200-201).

GovS 002 requires controlled closure and a closure review within its scope. It says the treatment of unfulfilled requirements should be documented, continuing responsibilities transferred and accepted, records securely archived and stakeholders informed. The chapter's distinction between closing a project and erasing unfinished obligations is consistent with that guidance; the particular acceptance and retention arrangements still need to be established for the project concerned (Government Project Delivery, 2025, section 6.4.8).

13.7 Produce an honest final schedule account

The final schedule report explains the delivered outcome and the route taken to reach it. Begin with the scope covered by the report, the final status date, the relevant acceptance or closure boundary and the versions used for comparison. Reconcile activity actuals with available records, identify any remaining forecast work and resolve unexplained inconsistencies. A final report can legitimately contain residual work transferred to another plan, but it should not imply that those activities have already happened. Use the term 'as-built' or an equivalent final record only to the extent supported by actual evidence. An unverified latest forecast does not become historical fact because the project is ending.

Compare the final outcome with the original baseline and, where different, the latest approved baseline. Show the chronology of authorised changes and distinguish them from performance movement, corrections and unresolved explanations. The original reference preserves what the organisation initially expected; the latest approved reference supports the assessment of delivery against authorised scope and conditions. Neither should be silently overwritten. A bridge between them helps readers understand why the project finished where it did. This chapter's earlier distribution-centre example provides a simple demonstration, but a real project may require separate bridges for major phases, interfaces and scope changes rather than one number at project level.

Worked example: a final SPI of 1.00 can coexist with lateness

Assume the illustrative distribution-centre project eventually completes all authorised scope at the end of week 40. Its original budget was £1,000,000 and its original planned duration was 32 weeks. The authorised scope change established a budget at completion of £1,200,000 and a revised planned duration of 36 weeks. Final actual cost is £1,320,000. For this calculation, all work in the revised performance measurement baseline is complete and all its planned value has accrued. Consequently, cumulative earned value and planned value both equal £1,200,000. These assumptions matter: they describe a completed baseline, not a claim that every real project has identical earned value conditions at every closure point.

Substitute those cumulative earned value (EV), planned value (PV) and actual cost (AC) amounts into the EVM relationships. Schedule variance in cost units is EV minus PV, and the conventional schedule performance index is EV divided by PV. The final values are therefore £0 and 1.00. Cost variance is EV minus AC, giving minus £120,000, and the cost performance index is EV divided by AC, approximately 0.91. The scheduling standard discusses these measures alongside time-based approaches; the conventional monetary relationships used here do not convert money into weeks (PMI, 2019, pp. 84-88).

Final earned value measures and actual completion time

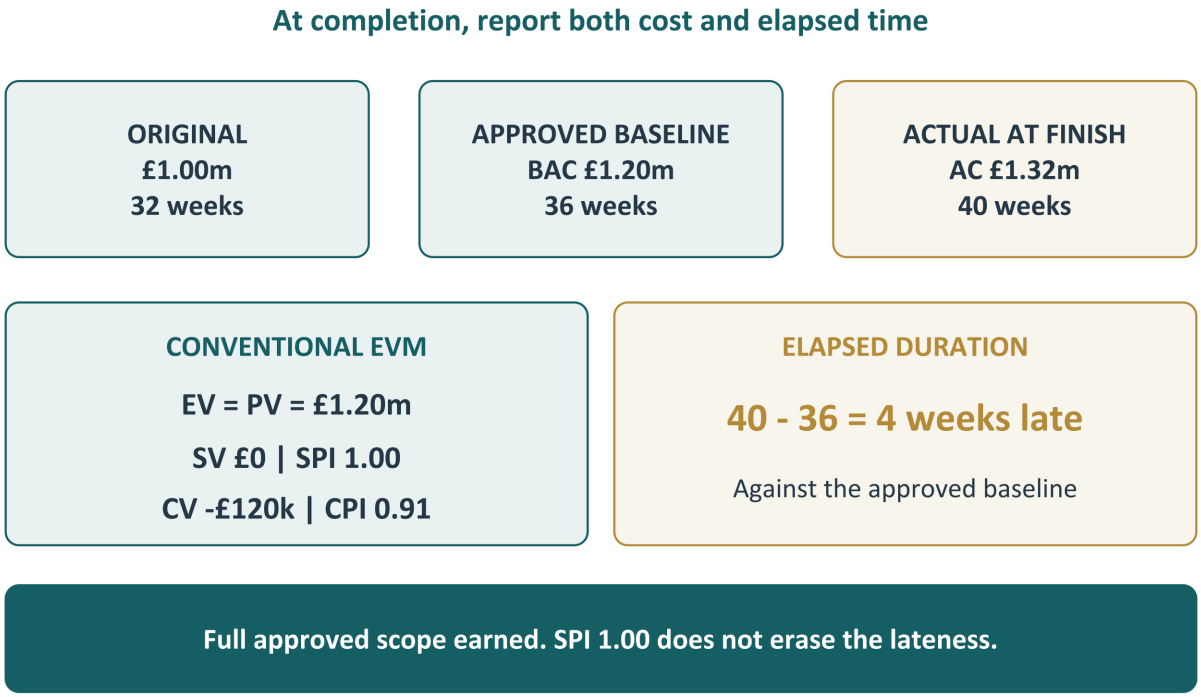


Figure 13.6. With all baseline work complete, conventional SV and SPI converge to zero and one respectively. The actual finish remains four weeks later than the revised baseline. Monetary performance and elapsed-time performance answer different questions.

Table 13.4 | Why final SPI can conceal late completion

Measure in the illustrative final report	Calculation or comparison	Interpretation
Finish against the original baseline	Week 40 minus week 32 = 8 weeks later	Preserves original history, but includes a change of authorised scope
Finish against the revised baseline	Week 40 minus week 36 = 4 weeks later	Shows lateness against the current approved reference
Conventional schedule variance and SPI	£1,200,000 minus £1,200,000 = £0; £1,200,000 / £1,200,000 = 1.00	All revised baseline work is complete; these final values do not prove timely delivery
Cost variance and CPI	£1,200,000 minus £1,320,000 = -£120,000; £1,200,000 / £1,320,000 = 0.91 rounded	Actual cost exceeds the budgeted value of completed authorised work
Budget and scope history	Original £1,000,000; approved £1,200,000; actual £1,320,000	Explain the £200,000 authorised budget movement separately from the £120,000 final overrun

The final report should therefore state the actual duration and milestone variance directly. An SPI of 1.00 at completion is not evidence that the project finished on time. The outcome is eight weeks later than the original reference and four weeks later than the revised one. Equally, it would be misleading to call the entire £320,000 increase from original budget to actual cost an overrun on unchanged scope: £200,000 arose from an authorised change in this example. The numerical bridge does not settle questions of

causation, responsibility or entitlement. It establishes the comparators that a reasoned explanation must address.

A mature closeout account also explains forecast performance. Identify when the eventual finish first became visible, whether reports communicated the developing position and whether decisions were made while effective responses remained available. A project that ended late may still have improved its forecasting and response discipline; a project that finished on its original date may have used unreliable reporting and benefited from favourable events. Evaluate the process as well as the outcome. Stakeholder feedback helps establish whether presentations were understood, whether the right decisions were requested and whether the reporting burden was proportionate. Do not use hindsight to imply that information available only at completion should have been known with certainty months earlier.

13.8 Turn experience into reusable scheduling knowledge

> **Lessons Learned.** 'The knowledge gained during a project which shows how project events were addressed or should be addressed in the future for the purpose of improving future performance.' (PMI, 2019, p. 182)

Learning should begin during delivery, while the people involved can explain what happened and the evidence remains accessible. A closing workshop can consolidate knowledge, but it is a poor substitute for contemporaneous records. Ask what was expected, what occurred, why the difference arose, what action was taken and what should change in future. Include successful practices as well as failures. A realistic planning assumption that prevented a missed interface can be as valuable as an account of a delay. The purpose is to improve future judgement, not to create a list of general statements that could have been written before the project began.

From an observed event to applied learning

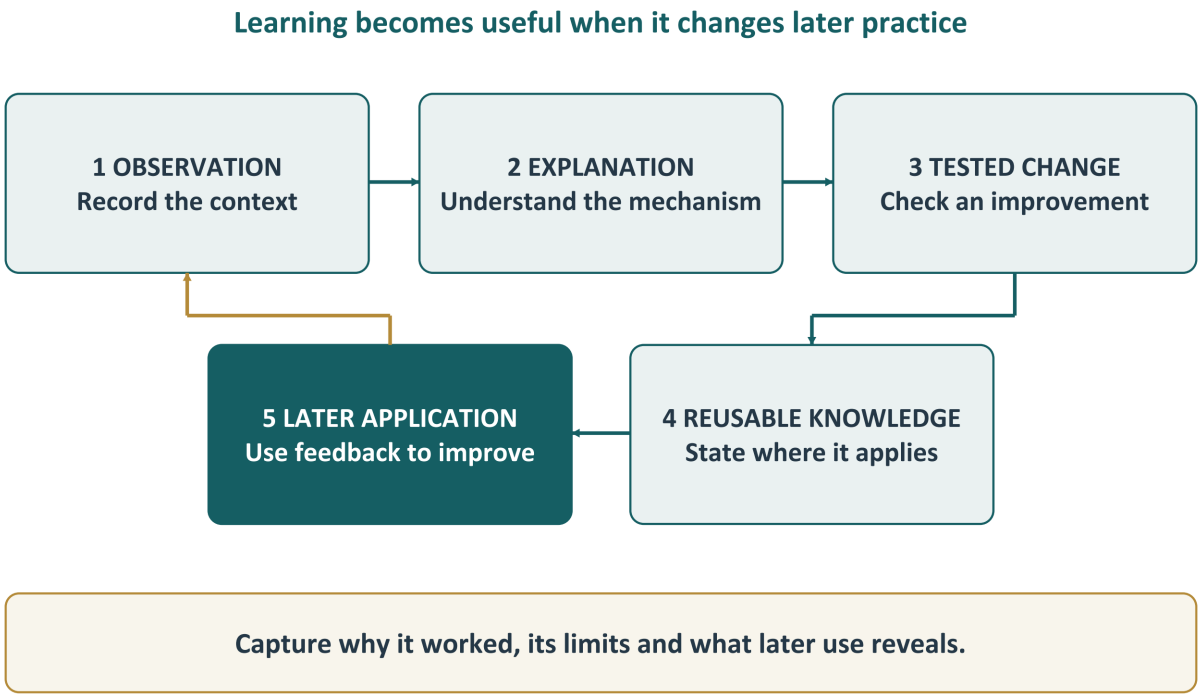


Figure 13.7. A lesson becomes useful when its evidence and context lead to a tested change and informed reuse. Filing a statement is only one step in the learning cycle.

Separate an observation from an explanation and an action. 'Testing finished three weeks late' is an observation. 'The supplier's specialist was booked after the required slot had filled' is a possible explanation that needs evidence. 'Reserve the specialist before the design release gate on comparable projects' is a proposed response. Validate the connection rather than assuming it: the late booking may have been a symptom of delayed design information, and an early reservation may be impractical without an agreed specification. A useful lesson states the conditions under which the proposed change is likely to help. This keeps the recommendation specific enough to act on while avoiding a universal rule drawn from one experience.

Stakeholder feedback should evaluate the scheduling approach, not merely the visual attractiveness of the report. Ask whether model detail was appropriate, whether durations and calendars reflected the work, whether interfaces were visible, whether progress evidence was reliable and whether uncertainty was communicated intelligibly. Explore the experience of people who supplied information as well as those who received it. A reporting process that produces a polished dashboard by demanding repeated manual reconciliation may be fragile and expensive. Feedback can identify a better data source, a clearer responsibility or an unnecessary duplicate report. Record the reason for any proposed change and check its effect on assurance, contractual reporting and future users before simplifying the process.

Research perspective: transfer requires people as well as records

Eikelenboom and van Marrewijk studied knowledge transfer between strategic projects in a public organisation pursuing circular construction. Their case identified informal practices that obstructed transfer and others that enabled it, including the importance of recognising connections and shared direction across projects. This was an interpretive organisational study, not a quantified test of schedule savings. Its implication for closeout is to arrange dialogue and ownership alongside retained documents. Uploading a lesson does not establish that another team has understood its conditions or incorporated it into planning (Eikelenboom and van Marrewijk, 2024).

Preserve productivity evidence with its conditions

An independent illustrative work package installs and accepts 120 identical sensor assemblies using 600 recorded labour-hours, including the package's recorded preparation and rework. Its aggregate labour requirement is 600 / 120 = 5 labour-hours per accepted assembly. Suppose 360 hours were classified as direct installation and the remaining 240 as other package effort. The direct-installation measure is 3 hours per accepted assembly, but using that rate as if it represented the entire package would omit 2 hours per assembly of recorded effort. Neither figure is inherently wrong; each describes a different boundary. The record must state which hours, quantities and acceptance conditions are included.

For a genuinely comparable package of 80 assemblies, a simple estimate using the all-in rate would be 400 labour-hours. With four equally productive technicians available for six productive hours each day, the arithmetic gives 24 labour-hours per day and about 16.7 working days of effort capacity, before applying the organisation's rounding convention. This is a capacity illustration, not a validated duration forecast. It assumes divisible work, full crew availability and comparable conditions. Access windows, supervision, sequence, testing, learning effects and calendar restrictions may alter the duration. A scheduling database should preserve the evidence and context that allow the next planner to judge those assumptions, rather than store the number 5 as an unexplained universal rate.

The record should therefore distinguish quantity installed from quantity accepted, productive effort from elapsed duration, and one-off setup from repeatable work. Preserve crew composition, shifts, calendar, location, design maturity and significant interruptions where they affect comparability. Small samples should be treated with appropriate caution. One difficult workfront or one unusually experienced team may not represent future conditions. Where several comparable observations exist, examine their spread

and the reasons for variation instead of selecting the most favourable rate. This produces a more useful basis for analogous estimates and helps explain why a forecast changed when the work environment differed from the original assumptions.

Learning also needs an owner and a route into use. A validated lesson may change an estimating guide, a schedule review question, an interface agreement or a training example. Identify who maintains the relevant knowledge source and how future teams will find it. Check later whether the change was used and whether it helped. An archive of hundreds of lessons without retrieval, review or application can create the appearance of learning without changing behaviour. Organisational memory depends both on retained records and on people who can explain their meaning. The scheduling professional should help preserve both while avoiding unsupported claims that a new process caused every subsequent improvement.

13.9 Archive a schedule that another person can reconstruct

The archive is the controlled record of what was known, modelled, reported and authorised at different points. Preserve the native schedule, the original and revised approved baselines, important updates, final actual data, released presentations and the records explaining material changes. Include the calendars, coding structures, resource assumptions, software settings and external links needed to interpret the model. A PDF preserves the visible output, but it cannot by itself recreate the scheduling calculations. Conversely, a native file without its assumptions and approval history may open successfully while leaving its meaning uncertain. Use both executable and human-readable forms where appropriate to the organisation's systems and retention arrangements.

Three connected layers of the scheduling archive

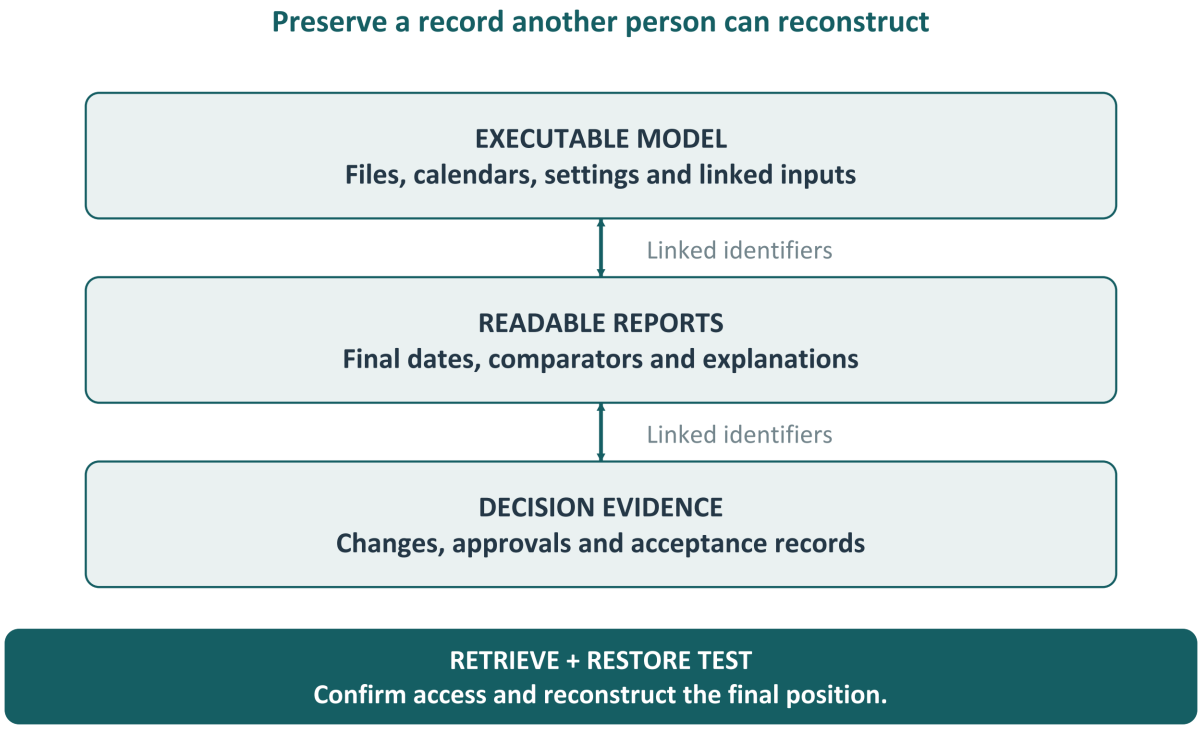


Figure 13.8. A useful archive connects the model, its published views and the evidence behind decisions. Retrieval and restoration checks confirm that these connections survive.

Version control should preserve chronology and prevent ambiguity about authority. Assign identifiers that distinguish the original baseline, approved revisions, routine updates and unapproved scenarios.

Retain the reporting data date separately from the date a file was exported or published. Link a major logic change to the contemporaneous explanation and the applicable approval record. If an updated model contains an imported external schedule, preserve the relevant interface reference and its version so that the combined result can be understood later. Avoid relying on a person's memory of which file called 'final revised latest' was actually used at the decision meeting.

PMI's record-maintenance guidance calls for the initial logic, major decisions and the reasoning behind changes to be retained, and for comparison of the original baseline with the final update to support future learning. Appendix X5, on forensic schedule analysis, explains why planned and actual records need supporting explanations of what changed and why. The scheduling professional should therefore retain the explanations alongside the data, not reconstruct a convenient narrative after the event. An activity note written when an access restriction arose is stronger evidence of the team's contemporary understanding than a retrospective statement created without supporting records (PMI, 2019, p. 70 and pp. 165-168).

Table 13.5 | Preserving a reconstructable schedule archive

Archive layer	Examples of records to preserve	Question a later reviewer should be able to answer
Executable scheduling information	Native models, baselines, selected updates, calendars, resources, settings and relevant interface files	Can the reviewed version be opened and its logic and assumptions understood?
Readable issued information	Milestone tables, bar charts, narratives, performance reports and final accounts	What position was communicated, to whom, and at what reporting date?
Decision and acceptance evidence	Change approvals, key meeting decisions, acceptance records, residual-work transfers and supporting actuals	Why was the model changed, who authorised the decision and what obligation remained?
Catalogue and stewardship	Record index, identifiers, access arrangements, retention responsibility and restoration checks	Can an authorised user find the correct record and distinguish it from a superseded or incomplete one?

Reconstruction requires more than retaining a large collection of files. Test a representative archive package before the team disperses. Can an authorised colleague find the final model, identify the correct baseline and locate the decision explaining a major milestone movement? Do the files open in the intended environment, and do referenced calendars and linked schedules remain available? Where software migration or export changes calculation behaviour, record the limitation and retain appropriate static evidence of the original result. Checksums can help detect file alteration, but they do not prove that the original contents were correct. A file that can be opened is not automatically a model that can be interpreted or reproduced.

Access and retention should follow applicable organisational, contractual and legal arrangements. There is no single retention period that a scheduling chapter can prescribe for every project. Separate legitimate access from uncontrolled circulation, especially where records contain personal information, sensitive infrastructure details or commercial material. Ensure that responsibility for maintaining the archive survives project closure. A cloud folder owned solely by a departing team member is a weak long-term arrangement. Record who controls access, who can authorise migration or disposal and how essential information remains available. Preserve disputed material through the appropriate process rather than deleting it to produce a tidier closeout record.

The US GAO Schedule Assessment Guide recommends explanatory narratives for updates and preservation of identifiable schedule versions. It gives particular value to the final as-built record for learning and analogous estimates, including the implemented sequence, durations, resources and productivity. This established guidance supports retaining a final record that can be compared with the original plan, while preserving the context that makes a comparison useful. It does not prescribe one universal legal retention period or make an unexplained historical productivity rate automatically transferable (GAO, 2015, pp. 130-132, 135-136).

13.10 Bring communication, closure and learning together

An effective closeout sequence begins with a reconciled status position and a clear boundary for the decision. Confirm the relevant acceptance evidence, identify residual obligations and obtain the receiving owners' agreement. Produce the final schedule account, distribute it to the identified stakeholders and invite the feedback needed to evaluate the scheduling approach. Obtain the appropriate closure decision, then verify that the archive and knowledge records are usable by the continuing organisation. These activities may overlap and may be repeated for staged delivery. The essential relationship is that authority, evidence and responsibility remain connected throughout the transition.

A controlled closeout workflow

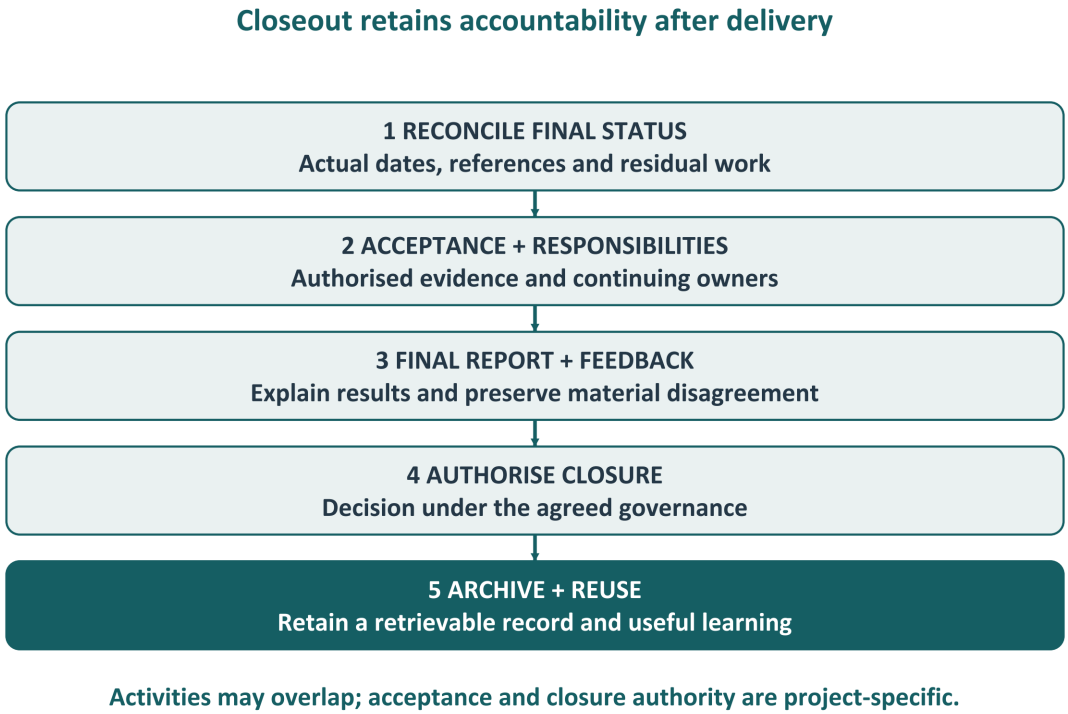


Figure 13.9. Closeout joins final status, acceptance boundaries, communication, authority and preserved knowledge. Original workflow; the actual sequence is adapted to the project's governance.

Return to the illustrative distribution-centre project. The week-40 finish is supported by actual records for the authorised scope, while the report retains both the week-32 original and week-36 revised baselines. Its conventional final SPI is 1.00, but the narrative reports the four-week lateness against the revised reference. A remaining obligation, if accepted for transfer under the project's arrangements, is identified separately with its owner and due point rather than hidden within a claim of universal completion. The lessons record explains which forecasts were useful, which assumptions failed and what

comparable productivity information can be reused. The archive preserves the evidence needed to examine those statements later.

For PMI-SP preparation, this chapter directly addresses stakeholder communication and schedule closeout. PMI's published outline includes obtaining feedback on the scheduling approach, updating organisational knowledge, archiving schedule records and distributing final reports, alongside establishing and managing stakeholder communication. The certification page checked for this chapter lists Schedule Closeout at 6 per cent and Stakeholder Communications Management at 14 per cent of examination content. Those weights describe the examination blueprint, not the proportion of this chapter that must be memorised. In situational questions, identify the evidence, authority and purpose before selecting an action; verify current PMI examination information when preparing to apply (PMI, 2012, pp. 8-10; PMI, n.d.).

At Level 6, the professional should be able to defend a recommendation when the information is incomplete or different stakeholders prefer different outcomes. That means explaining limitations, comparing feasible alternatives and preserving an honest account of the decision. It also means recognising when a communication problem is actually a data problem, a missing authority or an unresolved interface. The next chapter brings the scheduling lifecycle together for integrated revision and PMI-SP examination readiness. The enduring practice is the same: use a credible model, communicate its meaning accurately and leave a record from which the organisation can learn.

Knowledge check and examination practice

These original questions support learning and are not reproduced from a PMI examination. Select the best answer from the information given. All week references in the calculations use a common elapsed-time origin.

Question 1

A sponsor needs to decide whether to fund an additional testing team. The current forecast has moved, but the sponsor receives only a full activity listing. What should the scheduler do first to improve the communication?

A Prepare a concise decision explanation showing the controlled forecast, consequence, feasible options and decision deadline, with supporting detail available.
B Remove the adverse activities so that the sponsor can focus on the desired finish.
C Issue a new baseline showing the testing team's assumed benefit.
D Wait until all uncertainty about the testing outcome has disappeared.

Question 2

A project's original finish is week 32, revised approved finish week 36, previous forecast week 38 and current forecast week 40. Which statement is accurate?

A The project has slipped eight weeks since the previous report.
B The current forecast is two weeks later than the revised baseline.
C The forecast is four weeks later than the revised baseline and two weeks later than the previous forecast.
D Approval of week 36 means the original week-32 reference should be removed.

Question 3

A delivery team and a sponsor use different charts from the same schedule release. The sponsor's chart contains fewer activities. What is the most important control?

A Both charts must contain exactly the same activity rows.
B Each audience should choose whichever completion date it prefers.
C The detailed chart should be replaced by the sponsor's version.
D Their scope, data date, version and common milestones should remain traceable and consistent, with filters and exclusions clear.

Question 4

An installation is physically complete, but a required integrated test has not been accepted. The project manager asks for the operational-readiness milestone to be marked complete because almost all activities are finished. What is the best response?

A Mark the milestone complete and record the test as a lesson.
B Retain the actual physical completion, report the unmet readiness condition and obtain the appropriate evidence and authority before recording operational readiness.
C Delete the test because it is a small proportion of the schedule.
D Change the data date so that the test appears in the past.

Question 5

All authorised work is complete. Cumulative EV and PV both equal £1,200,000, actual cost is £1,320,000 and completion occurred at week 40 against a revised baseline of week 36. Which conclusion is correct?

A SPI is 1.00 and CPI is approximately 0.91, while the project finished four weeks later than the revised baseline.
B SPI of 1.00 proves that completion was on time.
C The £120,000 cost variance means the project was 120,000 days late.
D Final cost and schedule comparisons are unnecessary once work is accepted.

Question 6

A package used 600 total labour-hours to deliver 120 accepted units; 360 hours were direct installation. Which statement provides the most defensible starting point for reuse?

A Use 3 hours per unit for every future project because direct installation is the only relevant work.
B Use 5 elapsed days per unit because labour-hours and duration are equivalent.
C Retain both the 5 total hours per unit and 3 direct-installation hours per unit, with their boundaries and conditions, before assessing comparability.
D Select the lower rate and delete the preparation and rework records.

Question 7

An authorised closure arrangement transfers specified residual work to an operations team. What should the final schedule account show?

A Every residual activity as actually finished on the closure date.
B No reference to the work because another team now owns it.
C A general note stating that operations will deal with any issues.
D The status at transfer, remaining obligation, accepting owner, due point and links to the receiving plan and relevant conditions.

Question 8

A team has archived the final bar chart, but the native model, calendar settings and approved changes are missing. What is the most appropriate conclusion?

A The archive is complete because the final dates are visible.
B The visible report is useful, but reconstruction is limited; recover and catalogue the model and explanatory records where available, then test retrieval.
C Recreate a new baseline that matches the final actual dates and call it the original.
D Delete earlier reports to avoid contradictory information.

Answer explanations

1: A. The sponsor needs a decision, its consequences and the time available to act. A concise explanation can be supported by detailed scheduling evidence. Removing adverse information, assuming approval or waiting for perfect certainty undermines useful communication.

2: C. Week 40 minus week 36 is four weeks; week 40 minus week 38 is two weeks. The eight-week difference from the original baseline remains relevant but spans an authorised change of scope in the worked example. Preserve each reference and explain its meaning.

3: D. Tailored presentations can legitimately contain different detail. Their shared dates and interpretation must reconcile to the controlled source, and readers need to understand the scope of each view. Tailoring does not authorise different undisclosed versions of the forecast.

4: B. Physical completion and operational readiness are separate states. Retain the genuine actual progress and expose the unmet condition. Percentage completion cannot substitute for the required test result or an authorised acceptance decision.

5: A. SPI = EV / PV = 1.00; CPI = EV / AC = 1,200,000 / 1,320,000 = 0.909… . The conventional final SPI does not express the four-week late finish. Cost variance is minus £120,000 in monetary units, not a duration.

6: C. Total effort gives 600 / 120 = 5 hours per accepted unit, while direct installation gives 360 / 120 = 3. Both are meaningful only with their boundaries and context. Neither alone is an elapsed duration, and comparability must be assessed before reuse.

7: D. A valid transfer needs a clear obligation, an accepting owner and a means of future control. Record actual status honestly and preserve the relationship with the receiving plan. Closure does not justify fictitious actual finishes or undocumented disappearance of work.

8: B. A bar chart preserves a presentation but usually cannot reproduce the model or explain its authorised history. Recover the missing evidence where possible, identify any remaining limitations and test the archive. Do not rewrite the original reference to match the eventual outcome.

References and further reading

PMI page numbers refer to the printed pages of the third edition. Cases describe the reporting position at the stated date; forecasts and announced future stages are not presented as achieved outcomes. Frameworks, figures, worked numerical examples and examination questions are original teaching material.

Australian National Audit Office (ANAO) (2025). *Department of Defence's Sustainment of Canberra Class Amphibious Assault Ships (Landing Helicopter Dock).* Auditor-General Report No. 50 of 2024-25, 27 June. Especially pp. 27-30, paragraphs 2.1 and 2.9-2.14. Official audit.

Deutsche Bahn (2026). *Stuttgart 21: Deutsche Bahn stellt Inbetriebnahmeplan neu auf.* 26 June. Opening account of the internal review, staged commissioning list and project-organisation section. Official announcement.

Eikelenboom, M. and van Marrewijk, A. (2024). 'Tied islands: The role of organizational members in knowledge transfer across strategic projects'. *International Journal of Project Management*, 42(3), 102590. https://doi.org/10.1016/j.ijproman.2024.102590.

Government of Dubai Media Office (2025). *dnata rolls out autonomous vehicles in airport operations.* 15 July. Sections on controlled trials, live operation and later development. Official government account.

Government Project Delivery (2025). *Government Functional Standard GovS 002: Project delivery.* Version 2.1, 1 September; official HTML modified 29 March 2026. Sections 6.4.8, 7.5 and 7.13. Official standard.

National Audit Office (NAO) (2024). *The UK border: Implementing an effective trade border.* HC 730, Session 2023-24, 20 May. Especially p. 36, paragraph 2.18. Official report.

National Telecom Regulatory Authority, Egypt (NTRA) (2025). *The National Telecom Regulatory Authority (NTRA) carries out the necessary procedures and measurements to ensure the provision of high-quality telecommunications services for visitors during the opening of the Grand Egyptian Museum.* 29 October. Official regulator account.

Presidency of the Arab Republic of Egypt (2025). *Opening Ceremony of The Grand Egyptian Museum.* 1 November. Official ceremony record.

Government Analysis Function (2026). *Stakeholder mapping*. Updated 12 June. Official guidance.

Project Management Institute (PMI) (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline.* Domains 4 and 5 and cross-cutting skills, pp. 8-10. Official outline.

Project Management Institute (PMI) (2019). *Practice Standard for Scheduling.* 3rd edn. Newtown Square, PA: PMI. Core coverage: section 2.5, pp. 30-31; sections 3.3.6-3.3.8, pp. 69-70; section 3.5, pp. 88-91; Schedule Model Presentation component, p. 130; and Appendix X5, pp. 165-168. Related schedule levels and EVM treatment support the worked examples. Formal definitions cite their printed pages individually.

Project Management Institute (PMI) (n.d.). *PMI Scheduling Professional (PMI-SP).* Examination information, including published domain weights. Official certification page.

Secrétariat général, Bureau des tutelles des établissements publics (2026). *Les établissements publics nationaux.* June. French ministerial collection, SOLIDEO entry, printed pp. 200-201. Official publication.

Skills England (n.d.). *Project controls professional.* Occupational standard ST0845, version 1.1. Occupation summary and duties concerning reliable controls information and communication of recommendations. Official occupational standard.

Tang, J., Yang, F., Wu, J., Wang, Y., Zhou, J., Cai, X., Yu, L. and Wu, Y. (2024). 'A Comparative Study on Fixed-Order Event Sequence Visualizations: Gantt, Extended Gantt, and Stringline Charts'. *IEEE Transactions on Visualization and Computer Graphics*, early-access publication. https://doi.org/10.1109/TVCG.2024.3358919.

Transport for London (TfL) (2023). *Commissioner's Report.* June. Elizabeth line service and programme closure, especially p. 18. Official report.

US Government Accountability Office (GAO) (2015). *Schedule Assessment Guide: Best Practices for Project Schedules.* GAO-16-89G, 22 December. Schedule narrative and communication, pp. 130-132; baseline, current and final records, pp. 135-136. Official guide.

US Government Accountability Office (GAO) (2024). *FAFSA: Education Needs to Improve Communications and Support Around the Free Application for Federal Student Aid.* GAO-24-107407, 24 September. Communication of processing dates and delays, pp. 29-31. Official audit.

CHAPTER 14

Demonstrating Credible Planning and PMI-SP Readiness

A credible schedule is the result of connected reasoning. Scope must be complete enough for the decision, logic must represent the work, resources must be available, uncertainty must be understood and the reported dates must retain their relationship with the evidence. A professional can calculate a critical path correctly and still recommend an infeasible finish if a scarce specialist has been assigned to two places at once. Equally, a detailed risk simulation can produce impressive percentiles from an incomplete model. This concluding chapter brings the separate scheduling disciplines together and asks the learner to defend a recommendation, including the conditions under which it remains credible.

The chapter uses one independent illustrative example to follow that reasoning from initial logic to an authorised response. It then explains how to revise across the whole source standard and all five PMI-SP examination domains. The full-length practice examination in Appendix C contains 170 original questions and explained answers; the shorter diagnostic set within this chapter tests the principal connections. Neither set reproduces a PMI examination or predicts a pass. The aim is to recognise a situation, select an appropriate method, check its assumptions and explain the resulting decision. Familiarity with a formula is a starting point; professional readiness includes knowing when the formula is relevant and what its result cannot establish.

14.1 Make the connections visible

> **Schedule Model.** 'A representation of the plan for executing the project's activities, including durations, dependencies, and other planning information, used to produce a project schedule along with other scheduling artifacts. See also schedule model analysis.' (PMI, 2019, p. 190)

The integration framework in Figure 14.1 asks six connected questions. Is the promised outcome clear? Does the logic explain how it will be delivered? Can the people, equipment, materials and access arrangements support that sequence? What uncertainty could change the outcome? Are the status, baseline and changes controlled? Finally, is the recommendation supported by evidence and addressed to an appropriate decision-maker? This is an original teaching framework rather than an additional PMI standard. Its purpose is to expose a broken connection. A strong answer to one question cannot silently substitute for a missing answer to another, and a favourable average across the questions would not make a critical missing prerequisite acceptable.

Six connected tests of schedule credibility

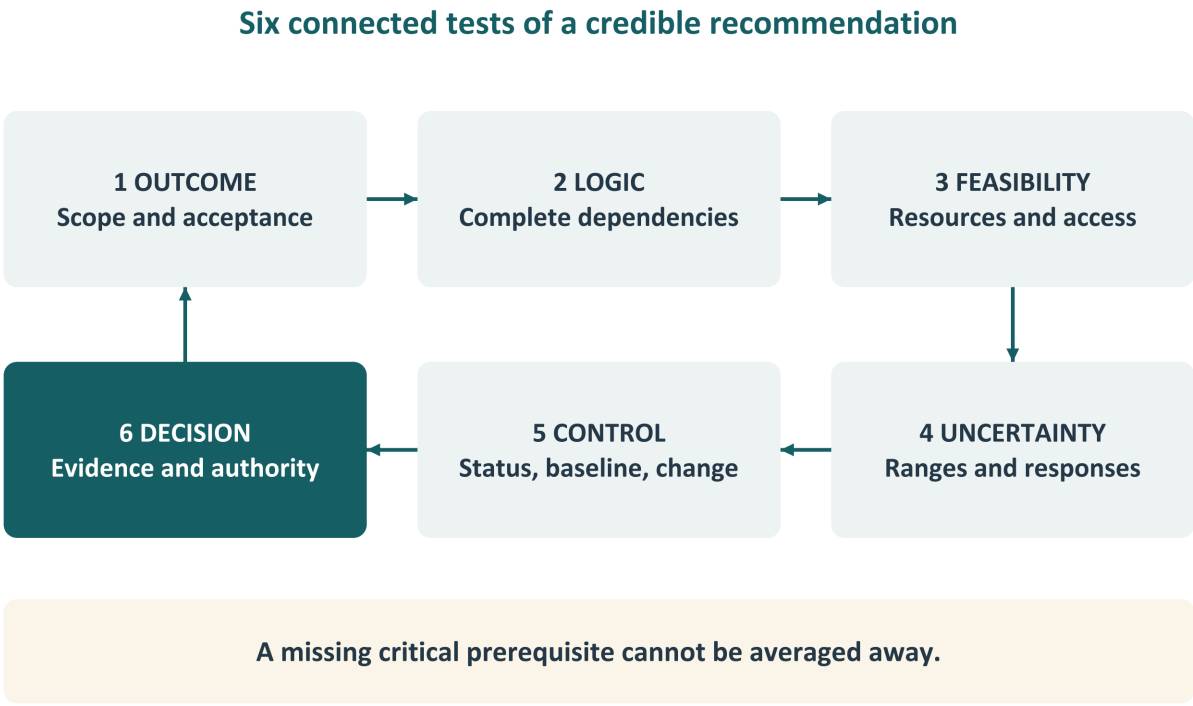


Figure 14.1. Credibility depends on the connection between scope, logic, feasibility, uncertainty, controls and a defensible decision. Original integration framework.

Start with the claim that the schedule is expected to support. 'Finish construction', 'begin trial operation' and 'provide the full contracted service' may be different milestones with different acceptance conditions. Identify the deliverable, boundary, date basis and authority. Then work backwards through the prerequisites, including approvals, external information, testing and operational preparation. The exercise is not to produce the largest possible activity list. It is to identify the work and decisions that could materially affect the promised outcome, at a level of detail appropriate to the planning horizon. Near-term commitments need more precise readiness evidence than a distant strategic option, although both require transparent assumptions.

The Level 6 professional is expected to interrogate controls information and recommend a suitable framework, level of detail and schedule basis. The current occupational standard connects credible control schedules with assurance, risk analysis and an explanation of dependencies, constraints and uncertainty. This supports a demanding form of judgement: the professional should be able to explain why an approach is appropriate and how the evidence supports the recommendation, while recognising the limits of their decision authority. It does not make a textbook or PMI-SP certification equivalent to the whole occupational qualification (Skills England, 2025, skills S12, S20-S21).

England: sufficient evidence depends on the decision

The NAO's June 2026 review of Palace of Westminster restoration found that costed options provided enough information to choose a way forward, while less mature options remained more uncertain. Estimates had received internal and external assurance, but phase-one plans still needed development into a deliverable programme. Temporary accommodation lay on the critical path, with limited buffer and assumptions requiring reconsideration. These were planning findings, not completed delivery results. The teaching inference is that evidence adequate for selecting an option is not automatically sufficient to defend an unconditional delivery commitment (NAO, 2026, pp. 18-19, 24-25).

This distinction also changes the professional's response to incomplete information. At an early option decision, conditional estimates and a clear plan to resolve uncertainty may be appropriate. Before a near-term release, a missing critical approval may prevent a positive recommendation. The scheduler should state what is known, what is assumed, what remains unresolved and when better evidence is required. An assertion that the schedule is 'too early to assess' can be as unhelpful as an unsupported promise. Assess it against the decision actually being made, and explain the additional work needed before the next level of commitment.

14.2 Select and combine methods deliberately

> **Schedule Model Analysis.** 'A process used to investigate or analyze the output of the schedule model in order to optimize the schedule. See also schedule model.' (PMI, 2019, p. 190)

Method selection begins with the nature of the work and the decision, rather than the software already available. A dependency network is useful where sequence controls the outcome. Resource analysis becomes essential when scarce capacity limits parallel work. Repetitive work across locations may benefit from production-flow views, while uncertain product detail may require rolling-wave planning and adaptive delivery. A project can use several methods, provided the interfaces between them are controlled. For example, a team's iteration plan can supply a release forecast to an integrated programme model, but it should not be treated as a promise of fixed scope unless the relevant acceptance and capacity assumptions support that interpretation.

The comparison below summarises the decision each approach can support and the question that must remain visible. It is a revision aid, not a ranking. A method that is appropriate for one part of a project can be unsuitable for another. The professional should also distinguish the calculation method, management approach and presentation. A resource histogram does not replace dependency logic, a building information model does not automatically establish a credible programme, and a visually attractive board does not remove the need to coordinate external approvals. Integration requires those tools to exchange defined information rather than merely appear together in a report.

Table 14.1 | Selecting and combining scheduling methods

Approach or view	Useful decision	Essential qualification
Critical path and precedence networks	Identify sequence, driving work and the effect of dependencies	Verify calendars, constraints, logic and the treatment of resources before defending the finish
Resource-constrained planning and critical-chain approaches	Coordinate scarce capacity and manage commitments with explicit resource assumptions	Confirm actual availability and the chosen buffer or control policy; do not relabel every resource delay as critical-chain practice
Rolling-wave and adaptive planning	Commit detailed near-term work while progressively resolving future scope	Retain release boundaries, interfaces, acceptance conditions and a disciplined means of updating forecasts
Lean, location-based and line-of-balance approaches	Protect production flow, workfront readiness and continuity between locations	Test quantities, production rates, space, crew movement and differences between locations
BIM and other digital representations	Link modelled assets, sequence and shared information	Control identifiers, versions and information maturity; a visual simulation is not proof of schedule feasibility
Risk analysis and scenario comparison	Assess uncertainty and compare possible responses	Use a credible underlying model and explicit assumptions; percentiles are conditional outputs

Tailoring should be justified in the basis of schedule. Explain the chosen planning horizon, level of detail, calendars, relationships, estimating methods, resource assumptions and interfaces. Record why an alternative was unsuitable or where it remains useful. A credible explanation is more specific than 'this is our standard software'. For example, an activity network may manage integration and commissioning while location-based views support repetitive installation. The joining milestones then require agreed meanings, responsible owners and consistent data dates. Without those agreements, one team may report a location complete when another still needs access, inspection or testing before its successor work can start.

Egypt: include the prerequisites that make the outcome usable

The Suez Canal Authority reported a two-vessel trial through the new Small Bitter Lakes waterway on 28 December 2024. Preparations included navigational aids, escort tugboats and pilots who had inspected and rehearsed the transit. The Authority stated that actual operation still depended on new navigational charts. On 3 February 2025 it announced updated charts, amended electronic information and notification to shipping chambers, and reported readiness following technical and navigational preparations. These accounts distinguish the trial from the wider readiness claim; they do not establish a first routine commercial transit date or a baseline comparison (SCA, 2024; 2025).

The example reinforces a general completeness test. Ask what must be available at the moment the promised service begins, who provides it and how its readiness will be evidenced. Construction quantities may be complete while an information release, trained operator or specialist resource remains unavailable. These are scheduling matters whenever their timing affects the milestone. They should not be left outside the model merely because they belong to a different organisation. The model can represent an external dependency without pretending that the project controls the external authority's decision.

14.3 Build and challenge a coherent network

Critical Path. 'The sequence of activities that represents the longest path through a project, which determines the shortest possible duration. See also critical path activity and critical path method.' (PMI, 2019, p. 178)

Consider a small control-system upgrade. All durations are in working days on one common calendar. Time is measured at day boundaries from zero: an activity starting at 2 and lasting 4 days finishes at boundary 6. All relationships are finish-to-start with zero lag; there are no imposed date constraints in the initial calculation. Activities cannot be split. The initial logic calculation assumes sufficient resources, an assumption that will be challenged next. These are original teaching data, not a documented project. The same stated assumptions should be retained when checking each result rather than silently moving between elapsed days, inclusive date counts and working-day arithmetic.

Table 14.2 | Building the integrated worked network

Activity and work	Duration and predecessors	Earliest start and finish
A: release scope	2 days; no predecessor	0 to 2
B: prepare hardware	4 days; A	2 to 6
C: build software	5 days; A	2 to 7
D: install hardware	3 days; B	6 to 9
E: integrate system	4 days; C and D	9 to 13
F: verify system	2 days; E	13 to 15
G: train operators	3 days; C	7 to 10
H: hand over	1 day; F and G	15 to 16

The upgrade network before resource constraints

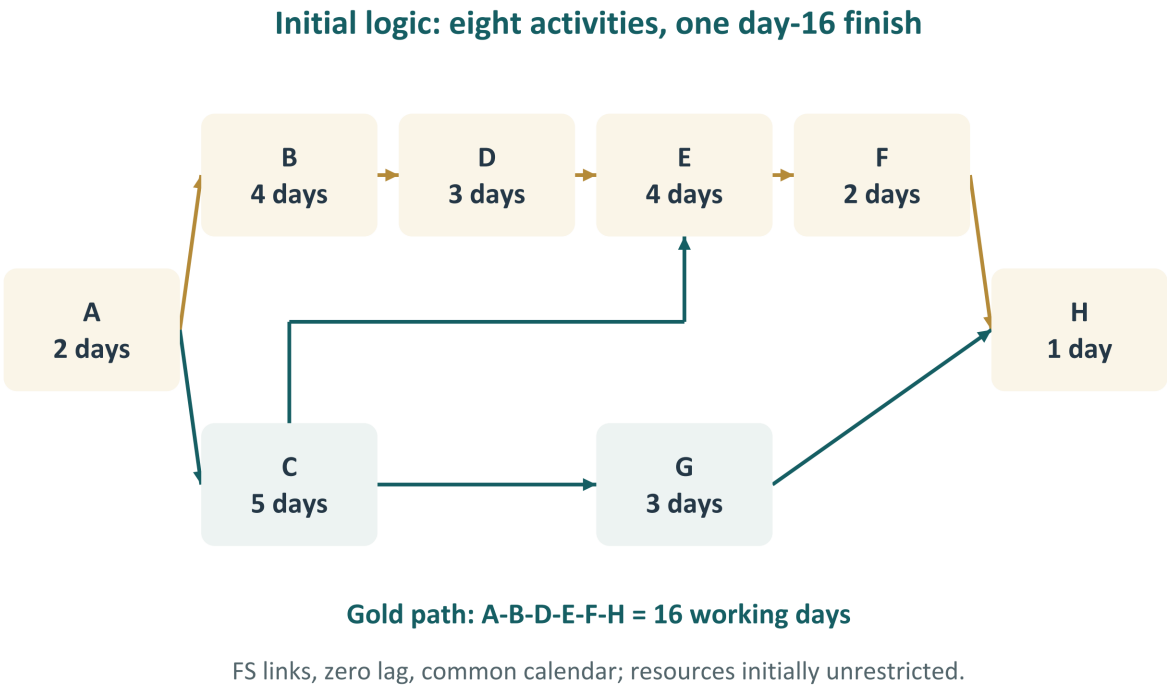


Figure 14.2. The original logic-only network finishes at day 16. The A-B-D-E-F-H path controls that result under the stated assumptions.

The forward pass takes the latest predecessor finish when an activity has more than one predecessor. E cannot start when C finishes at day 7 because D remains incomplete until day 9. H similarly waits until F finishes at day 15 even though G finishes at day 10. The longest sequence A-B-D-E-F-H has duration 2 + 4 + 3 + 4 + 2 + 1 = 16 days. Adding every activity duration would double-count parallel work. Selecting the earliest predecessor finish would omit required work. These are common calculation errors, but their practical consequence is a falsely early delivery date rather than simply a lost examination mark.

Distinguish total float from free float

Total Float. 'The amount of time that a schedule activity can be delayed or extended from its early start date without delaying the project finish date or violating a schedule constraint. See also free float, critical path, and near-critical activity.' (PMI, 2019, p. 192)

Free Float. 'The amount of time that a schedule activity can be delayed without delaying the early start date of any successor or violating a schedule constraint. See also total float, critical path, and near-critical path.' (PMI, 2019, p. 181)

For the unconstrained network, the backward pass starts from H's finish at day 16. H's latest start is 15; F's latest start is 13; E's latest start is 9. G must finish by H's latest start, so its latest start is 12. C precedes both E and G, and its latest finish is the earlier of their latest starts: the minimum of 9 and 12, which is 9. Its latest start is therefore 9 minus 5, or 4. C's total float is 4 minus its early start of 2, giving 2 days. This result is specific to the initial logic-only model and its day-16 finish reference.

Two kinds of float in the original network

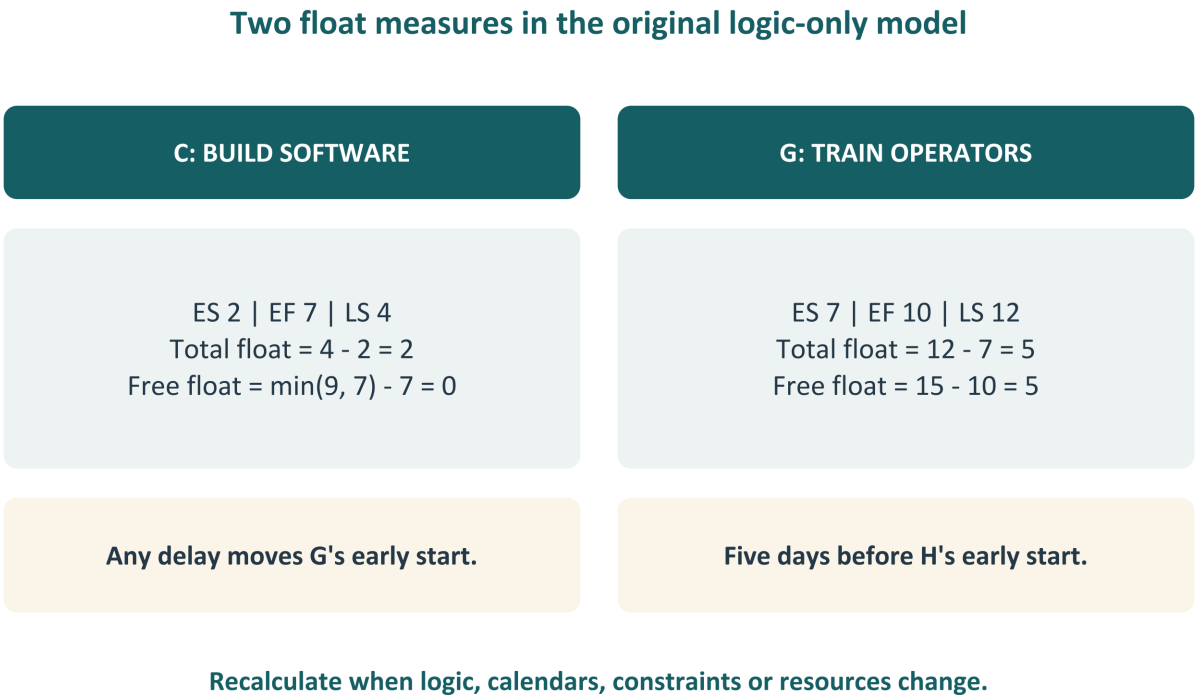


Figure 14.3. C has two days of total float but no free float, because G is scheduled to start immediately after it. G has five days of each in the original logic-only model.

C's free float is zero. Under these finish-to-start, zero-lag assumptions, compare C's early finish of 7 with the earliest of its successors' early starts: E starts at 9 and G at 7. The result is 7 minus 7, or zero. Delaying C by one day therefore moves G's early start even though the original project finish need not move. G has five days of total float and five days of free float because its early finish is 10 and H's early start is 15. Float belongs to the network relationships and comparison conditions; it is not a collection of independent allowances that every activity can spend simultaneously.

Apply the missing resource test

Now introduce one shared specialist who must work full-time throughout both E and G. All other resources are distinct and available. The original programme puts G at 7-10 and E at 9-13, creating an overlap from 9 to 10. If G goes first, it occupies the specialist until day 10; E then runs 10-14, F runs 14-16 and H finishes at 17. If E goes first, it runs 9-13 and G follows at 13-16; H again finishes at 17 after both F and G. These are the two possible orders for the two non-pre-emptive specialist activities. The earliest finish with that one specialist is therefore 17, not 16.

The new constraint cannot be resolved by pointing to G's five days of float from the earlier calculation. That float was calculated under different resource assumptions. Once the resource order changes, recalculate the affected dates and analyse the resulting sequence. The professional should also consider whether splitting work, moving training, changing the method or securing another qualified person is feasible, but none should be assumed without evidence. If the agreed delivery strategy retains one specialist, preserve a resource-feasible plan and explain the additional day in its basis. A plausible-looking Gantt chart is not sufficient justification for simultaneously assigning one person to two full-time tasks.

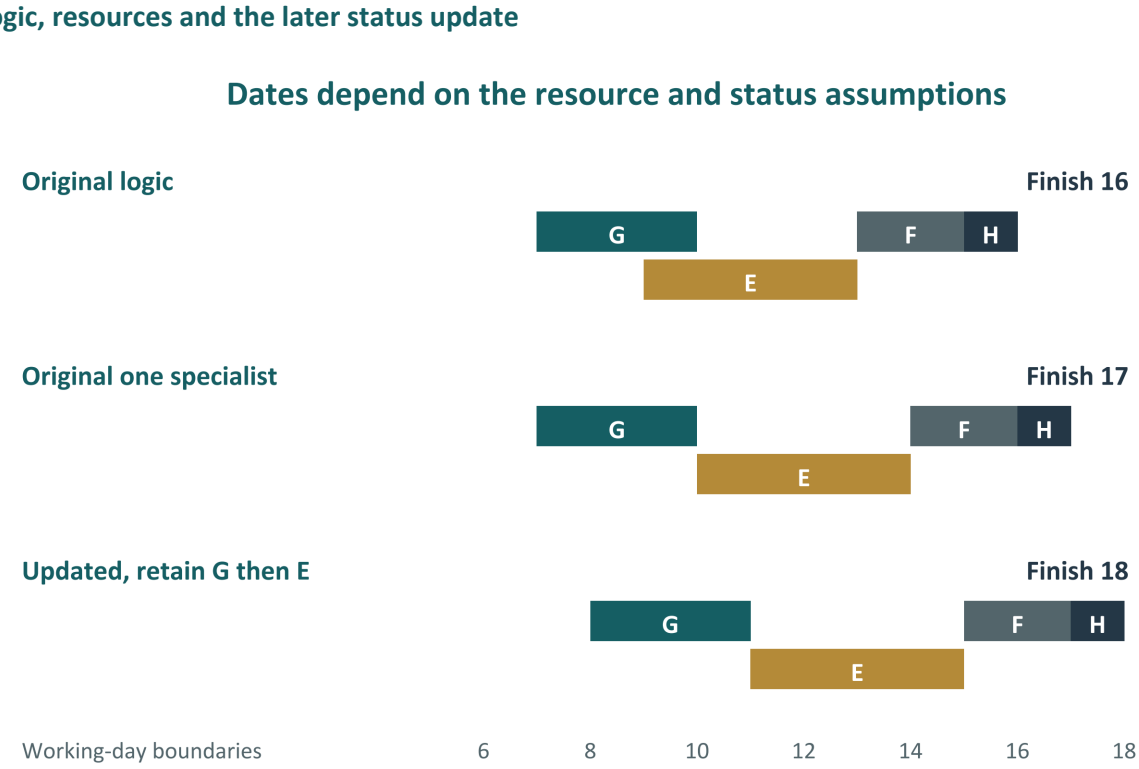


Figure 14.4. The original logic-only finish is day 16; one shared specialist makes it day 17. After the progress update described next, retaining the approved G-before-E sequence gives a day-18 forecast.

14.4 Update the position without rewriting the reference

> **Schedule Baseline.** 'The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and performance measurement baseline.' (PMI, 2019, p. 189)

Assume the one-specialist, G-before-E plan finishing at day 17 is approved as the baseline. At the status boundary at day 6, A and B have finished as planned. C started at day 2 and has two working days remaining. D is ready to start at the status boundary and still requires three days. No actual dates are recorded for future work. C is now forecast to finish at day 8, one day later than originally planned. A fresh logic-only calculation would still allow E to start at day 9 because D finishes then. A reviewer looking only at that unconstrained sequence could therefore miss the effect of C's movement on the shared specialist.

With G before E, G now runs from day 8 to day 11. E follows at 11-15, F at 15-17 and H at 17-18. The other resource order produces an earlier result: E runs 9-13, G runs 13-16 and F runs 13-15, allowing H to finish at 17. This distinction matters. The approved G-before-E sequence produces day 18, but changing the resource order to E-before-G provides a feasible day-17 alternative under the stated assumptions. Report the day-18 forecast for the retained sequence and present resequencing as a separately evaluated response, rather than claiming that day 18 is the minimum possible finish.

The update illustrates why the basis and chosen resource sequence must travel with the dates. A scheduler should not silently switch the order between reports to conceal deterioration or imply that the approved sequence is optimal under every later condition. Identify the effect of the new information, preserve the current modelling decision and compare feasible alternatives. In this example, the E-before-G alternative needs agreement that training can move later while preserving the handover

conditions. The model shows the time consequence; the operational owner confirms that the change is acceptable. The day-17 baseline remains the approved reference unless the formal change process authorises something different.

Reconcile schedule, cost and the meaning of the measure

At the same data date, suppose planned value is £60,000, earned value is £54,000 and actual cost is £63,000, against a budget at completion of £160,000. The financial data relate to the same authorised scope and cut-off. Schedule variance in monetary units is 54,000 minus 60,000, or minus £6,000. The conventional schedule performance index is 54,000 / 60,000 = 0.90. Cost variance is 54,000 minus 63,000, or minus £9,000, and the cost performance index is 54,000 / 63,000, approximately 0.86. These indicators describe budgeted accomplishment and cost efficiency; they do not say that the project is six thousand days late (PMI, 2019, section 3.4).

If a reviewer uses BAC / CPI to estimate final cost, the result is £160,000 / (54,000 / 63,000), approximately £186,667. That calculation assumes the observed cost efficiency is representative of remaining work. A known change of method, an unrepresentative start-up cost or a separate estimate for the remaining work may justify another approach. Do not turn the result into an unconditional forecast or combine it with an additional-resource proposal without checking whether the proposal is already reflected in the estimate. The purpose of integration is to reconcile the measures and assumptions, not to force money, days and confidence into one apparently precise number.

14.5 Compare uncertainty and feasible responses

Use the retained G-before-E forecast of day 18 as the starting point for a small illustrative risk model. There are four mutually exclusive, collectively exhaustive states. No additional issue occurs with probability 0.50. A retest adds two days with probability 0.20; loss of an access opportunity adds three days with probability 0.20; both occur and add five days with probability 0.10. These are specified joint-state probabilities for teaching, not estimates derived from project data. No independence assumption is needed because the combined state has already been assigned a probability. Within each state, the stated delay is assumed to affect completion by the full amount, without overlap or mitigation.

Table 14.3 | Joint states and milestone confidence

Joint state in the illustrative model	Probability and finish	Cumulative probability by that finish
Neither issue	0.50; day 18	0.50
Retest only	0.20; day 20	0.70
Access loss only	0.20; day 21	0.90
Both issues	0.10; day 23	1.00

The mean finish is 0.50 x 18 + 0.20 x 20 + 0.20 x 21 + 0.10 x 23 = 19.5. The probability of finishing by day 20 is 0.50 + 0.20 = 0.70. Using the earliest finish with cumulative probability at least 0.80 as the discrete P80 convention, P80 is day 21. The mean of 19.5 is therefore neither the deterministic forecast of 18 nor the P80 date of 21. A response should name the statistic that answers the decision-maker's question. The result is conditional on the completeness and credibility of these four states; it is not a guarantee that the real project has precisely the stated chance of completion.

A small discrete model of completion uncertainty

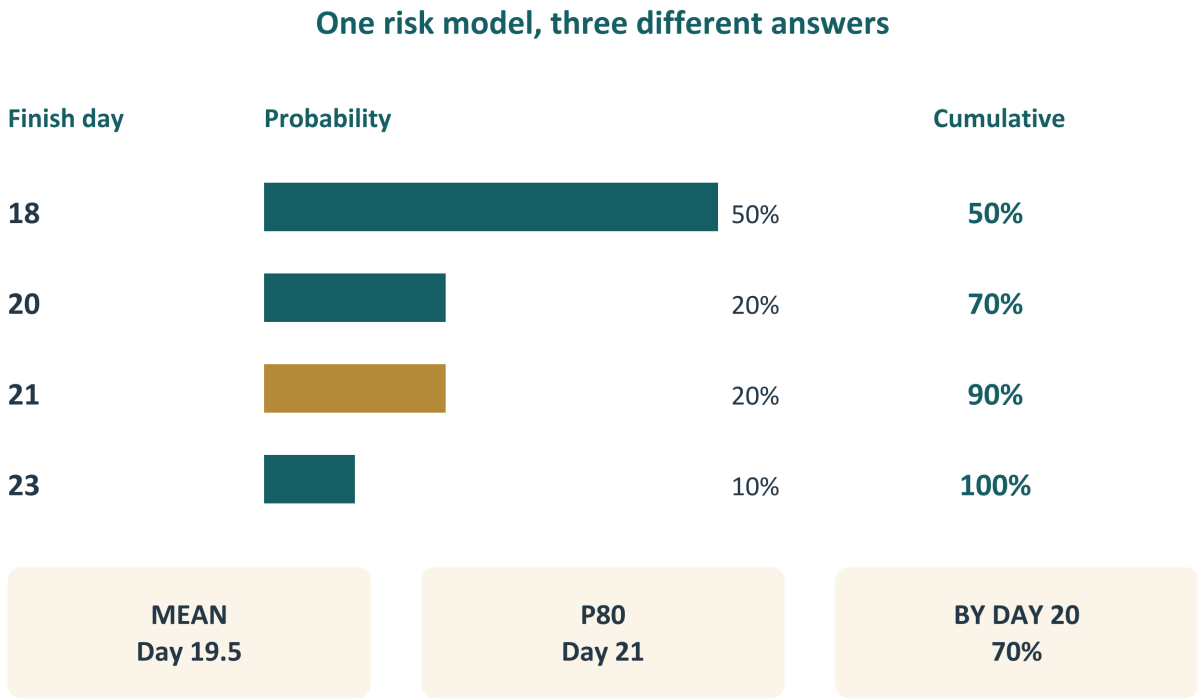


Figure 14.5. Under the specified four-state model, the day-18 plan has a 70% probability of completion by day 20 and a discrete P80 finish of day 21. The mean is day 19.5.

Consider two responses as well as retaining the sequence. First, move training after integration using the same specialist. The deterministic forecast becomes day 17 if operations confirms that the later training is acceptable. If the same delay states and probabilities remain applicable, the finishes become 17, 19, 20 and 22. The probability of completion by day 20 becomes 0.90 and the discrete P80 becomes day 20. Second, obtain an additional qualified specialist at an illustrative incremental cost of £8,000. If that person can support E from day 9 while the first specialist delivers G at 8-11, the logic-only day-16 finish becomes feasible. The corresponding illustrative risk finishes become 16, 18, 19 and 21; P80 is day 19 and the probability of completion by day 20 is again 0.90.

Compare the retained plan and feasible responses

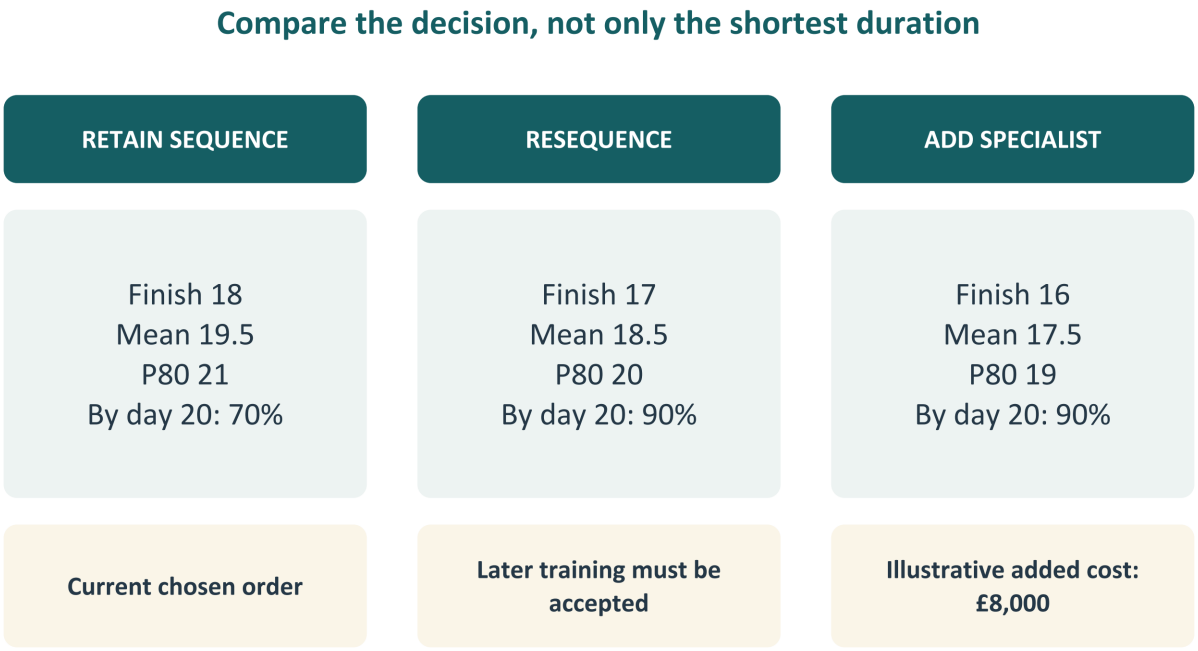


Figure 14.6. Resequencing and additional capacity answer different needs. Both reach 90% by day 20 in this deliberately coarse risk model, while their deterministic and P80 finishes differ. All results depend on the stated assumptions.

This is a useful challenge to automatic acceleration. The extra specialist buys an earlier deterministic finish and an earlier P80 date, but does not improve the probability of meeting the particular day-20 deadline beyond the resequenced alternative in this four-state model. Whether it is worthwhile depends on the value of earlier completion, operational preferences, the response cost and the credibility of unchanged risk assumptions. The coarse probabilities may conceal distinctions that a better model would reveal. A professional recommendation should therefore compare the feasible options and identify the decision criterion, rather than choose the option with the shortest bar or the largest resource increase.

A hard finish constraint at day 20 would not, by itself, change any of these physical sequences or risk states. It might change calculated float or the way the software displays lateness, but it would not create a second specialist or eliminate a retest. Similarly, removing required training would change scope and acceptance conditions, rather than demonstrate a valid recovery within the authorised plan. Distinguish a genuine response from a presentational adjustment. Before implementing a selected response, confirm its resources, operational conditions, cost treatment and authority; then update the controlled forecast and preserve the decision record.

14.6 Turn assurance into a defensible recommendation

An integrated review should distinguish model conformance, delivery confidence and decision readiness. Conformance asks whether the applicable scheduling components have been incorporated and used correctly. Delivery confidence concerns the possibility of achieving the stated outcome, given the model, resources and uncertainty. Decision readiness concerns whether the evidence is sufficient for the particular commitment being considered. These questions are related, but their answers are not interchangeable. A complete set of scheduling fields does not prove that durations are achievable, while a favourable risk percentile does not excuse missing dependencies. Equally, an unresolved future detail need not prevent an early option decision if its consequence and planned resolution are transparent.

The source standard's conformance approach uses 111 potentially scored components within a wider catalogue of 126 components. For a separate example requiring resource loading and schedule risk management, but not earned value management, the required set comprises 36 core components, 13 resource-related components and seven risk-related components: 56 altogether. Required components must be present and used correctly before an index is calculated. Suppose all 56 qualify, together with 14 optional components. The resulting index is 70 / 111 x 100, approximately 63.1%. If one required component is missing or incorrectly used, an apparently high raw count does not repair the failure or justify reporting an index under this method (PMI, 2019, section 5 and Appendices X3–X4).

Conformance requires a gate before a score

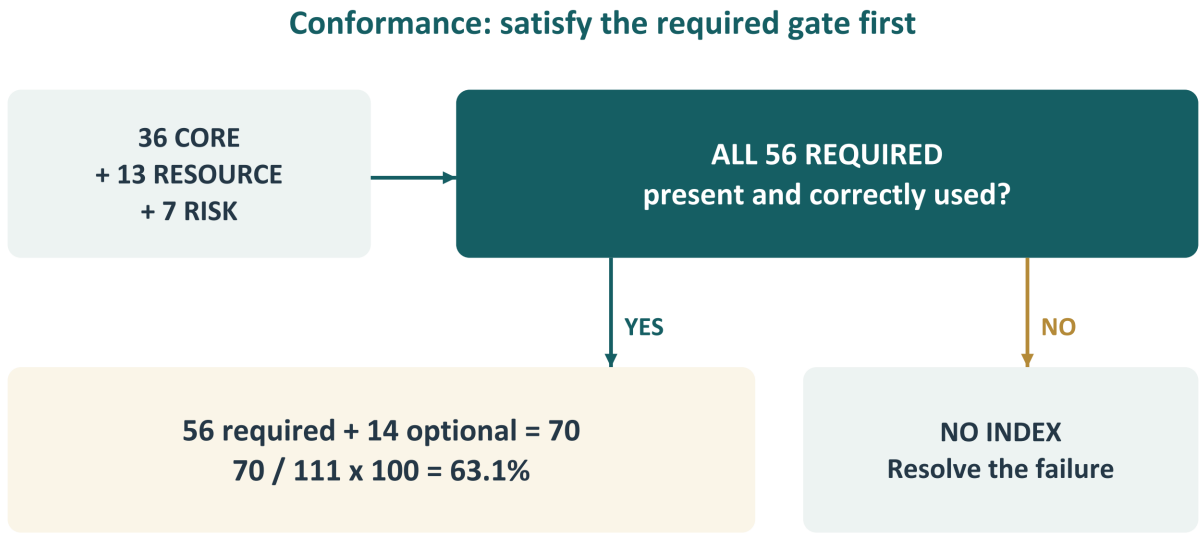


Figure 14.7. In this separate resource-and-risk example, which does not require EVM, all 56 required components must qualify before calculating 70 / 111. The resulting 63.1% is a conformance index, not a delivery probability or examination mark.

The interpretation matters more than the arithmetic. A conformance index of 63.1% does not mean a project has a 63.1% chance of finishing on time. It does not mean that 36.9% of the scope is absent, and it is not a mark for the planner's professional competence. The denominator belongs to the standard's assessment method. A separate judgement is needed about whether the model is suitable for its intended use and whether its inputs represent reality. Optional components should be selected because they add

useful information, not merely to increase a score. An assurance report should explain significant findings, their consequences and the evidence needed to close them.

USA: strengths in one control do not repair another

GAO's June 2026 review of a US Census Bureau modernisation programme assessed a November 2024 schedule and found reliability weaknesses despite stronger risk-management and cost-estimating practices. Findings included incomplete logic, missing resource information and unjustified constraints. GAO also identified a lack of evidence that the schedule used for risk analysis had first been assessed against relevant good practices. These were findings about the assessed programme and schedule, not all Census systems. The lesson is that confidence in one control process cannot be transferred automatically to another; a risk analysis needs a defensible schedule foundation (GAO, 2026, table 9, pp. 20–22).

When assurance identifies a material defect, the response should depend on its consequence. A minor coding inconsistency may be corrected without withholding an otherwise valid forecast. An omitted testing dependency that controls operational readiness can invalidate a proposed milestone. Record the finding, evaluate its effect and make the correction visible in the next controlled release. Where a decision must proceed before the issue is resolved, the decision-maker needs a clear qualification and a proportionate response. Hiding the defect because the report is due is unacceptable, but treating every issue as equally critical prevents attention being directed to the most consequential weaknesses.

Australia: delivery confidence requires current evidence

Infrastructure Australia's March 2026 evaluation of the Melton Line Upgrade recognised an established delivery framework, approvals and contracts. It also found limited updated programme information and project-specific risk and assurance evidence in the context of accelerated delivery. Its recommendations included coordinating interfaces and updating cost and schedule information. The evaluation did not demonstrate that the project could not finish. It showed why an acceleration proposal needs current supporting evidence even when established arrangements already exist. In scheduling terms, delivery capability and the credibility of a particular accelerated date are separate propositions (Infrastructure Australia, 2026, 'Deliverability' and 'Next steps').

Return to the upgrade example. A defensible recommendation might explain that the retained sequence forecasts day 18 against the day-17 baseline; resequencing offers day 17 subject to operational agreement; additional capacity offers day 16 at an estimated incremental cost. The recommendation should then identify the relevant risk results and their simplified assumptions. If the decision criterion is a 90% modelled probability of completion by day 20, both responses satisfy it in the stated model. If an earlier operational start has additional value, the paid response may deserve further consideration. The decision is not finished until an authorised person has accepted the conditions and the selected response has been incorporated into the controlled forecast.

14.7 Define what the milestone actually promises

A milestone is useful only when people understand what must be true at that point. In complex infrastructure, physical completion, testing, regulatory permission, initial service and full service can occur at different times. Those distinctions should appear in the schedule logic and narrative before a date becomes a public commitment. It is particularly dangerous to replace a qualified milestone with a shorter, more attractive label as information moves from delivery teams to senior stakeholders. The schedule professional should preserve the meaning of the commitment while tailoring the level of detail. A sponsor may need one date, but that date still requires a defined operational state and acceptance authority.

UAE: commercial operation follows a sequence of readiness gates

ENEC reported commercial operation of Barakah Unit 4 on 5 September 2024. FANR's accompanying account described the earlier operating licence, fuel loading, testing, criticality and grid connection, alongside regulatory oversight and preparedness requirements. These publications support a sequence of distinct readiness gates; they do not establish that a construction finish alone authorised commercial operation. Nor did entry into commercial operation end regulatory oversight. The scheduling inference is to represent the prerequisites and the authority for each gate, rather than place one undifferentiated 'complete' milestone at the end of the works (ENEC, 2024; WAM/FANR, 2024).

France: an approval can authorise only the next stage

On 31 January 2025, ASNR reported approval for Flamanville EPR testing above 25% of rated power. Its account referred to EDF's application, earlier test results, inspections, reported events and corrective actions. A further application was required before exceeding 80%. This was a staged authorisation, not evidence that all commissioning was complete or that the higher power level had already been reached on the announcement date. A schedule should therefore distinguish the submission, review, permission and execution events, and retain any conditions that limit what the approval permits (ASNR, 2025).

The two nuclear examples should not be treated as interchangeable regulatory procedures. Their transferable scheduling principle is narrower: evidence and authority determine whether work may pass a gate. When a regulator requires a further submission, the schedule needs the preparation, review and response activities as well as the milestone. Duration uncertainty should reflect the possibility of questions or corrective work where relevant. A planner cannot reduce a statutory or technical review period simply by shortening an activity bar. Any proposed improvement must change a genuine prerequisite, resource arrangement or process, while preserving the governing requirements.

Germany: restored service can coexist with remaining work

Deutsche Bahn's 12 December 2025 announcement described the planned return of through services on the Ahr Valley line from 14 December. The account also identified remaining work and an initial service configuration affected by work at Heimersheim. It therefore supported a distinction between the announced service restart and completion of every associated activity. Because the publication preceded the restart, it should be read as an announcement rather than independent proof of subsequent performance. The scheduling lesson is to identify the exact service offered, remaining restrictions and continuing obligations when presenting a reopening milestone (Deutsche Bahn, 2025).

The international cases can be compared through the same four questions: what outcome is claimed, what evidence supports it, who can authorise it and what remains unresolved? This comparison helps prevent a common reasoning error in examination questions and professional reports: selecting a true statement that does not answer the decision actually being made. Evidence that a trial succeeded may be relevant to readiness without proving routine service has begun. Evidence that a project has a competent delivery organisation may be relevant to capability without validating a newly accelerated finish. The quality of the conclusion depends on the connection between the evidence and the claim.

Table 14.4 | Interpreting milestone evidence from real projects

Decision or milestone	Evidence that matters	Limit to retain in the conclusion
Select a strategic option	Comparable scope, assumptions, estimates and material uncertainty	Option selection does not establish an unconditional delivery commitment
Defend an accelerated finish	Current logic, available resources, interfaces and risk assessment	Previous delivery arrangements do not alone substantiate a new date
Pass a technical or regulatory gate	Required submissions, results, corrective actions and approval	Permission may apply only to a defined stage or operating range
Begin an operational service	Accepted configuration, trained people, information and readiness evidence	Initial service may retain restrictions and outstanding obligations
Close the scheduling record	Reconciled final status, accepted records and assigned residual responsibilities	Administrative closure must not conceal unfinished obligations

Before communicating a recommendation, connect the claim, evidence, limitation, authority and next review. These five elements form a short original reasoning model. The claim states the outcome and date basis. The evidence identifies the controlled information supporting it. The limitation names material uncertainty or a condition. The authority identifies who can accept the commitment or response. The next review states when changed information must be considered. This is a way of testing the completeness of a recommendation, not a compulsory reporting template. Its purpose is to help the professional write a clear paragraph that another person can challenge and use.

14.8 Revise the whole standard through connected questions

A final revision should revisit the scheduling standard as a connected body of practice. Chapters 1–13 provide the detailed teaching; this concluding chapter tests whether the reader can move between the concepts without losing their assumptions. A useful route begins with purpose and model design, continues through development and maintenance, and ends with analysis, communication and close-out. Coverage is a foundation for study, while mastery requires the ability to reconstruct a calculation, interpret evidence, explain a limitation and defend a decision. Use the topic map below to identify the connections that need further practice.

Use the standard's structure as a navigation aid. Its opening sections establish the role and characteristics of scheduling. The model-management material connects planning, development, maintenance, analysis and communication. The component catalogue describes the information used within the model, while the assessment material considers conformance. Appendices supply supporting context, including how the edition changed and how assessment examples are presented. Glossary entries should be learnt with their formal wording and practical boundaries. A learner who can recite the total-float definition should also be able to calculate it, distinguish it from free float and explain why a resource change can alter its interpretation.

Table 14.5 | Revising the source standard through connected questions

Source-book area	Questions to retrieve from memory	Connection to professional judgement
Introduction and scheduling concepts	Why is a model different from one of its presentations? What purpose and level of detail are appropriate?	Select a model that supports the decision and planning horizon
Model planning and development	How are scope, activities, logic, durations, calendars and resources assembled?	Explain why the resulting sequence is complete enough and feasible
Maintenance and analysis	How are actuals, remaining work, changes, critical paths and uncertainty assessed?	Preserve references while producing a current, evidence-based forecast
Communication and control	Which audience needs which decision, comparison and response?	Tailor the view while retaining consistent dates, meanings and authority
Components and conformance	Which components are required for the model type, and are they used correctly?	Distinguish assessment rules from delivery confidence and usefulness
Appendices and glossary	What changed in the edition, and where are supporting explanations and definitions found?	Navigate the reference accurately without treating every appendix as a separate technique

Use the complete book references

Two integrated reference appendices support the fourteen chapters. Appendix A, *Complete Scheduling Glossary and Acronyms*, retains every glossary definition and acronym from the scheduling standard, with printed-page references and chapter links. Appendix B, *Complete Schedule Component Reference*, provides all 126 component entries and their attributes. Study these alongside the worked teaching, particularly Chapters 6 and 12; their presence is not a substitute for being able to calculate, interpret and challenge a schedule.

The references also identify inconsistencies in the source standard. Where a glossary sentence conflicts with the standard's worked method, the quotation is preserved and the discrepancy is explained separately. For example, the glossary's Finish-to-Start entry repeats finish-to-finish wording; the correct dependency remains the one developed in Chapter 5 and the source's relationship discussion. Use the explanation and underlying method rather than memorising a known printing error.

Understand the third edition in its historical context

Appendix X1 explains changes made for the third edition. Its account includes expanded agile coverage and additional figures, alongside attention to approaches and technologies such as location-based scheduling, on-demand scheduling, lean practice, intelligent systems, line of balance, building information modelling and earned schedule. It also identifies the addition of Appendices X1 and X5. These are changes described for the 2019 edition, not a statement that every item was newly invented then or that it constitutes a separate current examination domain. The value of this appendix is to help the reader understand the scope and development of the source reference (PMI, 2019, pp. 143–144).

The contributor material in Appendix X2 records development of the publication; it is not an additional scheduling method to memorise. Similarly, an index is a route to content rather than another body of technical requirements. Use these parts of the book appropriately. The professional should be able to locate an explanation, verify a definition and follow a cross-reference, while using the relevant technical sections to justify an approach. Edition awareness also matters when comparing sources: a newer

examination webpage and an older examination content outline can serve different purposes. The date on a source should be reported accurately rather than silently updated because it was accessed recently.

Three kinds of revision question are particularly useful. A recall question asks for a concept or rule without the answer being visible. An application question asks for a calculation or action in a stated situation. A challenge question changes an assumption and asks whether the earlier conclusion still holds. For example, calculate C's float in the original network, introduce the shared specialist, and then ask whether that earlier float remains a sufficient basis for promising the finish. This progression reveals shallow understanding more effectively than repeating the same numerical exercise. The correct response to the challenge includes naming the changed assumption and recalculating the affected model.

14.9 Build readiness through retrieval, explanation and return

Revision should produce evidence of understanding rather than a growing sense of familiarity. Reading a worked solution can make the reasoning feel obvious because each step is already supplied. In practice and in an examination, the learner must identify those steps independently. Close the explanation, reconstruct the problem, select the method and state the assumptions before checking the answer. If the result is wrong, locate the first point at which the reasoning diverged. A learner who chose the correct formula but used the wrong cut-off needs a different correction from someone who confused money-based schedule variance with days of delay.

Yang and colleagues' meta-analysis of classroom quizzing synthesised 222 studies involving 48,478 students. It found an overall achievement effect of g = 0.499, with substantial variation and influences including feedback and assessment format. This is a standardised effect, not a percentage-point gain or an examination pass probability. The relevant teaching inference is to attempt retrieval before viewing the explanation and to use feedback to correct the underlying reasoning. The research did not test PMI-SP preparation, so it does not justify a promised certification outcome or memorisation of answer positions (Yang et al., 2021, pp. 399, 409–412).

Lyle and colleagues studied spaced retrieval in an engineering-calculus course. Among 180 completers, later performance averaged 77% for spaced objectives and 71% for objectives practised together, although early spaced attempts were harder. The finding supports revisiting demanding material rather than judging learning only by immediate ease. It does not establish an optimal PMI-SP revision interval or predict a six-point improvement in this examination. A practical application is to return to a calculation after other topics and a delay, with changed numbers or assumptions, and explain the method again without the earlier solution visible (Lyle et al., 2022).

A revision cycle based on retrieval and feedback

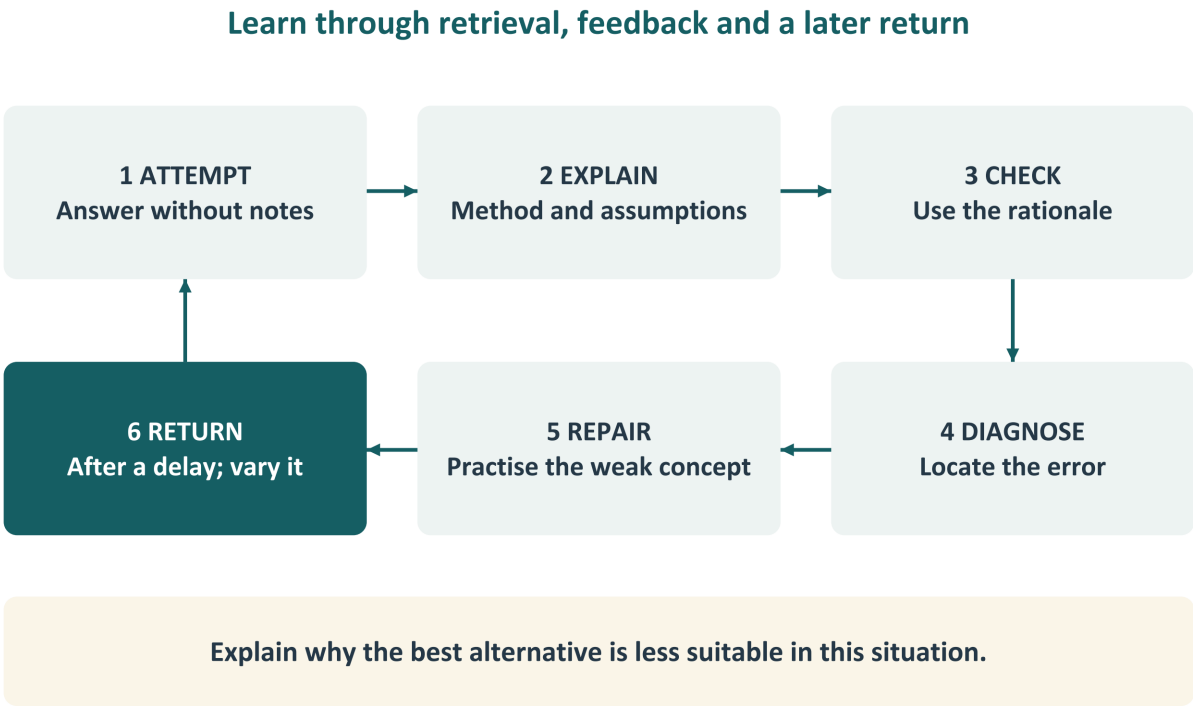


Figure 14.8. Attempt, explain, check, diagnose, repair and return. This original revision cycle applies research-informed principles without claiming a validated PMI-SP readiness score.

The most informative practice record is an explanation of the error and the correction, rather than a list of wrong question numbers. If the learner misses a resource conflict, the next exercise should require a resource-feasibility check. If the learner keeps choosing unauthorised baseline changes, the next exercise should distinguish forecasting, approval and implementation. If arithmetic is accurate but slow, short calculation practice may help; if the method is wrong, speed practice can reinforce the error. Revision should follow the evidence about the difficulty. A high aggregate practice mark can still hide a repeated weakness in a critical area.

Table 14.6 | Diagnosing and correcting study errors

Error pattern	What it reveals	A useful corrective practice
Concept or definition	Two related ideas are being treated as equivalent	Explain the distinction and create a counter-example
Units or reference	Money, time, data dates or baselines have been mixed	State the unit, cut-off and comparator before calculating
Arithmetic or network pass	The method is suitable but execution is incorrect	Rework the steps, checking predecessor maxima and successor minima
Model assumption	Resources, calendars, constraints or risk conditions were overlooked	Change one assumption and explain which result must be recalculated
Authority or judgement	A technically possible action is being treated as authorised or appropriate	Identify the decision-maker, conditions and permitted response
Reading the question	A true statement answers a different question	Restate the requested decision before considering the options

Confidence can be recorded alongside an attempted answer, but it should be tested against feedback. A confident error deserves particular attention because the learner may otherwise repeat it. A correct answer accompanied by weak reasoning should also be revisited: it may have resulted from guessing or recognition of familiar wording. When checking an answer, explain why the selected option fits the stated situation and why the strongest alternative does not. This is more demanding than deciding that the other options 'look wrong'. It also prepares the learner for situations in which several actions are useful but only one answers the immediate decision.

Prepare across the complete syllabus while giving additional attention to demonstrated weaknesses. Interleave calculations with judgement questions so that the method must be selected rather than supplied by the surrounding topic. For example, follow a critical-path calculation with a stakeholder question, then an earned-value calculation and a close-out scenario. The learner must recognise the evidence needed each time. A later attempt should use changed details, because remembering that a previous answer was option C says little about scheduling competence. Progress is shown by accurate, explainable performance on varied problems after a delay, with fewer repeated errors and realistic awareness of remaining uncertainty.

14.10 Prepare for the PMI-SP examination deliberately

PMI describes a 170-question examination lasting 210 minutes. The published examination content outline identifies 150 scored questions and 20 unscored pretest questions. The five domains and their published weights are shown below. The outline available from PMI retains its original publication history; it should not be described as a newly issued 2026 syllabus. Candidates should consult PMI's current certification information and appointment instructions when arranging their examination, because operational arrangements can change. The figures here establish the basis for this book's practice materials; candidates must also follow their official examination instructions (PMI, 2012; PMI, n.d.).

Table 14.7 | PMI-SP domains and examination practice

PMI-SP domain	Published weight and tasks	Practice questions in Appendix C
Schedule Strategy	14%; 5 tasks	24
Schedule Planning and Development	31%; 12 tasks	53
Schedule Monitoring and Controlling	35%; 6 tasks	59
Schedule Closeout	6%; 5 tasks	10
Stakeholder Communications Management	14%; 4 tasks	24

Appendix C contains 170 original practice questions, with answers and explanations for all 170. Its domain counts are an approximate whole-question allocation of the published weights; they do not reproduce an official examination form. In particular, it does not designate 20 practice questions as unscored, and a practice percentage must not be interpreted as PMI's passing threshold. The questions support learning and sustained timed practice. They are not recalled live examination items, a validated predictor of results or an official PMI product. Review performance by concept and error type as well as by domain, especially where a correct result depended on an unsupported assumption.

The available time averages about 74 seconds per question: 210 x 60 / 170. That is a planning average, not a requirement to spend the same time on every item. A straightforward conceptual question may take less time, leaving room for a network calculation or a difficult judgement. One optional practice plan allocates 180 minutes to the first attempt and 30 minutes to review, with approximately 57 questions completed after each hour of the first attempt. This is a suggested practice strategy, not a PMI timing rule. Adapt it using realistic timed practice and follow the actual examination interface and instructions.

An optional pacing plan for sustained practice

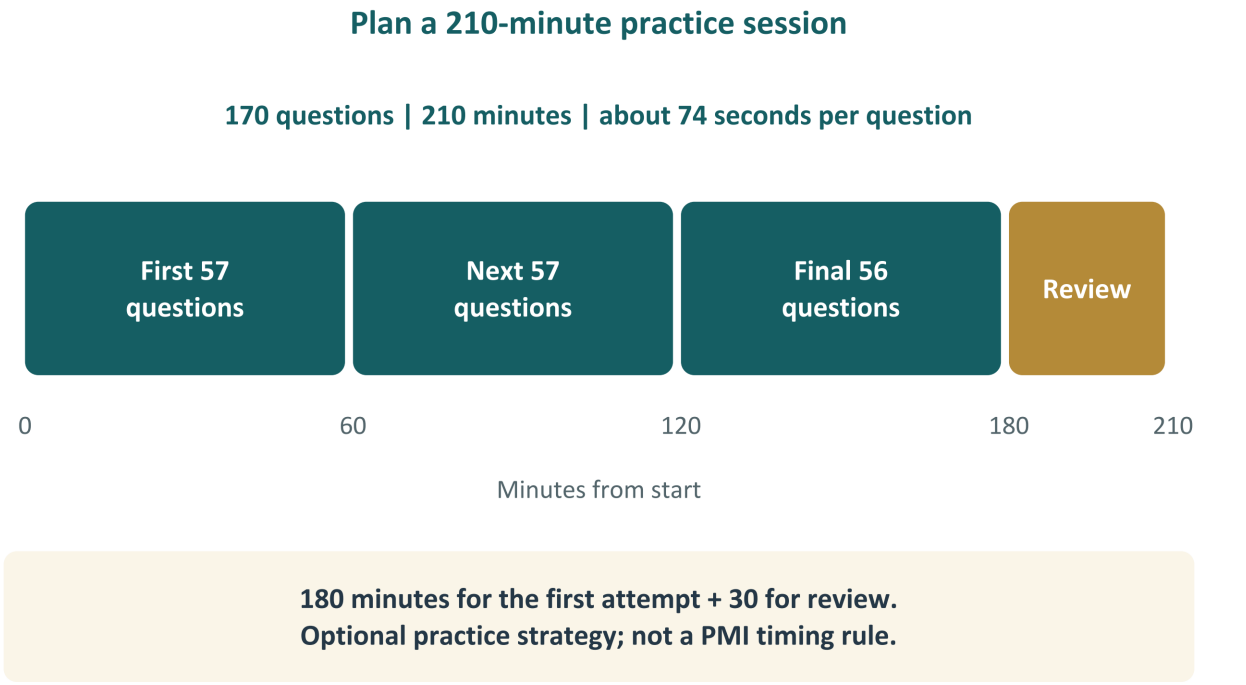


Figure 14.9. A 210-minute practice session can reserve 30 minutes for review after a 180-minute first attempt. The official total time is distinguished from this optional learning strategy.

Read the stem to establish the project state, available evidence, authority and requested decision. For a numerical item, write down the unit and comparison basis before choosing a formula. For a scenario, distinguish what needs to happen from what has already happened. If the question establishes that an authorised change has been approved and its effects assessed, repeatedly seeking the same approval is not the best action. Conversely, a technically attractive response does not justify bypassing required authority. Avoid universal shortcuts such as 'always escalate', 'always collect more data' or 'always choose the longest answer'. Sound answers depend on the stated situation.

When reviewing practice, first reconstruct the reasoning without reading the explanation. Then compare it with the supplied rationale and revisit the source topic where necessary. An incorrect answer should lead to a specific correction, while an uncertain correct answer should lead to another independent attempt. Allow enough time between attempts to test retention. Repeating the same full mock immediately can improve the score through memory of its content, so a higher second mark alone is weak evidence of readiness. The most useful conclusion identifies concepts now understood, errors that persist and the next practice that would resolve them.

Knowledge check and examination practice

These twelve original diagnostic questions test connections developed in this chapter. Allow approximately 15 minutes for a first attempt, then study the explanations. They are learning exercises, not official PMI examination items or a pass prediction. Unless a question says otherwise, use only its stated conditions. Questions referring to the upgrade use the day-boundary convention and the explicitly identified version of the model.

Question 1

A steering group receives a date labelled 'complete'. The underlying schedule distinguishes construction finish, trial operation and full service, each with different acceptance conditions. Before presenting the date as a delivery commitment, what should the scheduler establish?

A Whether the report can use a larger milestone symbol.
B Whether all three dates can be averaged for reporting.
C Which operational state, acceptance conditions and authority the commitment represents.
D Which date creates the smallest variance from the baseline.

Question 2

In the original logic-only upgrade, A lasts 2 days; B follows A for 4; D follows B for 3; E follows both C and D for 4; F follows E for 2; H follows both F and G for 1. C follows A for 5, and G follows C for 3. What is the earliest finish?

A Day 16, controlled by A-B-D-E-F-H.
B Day 15, because G finishes before F.
C Day 24, obtained by adding every duration.
D Day 17, before any resource restriction is applied.

Question 3

In the original unconstrained model, C has early start 2, early finish 7 and latest start 4. Its successors E and G have early starts 9 and 7. All relationships are finish-to-start with zero lag. What are C's total float and free float respectively?

A Zero days and two days.
B Two days and two days.
C Four days and seven days.
D Two days and zero days.

Question 4

One specialist must work full-time on E and G, which cannot be split. In the original model, G can run 7–10 and E 10–14, followed by F 14–16 and H 16–17. Reversing the specialist order also finishes at 17. What finish is supported by these two feasible orders?

A Day 16 because the original critical path is unchanged.
B Day 17 with the stated one-specialist restriction.
C Day 14 because E is the last specialist activity.
D Day 21 because all of G's float must be added.

Question 5

At the update, retaining G-before-E gives day 18. Resequencing E-before-G gives day 17 if operations accepts later training. The approved baseline is day 17. What is the most defensible report?

A Change the baseline immediately to day 18 to remove variance.
B Report day 17 without identifying the changed sequence.
C Show the retained-sequence forecast and the conditional resequencing option against the existing baseline.
D Report day 18 as the minimum possible finish under all resource orders.

Question 6

At one data date, planned value is £60,000, earned value is £54,000 and actual cost is £63,000. Scope and cut-off are consistent. What are conventional schedule variance and schedule performance index?

A Minus £6,000 and 0.90.
B Minus £9,000 and approximately 0.86.
C Six days late and 0.90.
D Plus £6,000 and approximately 1.11.

Question 7

A discrete model assigns finish days 18, 20, 21 and 23 probabilities 0.50, 0.20, 0.20 and 0.10 respectively. Define P80 as the earliest finish with cumulative probability at least 0.80. What is the P80 finish?

A Day 18, because it is the most likely single finish.
B Day 19.5, because it is the probability-weighted mean.
C Day 20, because 70% is close to 80%.
D Day 21, where cumulative probability reaches 90%.

Question 8

In the stated risk model, resequencing and an £8,000 additional specialist each give a 90% probability of completion by day 20. Their P80 finishes are days 20 and 19 respectively. What does this comparison support?

A The paid response necessarily improves the day-20 probability.
B The paid response buys an earlier P80, so its value depends on the decision criterion and assumptions.
C The options are identical in every operational respect.
D The resequenced plan guarantees completion by day 20.

Question 9

A resource-and-risk model uses a conformance assessment requiring 56 components. One required component is incorrectly used, although many optional components qualify. What should the assessor do under the stated gate-based method?

A Record the required-component failure and withhold the conformance index until it is resolved.
B Calculate a favourable index because optional components outweigh the omission.
C Interpret the raw count as the probability of finishing on time.
D Remove the required component from the denominator without explanation.

Question 10

A railway announces an initial service configuration while some associated works remain. Which schedule communication most accurately represents the milestone?

A Describe every associated activity as complete on the service date.
B Omit remaining work because passengers can use the line.
C State the service available, acceptance basis, restrictions and remaining obligations.
D Treat the announcement itself as proof of subsequent operating performance.

Question 11

A sponsor needs a milestone decision while delivery supervisors need near-term workfront detail. Both reports derive from the same controlled schedule release. What is the appropriate communication approach?

A Give each audience independently edited dates without retaining traceability.
B Tailor the detail while preserving the release, data date and meaning of the dates.
C Send the entire activity list to everyone without explanation.
D Let each audience choose the baseline that makes its report most favourable.

Question 12

A learner scores highly when immediately repeating a familiar mock but cannot explain why an unconstrained critical-path date changes after resource levelling. What is the most useful next practice?

A Repeat the same answer positions until they are automatic.
B Treat the improved score as a guaranteed examination pass.
C Avoid resource questions because the total score is already high.
D Attempt a varied resource-constrained example after a delay and explain the changed assumptions before checking feedback.

Answer explanations

1 — C. The meaning of the commitment must be established before its date can be defended. Construction finish, trial operation and full service can have different prerequisites and approval authorities. Presentation size and a favourable baseline comparison do not resolve that ambiguity, while averaging distinct milestones produces a date with no defined acceptance basis.

2 — A. A-B-D-E-F-H totals 2 + 4 + 3 + 4 + 2 + 1 = 16. E waits for D at day 9, and H waits for F at day 15. Adding all durations counts parallel activities twice. The day-17 result belongs to the later resource-constrained model, not this logic-only calculation.

3 — D. Total float is latest start minus early start: 4 − 2 = 2 days. Free float is the earliest successor early start minus C's early finish: min(9, 7) − 7 = 0. Delaying C moves G's early start immediately, even though the original project finish may remain unchanged within C's total float.

4 — B. Both possible non-pre-emptive orders of the two specialist activities finish at day 17 under the stated conditions. The original day-16 calculation assumed sufficient resources and contains an overlap. Float from that earlier model does not create additional specialist capacity, and its full amount should not be added mechanically to the finish.

5 — C. The retained sequence forecasts day 18. The day-17 resequencing alternative is technically feasible but requires operational acceptance of later training. Show both clearly against the existing baseline, preserving the distinction between forecast, response and approved reference. Neither deterioration nor an attractive alternative authorises an automatic baseline change.

6 — A. Conventional SV = EV − PV = £54,000 − £60,000 = −£6,000; SPI = EV / PV = 0.90. The minus £9,000 and approximately 0.86 results are cost variance and cost performance index. Monetary schedule variance is not a duration, so it cannot be described as six days of delay.

7 — D. Cumulative probabilities are 0.50 at day 18, 0.70 at day 20, 0.90 at day 21 and 1.00 at day 23. The first date meeting the stated 0.80 threshold is therefore day 21. The modal day, mean day and percentile answer different questions and should not be substituted for one another.

8 — B. The paid response has an earlier P80 but the same day-20 completion probability in this coarse model. Its value may depend on earlier-operation benefits, other requirements and the credibility of the unchanged risk assumptions. Neither option guarantees the deadline, and the result does not establish that their costs or operational consequences are identical.

9 — A. Required components must be correctly used before calculating the index under this method. Optional components cannot compensate for a failed required component. Report the finding and correct it before reassessment. A raw component count is neither a delivery probability nor a justification for altering the denominator to improve the result.

10 — C. An operational milestone must name the service configuration it represents. Remaining restrictions and obligations should remain visible and have appropriate ownership. A dated announcement can establish what was planned or reported at that time; it does not independently verify later operating performance or show that all associated work was complete.

11 — B. Different audiences need different levels of detail, but their views should retain consistent, traceable information from the controlled release. Independent date editing and opportunistic baseline selection undermine that consistency. Sending every activity to everyone also fails to address the actual decision and can obscure the information each audience needs.

12 — D. The difficulty concerns a model assumption, not answer-position memory. A changed example and delayed attempt test whether the learner can recognise the resource conflict and recalculate its

consequence. Feedback should address the reasoning. Familiarity-driven score improvement is useful only if it accompanies transferable understanding; it cannot guarantee an official examination outcome.

References and further reading

ASNR (2025). *Flamanville EPR: ASNR approval for reactor ramp-up*. 31 January. Official regulatory publication.

Deutsche Bahn (2025). *Die Bahn ist zurück im Ahrtal!* 12 December. Official service-restart announcement.

Emirates Nuclear Energy Corporation (ENEC) (2024). *UAE celebrates historic milestone as Unit 4 of the Barakah Plant commences commercial operation*. 5 September. Official project publication.

Government Accountability Office (GAO) (2026). *Information Technology: Census Bureau Needs to Better Manage Schedule for Modernization Program*. GAO-26-107629, 4 June, particularly table 9, pp. 20–22. Official report.

Infrastructure Australia (2026). *Melton Line Upgrade: Delivery Investment Business Case evaluation*. 24 March, particularly 'Deliverability' and 'Next steps'. Official evaluation.

Lyle, K. B., Bego, C. R., Ralston, P. A. S. and Immekus, J. C. (2022). 'Spaced Retrieval Practice Imposes Desirable Difficulty in Calculus Learning'. *Educational Psychology Review*, 34, 1799–1812. Publisher article, DOI: 10.1007/s10648-022-09677-2.

National Audit Office (NAO) (2026). *Restoration and Renewal of the Palace of Westminster: 2026 Update*. HC 32, 15 June, particularly pp. 18–19 and 24–25. Official report.

Project Management Institute (PMI) (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Available publication retains its original copyright date; back cover dated 2020. Official examination outline.

Project Management Institute (PMI) (2019). *Practice Standard for Scheduling*. Third edition. Newtown Square, PA: PMI. Key chapter references: model management in section 3; conformance in section 5 and Appendices X3–X4; third-edition changes in Appendix X1, pp. 143–144; glossary definitions on printed pp. 178, 181, 189–190 and 192. Printed page numbers are used throughout this chapter.

Project Management Institute (PMI) (n.d.). *PMI Scheduling Professional (PMI-SP)*. Certification information. Official certification page.

Skills England (2025). *Project controls professional, Level 6*. ST0845, version 1.1; updated 10 December 2025. Particularly skills S12 and S20–S21. Official occupational standard.

Suez Canal Authority (2024). *Navigation trials in the Small Bitter Lakes development area*. 28 December. Official trial publication.

Suez Canal Authority (2025). *Navigation charts for the southern-sector development project*. 3 February. Official chart and readiness publication. English descriptive titles are used for the two SCA entries.

WAM / Federal Authority for Nuclear Regulation (FANR) (2024). *Operation of Barakah's Unit 4 is fruit of years of efforts: FANR*. 5 September. Official news-agency account of the regulator's statement.

Yang, C., Luo, L., Vadillo, M. A., Yu, R. and Shanks, D. R. (2021). 'Testing (quizzing) boosts classroom learning: A systematic and meta-analytic review'. *Psychological Bulletin*, 147(4), 399–435. DOI: 10.1037/bul0000309. Author-hosted published article.

APPENDIX A

Appendix A: Complete Scheduling Glossary and Acronyms

This appendix is an integral reference for the fourteen-chapter book. The definitions and acronym expansions are reproduced from the *Practice Standard for Scheduling*, Third Edition (PMI, 2019), using its printed page numbers. Original spelling and wording are retained. Chapter links identify existing teaching or related discussion; they do not replace the quoted definition. Activity Duration Percent Complete appears twice with identical wording in the source and is consolidated here with both page references.

Using the definitions correctly

The source glossary contains several inconsistencies. The explanations below are separate from the quotations. They should be read before relying on an ambiguous entry.

Finish-to-start. On printed p. 181 the Finish-to-Start entry repeats Finish-to-Finish wording. The quotation below preserves that source text. For scheduling calculations, an FS relationship connects the predecessor's finish to the successor's start; see Chapter 5 and the standard's relationship diagram and discussion on printed pp. 59–60. An FS constraint does not require the successor to finish when the predecessor finishes.

AD. The source acronym table gives AD as activity duration, while the Activity Description heading also uses AD. Write out the intended field or declare the tool-specific convention.

Repeated and incomplete cross-references. Finish Date repeats its Project Finish Date cross-reference. Some See-also targets are discussed elsewhere in the standard but have no standalone glossary headword. Finish Not Earlier Than lacks a closing full stop in the source. These features are retained within the quoted wording.

Common acronyms

Table A.1 | Common scheduling acronyms

Acronym	Source expansion	Source printed page
AC	activity actual cost or actual cost	171
ACWP	actual cost of work performed	171
AD	activity duration	171
AF	actual finish date	171
AS	actual start date	171
BAC	budget at completion	171
CAM	control account manager	171
CPI	cost performance index	171
CPM	critical path method	171
CV	cost variance	171
DD	data date	171
DoD	definition of done	171
DU	duration	171
DUR	duration	171
EAC	estimate at completion	172
ETC	estimate to complete	172
EV	earned value	172
EVT	earned value technique	172
FF	free float	172
PC	percent complete	172
PCT	percent complete	172
PDM	precedence diagramming method	172
PV	planned value	172
RD	remaining duration	172
SPI	schedule performance index	172

Acronym	Source expansion	Source printed page
SV	schedule variance	172
TF	total float	172
WBS	work breakdown structure	172

FF also commonly denotes the Finish-to-Finish relationship in network discussion; the source acronym table above uses FF for free float. Read the context and spell out the meaning when ambiguity is possible.

Definitions

Activity

A distinct, scheduled portion of work performed during the course of a project. See also schedule activity.

(PMI, 2019, p. 172.)

Chapter teaching: Chapter 1, ‘Work, events, resources and relationships’.

Activity Actual Cost (AC)

The realized cost incurred for the work performed on an activity during a specific time period. See also budget at completion (BAC), earned value (EV), estimate at completion (EAC), estimate to complete (ETC), and planned value (PV).

(PMI, 2019, p. 172.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Activity Actual Duration

The total number of work periods, in calendar units, between the activity actual start date of the schedule activity and either the data date of the schedule model, if the schedule activity is in progress, or the activity actual finish date, if the schedule activity is complete. See also actual duration.

(PMI, 2019, p. 172.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Activity Actual Finish Date

The point in time at which a schedule activity is completed.

(PMI, 2019, p. 172.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Activity Actual Start Date

The point in time at which a schedule activity began.

(PMI, 2019, p. 172.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Activity Calendar

The project calendar or another specifically defined calendar from the calendar library assigned to the schedule activity that defines the work periods and nonwork periods in calendar format; used to replace the project calendar during schedule network analysis. See also calendar library.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 4, ‘Distinguish project, activity and resource calendars’.

Activity Code

> An alphanumeric value assigned to each activity that enables classifying, sorting, and filtering.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 3, 'Keep identity, classification and scope information distinct'.

Activity Cost Category

> A breakdown of the cost, such as labor cost, equipment cost, and material cost.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 4, 'Connect duration assumptions with the activity cost estimate'.

Activity Cost Estimate

> The projected cost of the schedule activity that includes the cost for all resources required to perform and complete the activity, including all cost types and cost components.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 4, 'Connect duration assumptions with the activity cost estimate'.

Activity Cumulative Probability Risk Distribution

> A table of dates and their associated cumulative probabilities of occurrence for schedule activity completion.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 8, '8.5 Interpreting confidence, criticality and sensitivity'.

Activity Current Finish Date

> See activity scheduled finish date.

(PMI, 2019, p. 173.)

Related topic: Chapter 5.

Activity Current Start Date

> See activity scheduled start date.

(PMI, 2019, p. 173.)

Related topic: Chapter 5.

Activity Description (AD)

> A short phrase or label for each schedule activity, used in conjunction with an activity identifier to differentiate a project schedule activity from other schedule activities. Also known as activity name or activity title.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 3, 'Write names that remain clear outside their original display'. Editorial clarification: AD is also expanded as activity duration in the source acronym table. Declare which field is intended.

Activity Duration

> The total number of work periods, in calendar units, between the activity early start date and the activity early finish date of a schedule activity. See also duration (DU or DUR).

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Activity Duration Percent Complete

The calculated percentage that the activity actual duration is of the activity total duration for a schedule activity that has work in progress.

(PMI, 2019, pp. 173, 176.)

Chapter teaching: Chapter 6, 'Explain why percentage-complete values differ'.

Activity Early Finish Date

The earliest possible point in time when the uncompleted portion of the schedule activity can be completed given the assigned resources. See also early finish date.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Activity Early Start Date

The earliest possible point in time when the schedule activity can begin based on the critical path method (CPM) forward pass of schedule model logic. See also early start date.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Activity Effort

The number of units required to complete a schedule activity or work breakdown structure component.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Activity Identifier

An alphanumeric value assigned to an activity and used to differentiate that activity from other activities. See also activity code and activity label.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 2, 'Preserve stable identities and distinguish saved instances'.

Activity Label

A phrase that names and describes an activity. See also activity code and activity identifier.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 3, 'Keep identity, classification and scope information distinct'.

Activity Late Finish Date

The latest possible point in time when the schedule activity can be completed without violating a schedule constraint or delaying the project end date. See also late finish date.

(PMI, 2019, p. 173.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Activity Late Start Date

The latest possible point in time when the schedule activity can begin without violating a schedule constraint or delaying the project end date. See also late start date.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Activity List

> A documented tabulation of schedule activities that shows the activity description, activity identifier, and a sufficiently detailed activity scope definition for the work so project team members understand what work is to be performed. The list may have additional activity attributes.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 3, ‘Translate a scope boundary into actions’.

Activity Most Likely Duration

> The total number of work periods in calendar units assigned to perform the schedule activity, considering all of the variables that could affect performance; it is determined to be the most probable activity duration.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Activity Name

> See activity description.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 3, ‘Write names that remain clear outside their original display’.

Activity Note

> Documentation of additional supporting information for an activity.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 13, ‘13.9 Archive a schedule that another person can reconstruct’.

Activity Optimistic Duration

> The total number of work periods in calendar units assigned to perform the schedule activity, considering all of the variables that could affect performance; it is determined to be the shortest possible activity duration.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Activity Original Duration

> The activity duration originally assigned to a schedule activity; this duration is typically not updated as progress is reported on the activity. Used for comparison with activity actual duration and activity remaining duration when reporting schedule progress. The activity original duration is normally developed by reliance on historical data, specialists, resource availability, financial considerations, and volume of work to be performed. Also known as planned duration.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 4, ‘Preserve the original estimate while improving the forecast’.

Activity Pessimistic Duration

> The total number of work periods in calendar units assigned to perform the schedule activity, considering all of the variables that could affect performance, it is determined to be the longest possible activity duration.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Activity Physical Percent Complete

> An estimate, expressed as a percent, of the amount of work that has been completed on a schedule activity, measured in terms of either physical work progress or by means of the earning rules of earned value management.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 10, 'Worked example: three percentages for one activity'.

Activity Planned Finish Date

> See activity scheduled finish date.

(PMI, 2019, p. 174.)

Related topic: Chapter 5.

Activity Planned Start Date

> See activity scheduled start date.

(PMI, 2019, p. 174.)

Related topic: Chapter 5.

Activity Remaining Duration

> The total number of work periods, in calendar units, (a) equal to the original duration for an activity that has not started or (b) between the data date of the project schedule and the critical path method (CPM) early finish date of a schedule activity that has an activity actual start date. This represents the time needed to complete a schedule activity where the work is in progress. See also remaining duration.

(PMI, 2019, p. 174.)

Chapter teaching: Chapter 10, 'Validate relationships between fields, not just individual entries'.

Activity Resource-Leveled Finish Date

> The point in time associated with the activity scheduled finish date of a resource-limited schedule activity in a resource-limited schedule.

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 7, 'Resolve the conflict and trace the new controlling sequence'.

Activity Resource-Leveled Start Date

> The point in time associated with the activity scheduled start date of a resource-limited schedule activity in a resource-limited schedule.

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 7, 'Resolve the conflict and trace the new controlling sequence'.

Activity Risk Criticality Index

> The probability that the schedule activity will be on a critical path.

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 8, 'Distinguish how often an activity is critical from its influence'.

Activity Scheduled Finish Date

> The point in time when work was scheduled to complete on a schedule activity. The activity scheduled finish date is normally within the range of dates delimited by the activity early finish date and the activity late finish date. It may reflect resource leveling of scarce resources. Also known as activity planned finish date. See also scheduled finish date.

(PMI, 2019, p. 175.)

Related chapter discussion: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Activity Scheduled Start Date

> The point in time when work was scheduled to begin on a schedule activity. The activity scheduled start date is normally within the range of dates delimited by the activity early start date and the activity late start date. It may reflect resource leveling of scarce resources. Also known as activity planned start date. See also scheduled start date.

(PMI, 2019, p. 175.)

Related chapter discussion: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Activity Scope Definition

> Documented narrative describing the work represented by the activity.

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 3, 'Keep identity, classification and scope information distinct'.

Activity Start Date

> A point in time associated with the beginning of the schedule activity in a project. Usually qualified by one of the following: actual, baseline, current, early, late, scheduled, or target. See also start date.

(PMI, 2019, p. 175.)

Related chapter discussion: Chapter 13, 'Communicating Schedule Decisions and Closing Out'.

Activity Title

> See activity description.

(PMI, 2019, p. 175.)

Related topic: Chapter 2.

Activity Total Duration

> The total number of work periods, in calendar units, to complete a schedule activity. For schedule activities in progress, it includes the activity actual duration plus the activity remaining duration.

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 4, 'Reconcile the current total without confusing time and progress'.

Activity Type

> A categorization designation that differentiates the discrete schedule activities that have different functions within the schedule model, such as milestone, task, summary, level of effort, and dummy.

(PMI, 2019, p. 175.)

Related chapter discussion: Chapter 3, 'Summary activities aggregate information'.

Actual Cost (AC)

The realized cost incurred for the work performed on an activity during a specific time period. See also budget at completion (BAC), earned value (EV), estimate at completion (EAC), estimate to complete (ETC), and planned value (PV).

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 10, '10.5 Earned value: relating accomplishment to plan and cost'.

Actual Cost of Work Performed (ACWP)

See actual cost (AC).

(PMI, 2019, p. 175.)

Related topic: Chapter 10.

Actual Duration

The time, in calendar units, between the actual start date of the schedule activity and either the data date of the project schedule, if the schedule activity is in progress, or the actual finish date if the schedule activity is complete. See also activity actual duration and project actual duration.

(PMI, 2019, p. 175.)

Chapter teaching: Chapter 4, 'Preserve the original estimate while improving the forecast'.

Actual Finish Date (AF)

The point in time that work actually ended on a schedule activity. (Note: In some application areas, the schedule activity is considered "finished" when work is "substantially complete.") See also project actual finish date.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 10, 'Validate relationships between fields, not just individual entries'.

Actual Start Date (AS)

The point in time that work actually started on a schedule activity. See activity actual start date and project actual start date.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 10, 'Validate relationships between fields, not just individual entries'.

Agile

A term used to describe a mindset of values and principles as set forth in the Agile Manifesto.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 9, '9.1 Understanding adaptive and hybrid delivery'.

Approve

The act of formally confirming, sanctioning, ratifying, or agreeing to something.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 13, '13.4 Facilitate challenge, disagreement and escalation'.

Arrow

The graphic presentation of a schedule activity in the arrow diagramming method or a logical relationship between schedule activities in the precedence diagramming method.

(PMI, 2019, p. 176.)

Related chapter discussion: Chapter 5, 'Read the relationship from the predecessor's event to the successor's event'.

As-of Date

See data date (DD).

(PMI, 2019, p. 176.)

Related chapter discussion: Chapter 6, '6.1 Distinguishing the tool, model, instance and presentation'.

Assumption

A factor in the planning process considered to be true, real, or certain, without proof or demonstration.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 6, 'Make assumptions testable and uncertainty visible'.

Backlog

See iteration backlog and product backlog.

(PMI, 2019, p. 176.)

Related chapter discussion: Chapter 9, '9.3 Planning iterations and managing adaptive dependencies'.

Backward Pass

A critical path method technique for calculating the late start and late finish dates by working backward through the schedule model from the project end date. See also forward pass.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Bar

A rectangular-shaped, graphical display object used to represent the occurrence of a data component in a document, such as a schedule activity in a bar chart whose length is determined by the activity start and end dates corresponding to the timescale used for the bar chart. Bars can overlap or be displayed side by side to indicate progress or baselines.

(PMI, 2019, p. 176.)

Related chapter discussion: Chapter 6, '6.1 Distinguishing the tool, model, instance and presentation'.

Bar Chart

A graphic display of schedule-related information. In the typical bar chart, schedule activities or work breakdown structure components are listed down the left side of the chart, dates are shown across the top, and activity durations are shown as date-placed horizontal bars. Also known as a Gantt chart.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 13, 'Select the view that answers the question'.

Baseline

The approved version of a work product that can be changed using formal change control procedures, and is used as the basis for comparison to actual results. Also known as performance measurement baseline. See also cost baseline and schedule baseline.

(PMI, 2019, p. 176.)

Chapter teaching: Chapter 1, 'Target, baseline, forecast and scenario'.

Baseline Date

The date on which the current baseline was established. Sometimes used with a modifier, such as project schedule, project scope, or project cost.

(PMI, 2019, p. 176.)

Related topic: Chapter 10.

Budget

> The approved estimate for the project or any work breakdown structure component or schedule activity. See also estimate.

(PMI, 2019, p. 177.)

Related chapter discussion: Chapter 3, 'Reconcile packages and budgets without counting the work twice'.

Budget at Completion (BAC)

> The sum of all budgets established for the work to be performed. See also actual cost (AC), earned value (EV), estimate at completion (EAC), estimate to complete (ETC), and planned value (PV).

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 10, '10.5 Earned value: relating accomplishment to plan and cost'.

Budgeted Cost of Work Performed (BCWP)

> See earned value (EV).

(PMI, 2019, p. 177.)

Related topic: Chapter 10.

Burndown Chart

> A graphical representation of the work remaining versus the time left in a timebox.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 9, '9.5 Interpreting burn charts and making conditional forecasts'.

Calendar

> Defines periods when work can or cannot occur during a project and the length of the work period, holidays, and exceptions.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 4, 'A calendar is a calculation rule as well as a working arrangement'.

Calendar Library

> See activity calendar and resource calendar.

(PMI, 2019, p. 177.)

Related chapter discussion: Chapter 4, 'Distinguish project, activity and resource calendars'.

Calendar Unit

> The smallest unit of time used in scheduling the project. Calendar units are generally in hours, days, or weeks, but can also be in quarter years, months, shifts, or even in minutes.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Change Control

> A process whereby modifications to documents, deliverables, or baselines associated with the project are identified, documented, approved, or rejected.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 6, 'Integrate the baseline with scope and cost where required'.

Change Request Identifier

> The primary key value for items in the program change log as related to the schedule model.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 11, '11.2 Preserving the evidence and identifying the authority'.

Component

> A constituent part, element, or piece of a complex whole.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 12, '12.3 Using the component catalogue as a system of checks'.

Constraint

> A factor that limits the options for managing a project, program, portfolio, or process.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 12, '12.7 Testing network integrity and delivery feasibility'.

Control

> Comparing actual performance with planned performance, analyzing variances, assessing trends to effect process improvements, evaluating possible alternatives, and recommending appropriate corrective action as needed.

(PMI, 2019, p. 177.)

Related chapter discussion: Chapter 10, 'Turning progress evidence into a credible forecast'.

Control Account

> A management control point where scope, budget, actual cost, and schedule are integrated and compared to earned value for performance measurement.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 3, 'Different breakdown structures answer different questions'.

Control Account ID

> An alphanumeric cost-accounting identifier typically assigned at the intersection of the work breakdown structure and organizational breakdown structure at the level where costs will be collected. Control accounts contain work packages.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 3, 'Keep identity, classification and scope information distinct'.

Control Account Manager (CAM)

> An alphanumeric designation of the single person accountable for the costs and achievement of the scope of work identified by the control account; this may be the name of an individual or a unique reference identifying the individual.

(PMI, 2019, p. 177.)

Related chapter discussion: Chapter 3, 'Establish one accountable owner without denying collaboration'.

Corrective Action

> An intentional activity that realigns the performance of the project work with the project management plan.

(PMI, 2019, p. 177.)

Chapter teaching: Chapter 11, '11.4 Selecting a feasible recovery approach'.

Cost

The monetary value or price of a project activity or component that includes the monetary worth of the resources required to perform and complete the activity or component, or to produce the component. A specific cost can be composed of a combination of cost components including direct labor hours, other direct costs, indirect labor hours, other indirect costs, and purchase price. (However, in the earned value management methodology, in some instances, the term cost can represent only labor hours without conversion to monetary worth.) See also actual cost (AC) and estimate.

(PMI, 2019, p. 178.)

Related chapter discussion: Chapter 4, 'Connect duration assumptions with the activity cost estimate'.

Cost Baseline

The approved version of work package cost estimates and contingency reserve that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and schedule baseline.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 8, 'Integrate the schedule with the approved budget'.

Cost Performance Index (CPI)

A measure of the cost efficiency of budgeted resources expressed as the ratio of earned value to actual cost. See also schedule performance index (SPI).

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 10, 'Calculate the indices and preserve their units'.

Cost Type

A subdivision of the cost such as direct cost, indirect cost, and fee.

(PMI, 2019, p. 178.)

Related topic: Chapter 10.

Cost Variance (CV)

The amount of budget deficit or surplus at a given point in time, expressed as the difference between the earned value and the actual cost. See also schedule variance (SV).

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 10, 'Calculate the indices and preserve their units'.

Crashing

A schedule compression technique used to shorten the schedule duration for the least incremental cost by adding resources. See also fast tracking and schedule compression.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 7, '7.7 Choosing responsible optimisation options'.

Criteria

Standards, rules, or tests on which a judgment or decision can be based, or by which a product, service, result, or process can be evaluated.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 12, '12.1 Agreeing what the review must establish'.

Critical Activity

> Any schedule activity on a critical path in a project schedule or through the use of calendars, resources, or constraints that is critical to some artifact other than the critical path.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 5, ‘Separate the driving path from the critical-colour display’.

Critical Chain Approach

> A schedule method that allows the project team to place buffers on any project schedule path to account for limited resources and project uncertainties.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 1, ‘Critical chain and protecting the delivery system’.

Critical Path

> The sequence of activities that represents the longest path through a project, which determines the shortest possible duration. See also critical path activity and critical path method.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 1, ‘Critical path and the consequences of dependence’.

Critical Path Activity

> Any activity on the critical path in a project schedule. See also critical path and critical path method.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 5, ‘Separate the driving path from the critical-colour display’.

Critical Path Method

> A method used to estimate the minimum project duration and determine the amount of scheduling flexibility on the network paths within the schedule model. See also critical path.

(PMI, 2019, p. 178.)

Chapter teaching: Chapter 1, ‘Critical path and the consequences of dependence’.

Current Finish Date

> The current estimate of the point in time when a schedule activity will be completed, where the estimate reflects any reported work progress. See also scheduled finish date.

(PMI, 2019, p. 178.)

Related chapter discussion: Chapter 13, ‘Communicating Schedule Decisions and Closing Out’.

Current Start Date

> The current estimate of the point in time when a schedule activity will begin, where the estimate reflects any reported work progress. See also scheduled start date.

(PMI, 2019, p. 179.)

Related chapter discussion: Chapter 13, ‘Communicating Schedule Decisions and Closing Out’.

Customer

> The person or organization that will use the project’s product, service, or result. See also user.

(PMI, 2019, p. 179.)

Related chapter discussion: Chapter 3, ‘Establish start and finish conditions’.

Data Date (DD)

> A point in time when the status of the project is recorded.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 6, '6.7 Completing a first controlled update'.

Date

> A term representing the day, month, and year of a calendar, and, in some instances, the time of day.

(PMI, 2019, p. 179.)

Related chapter discussion: Chapter 4, 'Work through a calendar example in hours'.

Decompose

> See decomposition.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 3, 'Decompose the total scope without turning the WBS into a timetable'.

Decomposition

> A technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 3, 'Decompose the total scope without turning the WBS into a timetable'.

Define Activities

> The process of identifying the specific schedule activities that need to be performed to produce the various project deliverables.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 3, 'Translate a scope boundary into actions'.

Definition of Done (DoD)

> A team's checklist of all the criteria required to be met so that a deliverable can be considered ready for customer use.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 9, 'From a look-ahead plan to executable work'.

Deliverable

> Any unique and verifiable product, result, or capability to perform a service that is produced to complete a process, phase, or project.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 3, 'Distinguish the reason for the project from the work it contains'.

Dependency

> See logical relationship.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 5, 'Read the relationship from the predecessor's event to the successor's event'.

Develop Schedule

> The process of analyzing schedule activity sequences, schedule activity durations, resource requirements, and schedule constraints to create the project schedule.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 6, '6.1 Distinguishing the tool, model, instance and presentation'.

Discipline

> A field of work requiring specific knowledge that has a set of rules governing work conduct (e.g., mechanical engineering, computer programming, cost estimating, etc.).

(PMI, 2019, p. 179.)

Related chapter discussion: Chapter 3, 'Translate a scope boundary into actions'.

Document

> A medium and the information recorded thereon that generally has permanence and can be read by a person or a machine. Examples include project management plans, specifications, procedures, studies, and manuals.

(PMI, 2019, p. 179.)

Related chapter discussion: Chapter 6, 'Making the schedule understandable, reproducible and controlled'.

Driving Resources

> Resources that are considered to have a direct impact on activity duration during resource leveling.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 7, 'Identify the resource that governs the duration'.

Duration

> The total number of work periods required to complete an activity or project, expressed in hours, days, or weeks. Usually qualified by one of the following: actual, baseline, current, original, remaining, scheduled, or target. See also effort.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Duration Percent Complete

> See activity duration percent complete and project duration percent complete.

(PMI, 2019, p. 179.)

Chapter teaching: Chapter 4, 'Reconcile the current total without confusing time and progress'.

Early Finish Date

> In the critical path method, the earliest possible point in time when the uncompleted portions of a schedule activity can finish based on the schedule network logic, the data date, and any schedule constraints. See also early start date, late finish date, late start date, and schedule network analysis.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Early Start Date

In the critical path method, the earliest possible point in time when the uncompleted portions of a schedule activity can start based on the schedule network logic, the data date, and any schedule constraints. See also early finish date, late finish date, late start date, and schedule network analysis.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Earned Schedule

An earned value technique that measures the time at which planned value equals earned value.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 10, '10.7 Earned schedule: translating accomplishment into a time comparison'.

Earned Value (EV)

The measure of work performed expressed in terms of the budget authorized for that work. See also actual cost (AC), budget at completion (BAC), estimate at completion (EAC), estimate to complete (ETC), and planned value (PV).

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 10, '10.5 Earned value: relating accomplishment to plan and cost'.

Earned Value Technique (EVT)

A specific technique for measuring the performance of work for a work breakdown structure component, control account, or project. Also referred to as the earning rules and crediting method. See also actual cost (AC), estimate at completion (EAC), and estimate to complete (ETC).

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 10, 'Establish earning rules before observing performance'.

Effort

The number of labor units required to complete a schedule activity or work breakdown structure component, often expressed in hours, days, or weeks. See also duration.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Estimate

A quantitative assessment of the likely amount or outcome, which is usually applied to project costs, resources, effort, and durations, is usually preceded by a modifier (i.e., preliminary, conceptual, feasibility, order-of-magnitude, definitive), and should always include some indication of accuracy (e.g., ± x %).

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Estimate Activity Durations

The process of estimating the number of work periods that are needed to complete individual schedule activities.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 4, 'Separate duration from effort and elapsed time'.

Estimate Activity Resources

The process of estimating the types and quantities of resources required to perform each schedule activity.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 7, 'Use the effort calculation as an explicit model'.

Estimate at Completion (EAC)

The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete. See also actual cost (AC), budget at completion (BAC), earned value (EV), estimate to complete (ETC), and planned value (PV).

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 10, '10.6 Forecasting cost and testing the efficiency required'.

Estimate to Complete (ETC)

The expected cost to finish all the remaining project work. See also actual cost (AC), budget at completion (BAC), earned value (EV), estimate at completion (EAC), and planned value (PV).

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 10, '10.6 Forecasting cost and testing the efficiency required'.

Expected Finish Date

A date constraint placed on both the activity early and late finish dates of an in-progress schedule activity that affects when the schedule activity can be scheduled for completion and is usually in the form of a fixed imposed date. See also finish date and project finish date.

(PMI, 2019, p. 180.)

Chapter teaching: Chapter 5, 'ASAP, ALAP and Expected Finish are different decisions'.

Fast Tracking

A schedule compression technique in which activities or phases normally done in sequence are performed in parallel for at least a portion of their duration. See also crashing and schedule compression.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 11, 'Fast tracking: overlap with a defensible release condition'.

Finish Date

A point in time associated with a schedule activity's completion. Usually qualified by one of the following: actual, baseline, current, early, expected, late, mandatory, original, scheduled, or target. See also project finish date. See also project finish date.

(PMI, 2019, p. 181.)

Related chapter discussion: Chapter 13, 'Communicating Schedule Decisions and Closing Out'.

Finish Not Earlier Than

A schedule constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, 'Compare the constraint families'.

Finish Not Later Than

A schedule constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, ‘Compare the constraint families’.

Finish On

A date constraint placed on the schedule activity that requires the schedule activity to finish on a specific date.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, ‘Compare the constraint families’.

Finish-to-Finish

A logical relationship in which a successor activity cannot finish until a predecessor activity has finished. See also finish-to-start, start-to-finish, start-to-start, and logical relationship.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Finish-to-Start

A logical relationship in which a successor activity cannot finish until a predecessor activity has finished. See also finish-to-start, start-to-finish, start-to-start, and logical relationship.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’. Editorial clarification: the quoted source entry repeats the FF condition. Apply the FS predecessor-finish → successor-start relationship explained in Chapter 5; see the source-inconsistency note above.

Float

Also known as slack. See also free float (FF) and total float (TF).

(PMI, 2019, p. 181.)

Related chapter discussion: Chapter 5, ‘5.4 Interpreting critical paths and float’.

Forecasts

Estimates or predictions of conditions and events in the project’s future based on information and knowledge available at the time of the forecast. Forecasts are updated and reissued based on work performance information provided as the project is executed.

(PMI, 2019, p. 181.)

Related chapter discussion: Chapter 10, ‘Turning progress evidence into a credible forecast’.

Forward Pass

A critical path method technique for calculating the early start and early finish dates by working forward through the schedule model from the project start date or a given point in time. See also backward pass.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, ‘The forward pass: satisfy the latest arriving prerequisite’.

Free Float

The amount of time that a schedule activity can be delayed without delaying the early start date of any successor or violating a schedule constraint. See also total float, critical path, and near-critical path.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, ‘5.4 Interpreting critical paths and float’.

Graph

> A visual graphical display using lines and shapes to represent data values, such as project status or forecast information.

(PMI, 2019, p. 181.)

Related chapter discussion: Chapter 9, '9.5 Interpreting burn charts and making conditional forecasts'.

Hammock Activity

> An activity whose duration is aggregated by logical relationships from a group of related activities within the schedule model. See also summary activity.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 3, 'Hammocks derive their span from related work'.

Imposed Date

> A fixed date imposed on a schedule activity or schedule milestone, usually in the form of a "start-no-earlier-than" and "finish-no-later-than" date.

(PMI, 2019, p. 181.)

Chapter teaching: Chapter 5, 'Compare the constraint families'.

Input

> Any item, whether internal or external to the project that is required by a process before that process proceeds.

(PMI, 2019, p. 181.)

Related chapter discussion: Chapter 3, 'Before a date can be credible'.

Integrated

> Interrelated, interconnected, interlocked, or meshed components blended and unified into a functioning or unified whole.

(PMI, 2019, p. 182.)

Related chapter discussion: Chapter 3, 'Before a date can be credible'.

Iteration

> A timeboxed cycle of development on a product or deliverable in which all of the work that is needed to deliver value is performed.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 9, '9.3 Planning iterations and managing adaptive dependencies'.

Iteration Backlog

> An ordered list of user-centric requirements that a team maintains for an iteration.

(PMI, 2019, p. 182.)

Related chapter discussion: Chapter 9, '9.3 Planning iterations and managing adaptive dependencies'.

Kanban Board

> A visualization tool that enables improvements to the flow of work by making bottlenecks and work quantities visible.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 9, '9.4 Managing flow with Kanban and work-in-progress controls'.

Kanban Method

> An agile method inspired by the original Kanban inventory control system and used specifically for knowledge work.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 9, '9.4 Managing flow with Kanban and work-in-progress controls'.

Lag

> The amount of time whereby a successor activity will be delayed with respect to a predecessor activity. See also lead.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 5, '5.6 Using leads and lags transparently'.

Late Finish Date

> In the critical path method, the latest possible point in time when the uncompleted portions of a schedule activity can finish based on the schedule network logic, the project completion date, and any schedule constraints. See also early finish date, early start date, late start date, and schedule network analysis.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Late Start Date

> In the critical path method, the latest possible point in time when the uncompleted portions of a schedule activity can start based on the schedule network logic, the project completion date, and any schedule constraints. See also early finish date, early start date, late finish date, and schedule network analysis.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Lead

> The amount of time whereby a successor activity can be advanced with respect to a predecessor activity. See also lag.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 5, '5.6 Using leads and lags transparently'.

Lessons Learned

> The knowledge gained during a project which shows how project events were addressed or should be addressed in the future for the purpose of improving future performance.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 13, '13.8 Turn experience into reusable scheduling knowledge'.

Level of Effort

> An activity that does not produce definitive end products and is measured by the passage of time.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 3, 'Level of effort represents support rather than a discrete product'.

Leveling

> See resource leveling.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 7, '7.4 Distinguishing smoothing from levelling'.

Logic

> See network logic.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Logic Diagram

> See project schedule network diagram.

(PMI, 2019, p. 182.)

Related chapter discussion: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Logical Relationship

> A dependency between two activities or between an activity and a milestone. See also finish-to-finish, finish-to-start, start-to-finish, and start-to-start.

(PMI, 2019, p. 182.)

Chapter teaching: Chapter 1, ‘Work, events, resources and relationships’.

Master Schedule

> A summary-level project schedule that identifies major deliverables, work breakdown structure components, and key schedule milestones. See also milestone schedule.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 2, ‘Distinguish a summary from an integrated model’.

Methodology

> A system of practices, techniques, procedures, and rules used by those who work in a discipline.

(PMI, 2019, p. 183.)

Related chapter discussion: Chapter 3, ‘The chapter framework’.

Milestone

> A significant point or event in a project, program, or portfolio.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 1, ‘Work, events, resources and relationships’.

Milestone Schedule

> A type of schedule that presents milestones with planned dates.

(PMI, 2019, p. 183.)

Related chapter discussion: Chapter 13, ‘13.1 Start with the decision, the audience and the evidence’.

Most Likely Duration

> An estimate of the most probable activity duration that takes into account all of the known variables that could affect performance. See also optimistic duration and pessimistic duration.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Near-Critical Path

> A sequence of activities with low float which, if exhausted, becomes a critical path sequence for the project. See also critical path, free float, and total float.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 5, ‘Near-critical and multiple critical paths’.

Network

> See project schedule network diagram.

(PMI, 2019, p. 183.)

Related chapter discussion: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Network Analysis

> See schedule network analysis.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 5, ‘The forward pass: satisfy the latest arriving prerequisite’.

Network Logic

> All activity dependencies in a project schedule network diagram. See also early finish date, early start date, late finish date, late start date, and network path.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Node

> A point at which dependency lines connect on a schedule network diagram. See also precedence diagramming method (PDM).

(PMI, 2019, p. 183.)

Related chapter discussion: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Nonwork Period

> A date, or part of a date, identified as a time for not performing work including designated holidays.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 4, ‘Separate duration from effort and elapsed time’.

Open End

> An activity with no predecessor, successor, or both.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 5, ‘5.7 Finding and repairing defective logic’.

Optimistic Duration

> An estimate of the shortest activity duration that takes into account all of the known variables that could affect performance. See also most likely duration and pessimistic duration.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Organization

> A group of persons organized for some purpose or to perform some type of work within an enterprise.

(PMI, 2019, p. 183.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Original Duration

> The activity duration originally assigned to a schedule activity and not updated as progress is reported on the activity. Typically used for comparison with actual duration and remaining duration when reporting schedule progress.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 4, ‘Preserve the original estimate while improving the forecast’.

Output

> A product, result, or service generated by a process. May be an input to a successor process.

(PMI, 2019, p. 183.)

Related chapter discussion: Chapter 3, ‘Before a date can be credible’.

Percent Complete (PC or PCT)

> An estimate expressed as a percent of the amount of work that has been completed on an activity or a work breakdown structure component.

(PMI, 2019, p. 183.)

Chapter teaching: Chapter 10, ‘Worked example: three percentages for one activity’.

Pessimistic Duration

> An estimate of the longest activity duration that takes into account all of the known variables that could affect performance. See also most likely duration and optimistic duration.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Phase

> See also project phase.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 3, ‘Keep identity, classification and scope information distinct’.

Physical Work Progress

> The amount of work physically completed on the project or task.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 10, ‘Worked example: three percentages for one activity’.

Planned Duration

> See activity original duration and project original duration.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 4, ‘Preserve the original estimate while improving the forecast’.

Planned Finish Date (PF)

> See scheduled finish date.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 6, ‘A documented US example: regular updating without a sufficient basis’.

Planned Start Date (PS)

> See scheduled start date.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 6, ‘A documented US example: regular updating without a sufficient basis’.

Planned Value (PV)

The authorized budget assigned to scheduled work. See also actual cost (AC), budget at completion (BAC), earned value (EV), estimate at completion (EAC), and estimate to complete (ETC).

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 10, '10.5 Earned value: relating accomplishment to plan and cost'.

Practice

A specific type of professional or management activity that contributes to the execution of a process and that may employ one or more techniques and tools.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 3, 'Translate a scope boundary into actions'.

Precedence Diagramming Method (PDM)

A technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed. See also node and project schedule network diagram.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 5, 'Read the relationship from the predecessor's event to the successor's event'.

Precedence Relationship

The term used in the precedence diagramming method for a logical relationship. See also logical relationship.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 5, 'Read the relationship from the predecessor's event to the successor's event'.

Predecessor Activity

An activity that logically comes before a dependent activity in a schedule. See also successor activity and summary activity.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 5, 'Read the relationship from the predecessor's event to the successor's event'.

Presentation

An output of a schedule model instance that presents the time-based information required by the communication plan, including activities with planned dates, durations, milestone dates, and resource allocation.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 3, 'Before a date can be credible'.

Procedure

A series of steps followed in a regular, definitive order to accomplish something.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 3, 'Translate a scope boundary into actions'.

Process

A set of interrelated actions and activities performed to achieve a specified set of products, results, or services.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 3, 'Translate a scope boundary into actions'.

Product

> An artifact that is produced, is quantifiable, and can be either an end item in itself or a component item. Also known as materials and goods. Contrast with result and service. See also deliverable.

(PMI, 2019, p. 184.)

Related chapter discussion: Chapter 3, ‘Before a date can be credible’.

Product Backlog

> An ordered list of user-centric requirements that a team maintains for a product.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 9, ‘9.3 Planning iterations and managing adaptive dependencies’.

Progress Override

> Schedule calculation that ignores logical relationships and allows activities with progress to continue even if the predecessors’ logical relationships have not been satisfied.

(PMI, 2019, p. 184.)

Chapter teaching: Chapter 10, ‘10.3 Updating the model and resolving out-of-sequence work’.

Progressive Elaboration

> The iterative process of increasing the level of detail in a project management plan as greater amounts of information and more accurate estimates become available.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 3, ‘Reconcile the old and new representations’.

Project

> A temporary endeavor undertaken to create a unique product, service, or result.

(PMI, 2019, p. 185.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Project Actual Duration

> The total number of work periods in calendar units between the project actual start date of the project and either the data date of the schedule model instance, if the project is in progress, or the project actual finish date, if the project is complete. See also actual duration.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Project Actual Finish Date

> The point in time associated with the activity actual finish date of the last schedule activity in the project. See also actual finish date.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Project Actual Start Date

> The point in time associated with the activity actual start date of the first schedule activity in the project. See also actual start date.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 10, ‘Validate relationships between fields, not just individual entries’.

Project Begin Date

> See project start date.

(PMI, 2019, p. 185.)

Related topic: Chapter 2.

Project Calendar

> A calendar that identifies working days and shifts that are available for scheduled activities.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 4, 'Distinguish project, activity and resource calendars'.

Project Completion Date

> See project end date.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Project Critical Path

> The longest schedule network path from the project start date or the current project data date to the project finish date. See also critical path.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Project Current Finish Date

> See current finish date, project baseline finish date, and project scheduled finish date.

(PMI, 2019, p. 185.)

Related topic: Chapter 5.

Project Current Start Date

> See current start date, project baseline start date, and project scheduled start date.

(PMI, 2019, p. 185.)

Related topic: Chapter 5.

Project Description

> Documented narrative summary of the project scope statement.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 3, 'Keep identity, classification and scope information distinct'.

Project Duration

> The total number of work periods, in calendar units, between the project early start date and the project early finish date. See also duration (DU or DUR).

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Project Duration Percent Complete

> An estimate expressed as the percentage that the project actual duration is of the project total duration for a project that has work in progress.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 10, 'Aggregate compatible information and preserve its meaning'.

Project Early Finish Date

> The earliest possible point in time associated with the completion of the last schedule activity of the project. See also early finish date.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Project Early Start Date

> The earliest possible point in time associated with the beginning of the first schedule activity of the project. See also early start date.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Project End Date

> The point in time set by the project late finish date as determined by a schedule network analysis or as established by a project finish constraint. Also known as project completion date.

(PMI, 2019, p. 185.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Project Finish Constraint

> A limitation or restraint placed on the project late finish date that affects when the project should finish and is usually in the form of a fixed imposed date.

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 5, 'Compare the constraint families'.

Project Finish Date

> A point in time associated with the completion of the last schedule activity in a project. Usually qualified by one of the following: actual, baseline, current, early, expected, late, mandatory, original, scheduled, or target. See also finish date.

(PMI, 2019, p. 186.)

Related chapter discussion: Chapter 13, 'Communicating Schedule Decisions and Closing Out'.

Project Identifier

> A short, unique numeric or text identification assigned to each project to differentiate a particular project from other projects in a program.

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 6, 'Keep identity, revision and approval status separate'.

Project Late Finish Date

> The latest possible point in time associated with the completion of the last schedule activity of the project.

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Project Late Start Date

> The latest possible point in time associated with the beginning of the first schedule activity of the project.

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Project Management Plan

The document that describes how the project will be executed, monitored and controlled, and closed.

(PMI, 2019, p. 186.)

Related chapter discussion: Chapter 2, 'Australia case study: keeping control records aligned'.

Project Management Team

The members of the project team who are directly involved in project management activities. On some smaller projects, the project management team may include virtually all of the project team members.

(PMI, 2019, p. 186.)

Related topic: Chapter 3.

Project Manager

The person assigned by the performing organization to lead the team that is responsible for achieving the project objectives.

(PMI, 2019, p. 186.)

Related chapter discussion: Chapter 13, 'Communicating Schedule Decisions and Closing Out'.

Project Name

A short phrase or label for each project, used in conjunction with the project identifier, to differentiate a particular project from other projects in a program. Also known as project title.

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 3, 'Keep identity, classification and scope information distinct'.

Project Phase

A collection of logically related project activities that culminates in the completion of one or more deliverables.

(PMI, 2019, p. 186.)

Related chapter discussion: Chapter 3, 'Keep identity, classification and scope information distinct'.

Project Physical Percent Complete

A calculation, expressed as a percent, of the amount of work that has been completed on the project, measured in terms of physical work progress.

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 10, 'Aggregate compatible information and preserve its meaning'.

Project Planned Finish Date

See also project scheduled finish date.

(PMI, 2019, p. 186.)

Related topic: Chapter 5.

Project Planned Start Date

See also project scheduled start date.

(PMI, 2019, p. 186.)

Related topic: Chapter 5.

Project Remaining Duration

> The total number of work periods, in calendar units, between the data date of the schedule model and the project early finish date of a project that has at least one activity actual start date. This represents the time needed to complete a project where the work is in progress. See also remaining duration (RD).

(PMI, 2019, p. 186.)

Chapter teaching: Chapter 10, 'Validate relationships between fields, not just individual entries'.

Project Resource-Leveled Finish Date

> The point in time associated with the last activity scheduled finish date of a resource-limited schedule activity in a resource-limited schedule.

(PMI, 2019, p. 187.)

Chapter teaching: Chapter 7, 'Resolve the conflict and trace the new controlling sequence'.

Project Resource-Leveled Start Date

> The point in time associated with the first activity scheduled start date of a resource-limited schedule activity in a resource-limited schedule.

(PMI, 2019, p. 187.)

Chapter teaching: Chapter 7, 'Resolve the conflict and trace the new controlling sequence'.

Project Schedule

> An output of a schedule model that presents linked activities with planned dates, durations, milestones, and resources.

(PMI, 2019, p. 187.)

Chapter teaching: Chapter 2, 'Design the reporting cycle around action'.

Project Schedule Management

> Project Schedule Management includes the processes required to manage the timely completion of the project.

(PMI, 2019, p. 187.)

Related chapter discussion: Chapter 2, 'Begin with the decisions the schedule must support'.

Project Scheduled Finish Date

> See current finish date and scheduled finish date.

(PMI, 2019, p. 187.)

Related topic: Chapter 5.

Project Scheduled Start Date

> See current start date and scheduled start date.

(PMI, 2019, p. 187.)

Related topic: Chapter 5.

Project Scope

> The work performed to deliver a product, service, or result with the specified features and functions.

(PMI, 2019, p. 187.)

Chapter teaching: Chapter 3, 'Distinguish the reason for the project from the work it contains'.

Project Scope Statement

> The description of the project scope, major deliverables, assumptions, and constraints.

(PMI, 2019, p. 187.)

Related topic: Chapter 3.

Project Sponsor

> See sponsor.

(PMI, 2019, p. 187.)

Related chapter discussion: Chapter 13, '13.1 Start with the decision, the audience and the evidence'.

Project Stakeholder

> See stakeholder.

(PMI, 2019, p. 187.)

Related chapter discussion: Chapter 13, '13.1 Start with the decision, the audience and the evidence'.

Project Start Constraint

> A limitation or restraint placed on the project early start date that affects when the project should start and is usually in the form of a fixed imposed date.

(PMI, 2019, p. 187.)

Chapter teaching: Chapter 5, 'Compare the constraint families'.

Project Start Date

> A point in time associated with the start of the first schedule activity in a project. Usually qualified by one of the following: actual, baseline, current, early, expected, late, mandatory, original, scheduled, or target. See also start date.

(PMI, 2019, p. 187.)

Related chapter discussion: Chapter 13, 'Communicating Schedule Decisions and Closing Out'.

Project Team

> All the project team members, including the project management team, the project manager, and for some projects, the project sponsor.

(PMI, 2019, p. 187.)

Related chapter discussion: Chapter 3, 'Translate a scope boundary into actions'.

Project Team Members

> The persons who report either directly or indirectly to the project manager, and who are responsible for performing project work as a regular part of their assigned duties.

(PMI, 2019, p. 187.)

Related topic: Chapter 3.

Project Time Management

> See Project Schedule Management.

(PMI, 2019, p. 187.)

Related topic: Chapter 2.

Project Title

> See project name.

(PMI, 2019, p. 187.)

Related topic: Chapter 3.

Project Total Duration

> The total number of work periods, in calendar units, to complete a project. For a project in progress, it includes the project actual duration plus the project remaining duration.

(PMI, 2019, p. 187.)

Chapter teaching: Chapter 4, ‘Reconcile the current total without confusing time and progress’.

Project Work

> See work.

(PMI, 2019, p. 188.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Relationship Line

> A logical relationship line drawn within a project schedule network diagram from one schedule activity to one or more other schedule activities indicating the type of logical relationship by the relative position of the beginning and end points of the line.

(PMI, 2019, p. 188.)

Related chapter discussion: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Remaining Duration (RD)

> The time, in calendar units, which is (a) equal to the original duration for an activity that has not started or (b) between the data date of the project schedule and the finish date of a schedule activity that has an actual start date. This represents the time needed to complete a schedule activity where the work is in progress. See also activity remaining duration and project remaining duration.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 4, ‘Preserve the original estimate while improving the forecast’.

Requirement

> A condition or capability that is required to be met or possessed by a system, product, service, result, or component to satisfy a contract, standard, specification, or other formally imposed documents.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 3, ‘Distinguish the reason for the project from the work it contains’.

Resource

> Skilled human resources (specific disciplines either individually or in crews or teams), equipment, services, supplies, commodities, budgets, or funds.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, ‘7.1 Defining the resources and capabilities required’.

Resource Assignment

> The linkage of one or more resources to a schedule activity and identification of the amount of each resource that is needed to accomplish the work on that schedule activity.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, ‘Use the effort calculation as an explicit model’.

Resource Attributes

> Multiple attributes associated with each resource that can be included within the resource library, such as resource identifier, resource name, resource type, resource availability, resource rate, resource code, constraints, and assumptions.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, 'Organise a resource breakdown structure and dictionary'.

Resource Availability

> The dates and number of work periods, in calendar units, that a given resource is available according to the appropriate resource calendar.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, 'Use the effort calculation as an explicit model'.

Resource Calendar

> A calendar that identifies the working days and shifts upon which each specific resource is available.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 4, 'Distinguish project, activity and resource calendars'.

Resource-Constrained Schedule

> See resource-limited schedule.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, 'Organise a resource breakdown structure and dictionary'.

Resource Dictionary

> See resource library.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, 'Organise a resource breakdown structure and dictionary'.

Resource Identifier

> A short, unique numeric or text identification assigned to each specific resource to differentiate that resource from other resources.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, 'Organise a resource breakdown structure and dictionary'.

Resource Lag

> The number of calendar units a resource is to wait after the activity start date before beginning work on the schedule activity.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, 'Identify the resource that governs the duration'.

Resource Leveling

> A resource-optimization technique in which adjustments are made to the project schedule to optimize the allocation of resources and which may affect critical path.

(PMI, 2019, p. 188.)

Chapter teaching: Chapter 7, '7.4 Distinguishing smoothing from levelling'.

Resource Library

> A documented tabulation containing the complete list, including resource attributes, of all resources that can be assigned to project activities. Also known as resource dictionary.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 7, ‘Organise a resource breakdown structure and dictionary’.

Resource-Limited Schedule

> A project schedule whose schedule activity, scheduled start dates, and scheduled finish dates reflect expected resource availability. Also known as resource-constrained schedule. See also resource leveling.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 7, ‘7.4 Distinguishing smoothing from levelling’.

Resource Name

> A short phrase or label for each resource used in conjunction with a resource identifier to differentiate that resource from other resources, for example, by type, role, or individual.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 7, ‘Organise a resource breakdown structure and dictionary’.

Resource Rate

> The unit cost rate assigned to a specific resource, including known rate escalations.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 7, ‘7.5 Connecting resource choices to time-phased cost’.

Resource Type

> A unique designation that differentiates a resource by skills, capabilities, or other attributes.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 7, ‘Organise a resource breakdown structure and dictionary’.

Result

> An output from performing project management processes and activities. Contrast with product and service. See also deliverable.

(PMI, 2019, p. 189.)

Related chapter discussion: Chapter 3, ‘Before a date can be credible’.

Retained Logic

> A schedule calculation which requires that an out-of-sequence activity cannot resume until all predecessors’ logical relationships have been satisfied.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 10, ‘10.3 Updating the model and resolving out-of-sequence work’.

Role

> A defined function to be performed by a project team member, such as testing, filing, inspecting, or coding.

(PMI, 2019, p. 189.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Rolling Wave Planning

> An iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 1, 'Rolling wave and deliberate progressive detail'.

Schedule

> See project schedule and schedule model.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 6, '6.1 Distinguishing the tool, model, instance and presentation'.

Schedule Activity

> A discrete, scheduled component of work performed during the course of a project. See also activity.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 3, 'Translate a scope boundary into actions'.

Schedule Analysis

> See also schedule network analysis.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 5, 'The forward pass: satisfy the latest arriving prerequisite'.

Schedule Baseline

> The approved version of a schedule model that can be changed using formal change control procedures and is used as the basis for comparison to actual results. See also baseline and performance measurement baseline.

(PMI, 2019, p. 189.)

Chapter teaching: Chapter 1, 'Target, baseline, forecast and scenario'.

Scheduled Finish Date

> The point in time when work was scheduled to finish on a schedule activity. Also known as planned finish date. See also activity scheduled finish date, current finish date, and project scheduled finish date.

(PMI, 2019, p. 189.)

Related chapter discussion: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Scheduled Start Date

> The point in time when work was scheduled to start on a schedule activity. Also known as planned start date. See also activity scheduled start date, current start date, and project scheduled start date.

(PMI, 2019, p. 189.)

Related chapter discussion: Chapter 5, 'The backward pass: respect the tightest downstream requirement'.

Schedule Level

> A project team-specified rule for the relative granularity of schedule activities in the overall schedule model.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 2, 'Detail should follow purpose'.

Schedule Milestone

> A significant event in the project schedule, such as an event restraining future work or marking the completion of a major deliverable. Also known as milestone activity. See also milestone.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 3, ‘Before a date can be credible’.

Schedule Model

> A representation of the plan for executing the project’s activities, including durations, dependencies, and other planning information, used to produce a project schedule along with other scheduling artifacts. See also schedule model analysis.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 2, ‘Select capability against the scheduling requirement’.

Schedule Model Analysis

> A process used to investigate or analyze the output of the schedule model in order to optimize the schedule. See also schedule model.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 14, ‘14.2 Select and combine methods deliberately’.

Schedule Model Instance

> A version of the schedule model that has been processed by a schedule tool and has reacted to inputs and adjustments made to the project-specific data within the scheduling tool (completed update cycle), which is saved for record and reference, such as data date version, target schedule models, and the baseline schedule model.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 2, ‘Preserve stable identities and distinguish saved instances’.

Schedule Network Analysis

> A technique to identify early and late start dates, as well as early and late finish dates, for the uncompleted portions of project activities. See also early finish date, early start date, late finish date, and late start date.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 5, ‘The forward pass: satisfy the latest arriving prerequisite’.

Schedule Performance Index (SPI)

> A measure of schedule efficiency expressed as the ratio of earned value to planned value. See also cost performance index (CPI).

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 10, ‘Calculate the indices and preserve their units’.

Schedule Variance (SV)

> A measure of schedule performance expressed as the difference between the earned value and the planned value. See also cost variance (CV).

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 10, ‘Calculate the indices and preserve their units’.

Scheduling Approach

> A system of practices, techniques, procedures, and rules used by project scheduling schedulers. This methodology can be performed either manually or with project management software specifically used for scheduling.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 2, ‘Select capability against the scheduling requirement’.

Scheduling Tool

> A tool that provides schedule component names, definitions, structural relationships, and formats to support the application of a scheduling method.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 6, ‘6.1 Distinguishing the tool, model, instance and presentation’.

Scope

> The sum of the products, services, and results to be provided as a project. See also project scope and product scope.

(PMI, 2019, p. 190.)

Related chapter discussion: Chapter 3, ‘Before a date can be credible’.

Scrum

> An agile framework for developing and sustaining complex products with specific roles, events, and artifacts.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 9, ‘9.3 Planning iterations and managing adaptive dependencies’.

Sequence Activities

> The process of identifying and documenting relationships among project activities.

(PMI, 2019, p. 190.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Service

> Useful work performed that does not produce a tangible product or result, such as performing any of the business functions supporting production or distribution. Contrast with product and result. See also deliverable.

(PMI, 2019, p. 191.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Slack

> See total float (TF) and free float (FF).

(PMI, 2019, p. 191.)

Related topic: Chapter 5.

Specified Critical Path

> The longest sequence of schedule activities in a project team member-specified schedule network path. See also critical path.

(PMI, 2019, p. 191.)

Related topic: Chapter 5.

In use, state the selected path boundary. The longest path to an intermediate handover can differ from the path controlling the project finish. Selecting a path for examination does not establish that it controls the whole project; that conclusion requires analysis of the relevant network, calendars and constraints.

Sponsor

> An individual or a group that provides resources and support for the project, program, or portfolio, and is accountable for enabling success. See also stakeholder.

(PMI, 2019, p. 191.)

Related chapter discussion: Chapter 13, ‘Communicating Schedule Decisions and Closing Out’.

Stakeholder

> An individual, group, or organization that may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project, program, or portfolio. See also sponsor.

(PMI, 2019, p. 191.)

Chapter teaching: Chapter 13, ‘13.1 Start with the decision, the audience and the evidence’.

Start Date

> A point in time associated with a schedule activity’s start. Usually qualified by one of the following: actual, baseline, current, early, expected, late, mandatory, original, scheduled, or target. See also project start date.

(PMI, 2019, p. 191.)

Related chapter discussion: Chapter 13, ‘Communicating Schedule Decisions and Closing Out’.

Start Not Earlier Than

> A schedule constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date.

(PMI, 2019, p. 191.)

Chapter teaching: Chapter 5, ‘Compare the constraint families’.

Start Not Later Than

> A schedule constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date.

(PMI, 2019, p. 191.)

Chapter teaching: Chapter 5, ‘Compare the constraint families’.

Start On

> A schedule constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date.

(PMI, 2019, p. 191.)

Chapter teaching: Chapter 5, ‘Compare the constraint families’.

Start-to-Finish

> A logical relationship in which a successor activity cannot finish until a predecessor activity has started. See also finish-to-finish, finish-to-start, start-to-start, and logical relationship.

(PMI, 2019, p. 191.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Start-to-Start

A logical relationship in which a successor activity cannot start until a predecessor activity has started. See also finish-to-finish, finish-to-start, start-to-start, and logical relationship.

(PMI, 2019, p. 191.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Status Date

A term whose meaning for status-data reporting varies by the brand of project management software used for scheduling, where in some systems the status date is included in the past and in some systems the status date is in the future. See also data date or time-now date.

(PMI, 2019, p. 191.)

Related chapter discussion: Chapter 10, ‘Turning progress evidence into a credible forecast’.

Subnetwork

A subdivision (fragment) of a project schedule network diagram, usually representing a subproject or a work package. See also summary activity.

(PMI, 2019, p. 191.)

Related topic: Chapter 5.

Subphase

A subdivision of a phase.

(PMI, 2019, p. 191.)

Related topic: Chapter 3.

Subproject

A smaller portion of the overall project created when a project is subdivided into more manageable components or pieces. See also summary activity.

(PMI, 2019, p. 191.)

Related topic: Chapter 2.

Successor

See successor activity.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Successor Activity

A dependent activity that logically comes after another activity in a schedule. See also predecessor activity and summary activity.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 5, ‘Read the relationship from the predecessor's event to the successor's event’.

Summary Activity

A group of related schedule activities aggregated and displayed as a single activity. See also predecessor activity and successor activity.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 3, ‘Summary activities aggregate information’.

System

> An integrated set of regularly interacting or interdependent components created to accomplish a defined objective, with defined and maintained relationships among its components, and the whole producing or operating better than the simple sum of its components.

(PMI, 2019, p. 192.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Target Schedule

> A schedule adopted for comparison purposes during schedule network analysis, which can be different from the baseline schedule. See also baseline.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 1, ‘Target, baseline, forecast and scenario’.

Task

> A term for work whose meaning and placement within a structured plan for project work varies by the application area, industry, and brand of project management software.

(PMI, 2019, p. 192.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Team Members

> See project team members.

(PMI, 2019, p. 192.)

Related topic: Chapter 3.

Technique

> A defined, systematic procedure employed by a human resource to perform an activity to produce a product or result or deliver a service, and that may employ one or more tools.

(PMI, 2019, p. 192.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Template

> A partially complete document in a predefined format that provides a defined structure for collecting, organizing, and presenting information and data.

(PMI, 2019, p. 192.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Three-Point Estimating

> A technique used to estimate cost or duration by applying an average or weighted average of optimistic, pessimistic, and most likely estimates when there is uncertainty with the individual activity estimates.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 4, ‘Ask for consistent scenarios, not three unrelated guesses’.

Time Now Date

> See data date.

(PMI, 2019, p. 192.)

Related topic: Chapter 10.

Timescale

A graduated marking of linear time, which displays time in specific units such as hours, days, weeks, months, quarters, or years. Timescales can show more than one unit of time. Usually shown above or below the data components within a document or electronic graphical display.

(PMI, 2019, p. 192.)

Related chapter discussion: Chapter 6, '6.1 Distinguishing the tool, model, instance and presentation'.

Tool

Something tangible, such as a template or software program, used in performing an activity to produce a product or result.

(PMI, 2019, p. 192.)

Related chapter discussion: Chapter 3, 'Translate a scope boundary into actions'.

Total Duration

See activity total duration and project total duration.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 4, 'Reconcile the current total without confusing time and progress'.

Total Float

The amount of time that a schedule activity can be delayed or extended from its early start date without delaying the project finish date or violating a schedule constraint. See also free float, critical path, and near-critical activity.

(PMI, 2019, p. 192.)

Chapter teaching: Chapter 5, '5.4 Interpreting critical paths and float'.

Unit of Measure

A designation of the type of quantity being measured, such as work hours, cubic yards, or lines of code.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 4, 'Establish quantities and productivity before using a formula'.

User

The person or organization that will use the project's product or service. See also customer.

(PMI, 2019, p. 193.)

Related chapter discussion: Chapter 3, 'Establish start and finish conditions'.

Variance

A quantifiable deviation, departure, or divergence away from a known baseline or expected value.

(PMI, 2019, p. 193.)

Related chapter discussion: Chapter 10, 'Turning progress evidence into a credible forecast'.

Variance Threshold

A predetermined range of normal outcomes that is determined during the planning process and sets the boundaries within which the team practices management by exception.

(PMI, 2019, p. 193.)

Related chapter discussion: Chapter 2, 'Begin with the decisions the schedule must support'.

Virtual Open Ends

> A condition that can occur when proper logical relationships are missing or when progress is reported on an activity that results in the activity no longer having any driving relationship. It reacts as if it has no predecessor or successor.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 5, ‘Inspect both activity boundaries’.

Work

> Sustained physical or mental effort, exertion, or exercise of skill to overcome obstacles and achieve an objective.

(PMI, 2019, p. 193.)

Related chapter discussion: Chapter 3, ‘Translate a scope boundary into actions’.

Workaround

> A response to a negative risk that has occurred.

(PMI, 2019, p. 193.)

Related topic: Chapter 11.

Work Breakdown Structure (WBS)

> A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 3, ‘Decompose the total scope without turning the WBS into a timetable’.

Work Breakdown Structure Component

> An entry in the work breakdown structure that can be at any level.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 3, ‘Decompose the total scope without turning the WBS into a timetable’.

Work Breakdown Structure Identifier (WBS ID)

> A short, unique numeric or text identification assigned to each WBS element or component to differentiate a particular WBS element from other WBS elements.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 3, ‘Keep identity, classification and scope information distinct’.

Work Package

> The work defined at the lowest level of the work breakdown structure for which cost and duration are estimated and managed.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 3, ‘Make work-package boundaries usable’.

Work Period

> A date or part of a date identified as a time for performing work, which may be further divided into calendar units such as shifts, hours, or even minutes.

(PMI, 2019, p. 193.)

Chapter teaching: Chapter 4, ‘Separate duration from effort and elapsed time’.

Reference

Project Management Institute (2019). *Practice Standard for Scheduling*. Third edition. Newtown Square, PA: Project Management Institute. Glossary, printed pp. 171–193.

APPENDIX B

Appendix B: Complete Schedule Component Reference

This appendix is an integral reference for the fourteen-chapter book and completes its component catalogue. It covers all 126 entries in section 4 of PMI's *Practice Standard for Scheduling*, Third Edition (2019), printed pages 98–136, and connects them to the conformance method in section 5 and Appendices X3–X4. It is a reference for understanding and checking a model, rather than a list of fields that every project must populate.

Each entry preserves the source's formal definition and printed page reference. The other material paraphrases its purpose, behaviour, good practices and conditional notes. The metadata row identifies the source's usage classification, manual/calculated designation and data format. Where the source provides no separate good-practice or conditional note, the entry says so explicitly. A blank source cell is not an instruction to invent a requirement. Chapter cross-references identify fuller teaching and examples.

Reading the eight component facets

The component name identifies the subject. Its usage classification explains whether it belongs to the core requirements, becomes required under an applicable modelling requirement, is optional, or is not scored. The manual/calculated field records how the source describes population of the component; it does not guarantee identical behaviour in every software product. The data format describes the representation expected by the catalogue. Behaviour explains what the component does in the model. Good practices identify recommended use. A conditional note may identify an alternative, dependency or related component. The definition gives the formal meaning.

For example, an Activity ID is labelled **Calculated** even though the associated guidance allows controlled numbering schemes; generation of an identifier is not a duration calculation. Activity Resource-Leveled Start Date is labelled **Manual**, whereas the corresponding finish and both project-level dates are **Calculated**. Activity Cumulative Probability Risk Distribution is labelled **Manual** because it stores analytical results, while Probability Risk Distribution is labelled **Calculated**. These are the source's classifications, not a claim that a user must type each result or that all products generate each distribution automatically. The actual tool, data interface and control process must be understood and documented.

The source's format descriptions also need context. A calendar is described as Date/time although its implementation is a structured pattern with exceptions. Resource Availability is described as Alphanumeric even though useful availability records contain dates and quantities. Driving Resources and Milestone use Boolean flag representations. Preserve the meaning, unit and provenance when transferring these records between systems.

Usage classes and the fixed scoring pool

CRC means core required; **RRC** means required when resource modelling is required; **ERC** means required when earned value management is required; **KRC** means required when risk analysis is required. **O** denotes an optional scoreable position. **NS** denotes an entry excluded from the conformance score. An NS component can still seriously affect calculation and therefore still needs technical review.

The 126 detailed entries are not 126 independent scored points. Activity Duration Percent Complete and Activity Physical Percent Complete share one required position. The corresponding two project measures share another. This leaves 124 assessment units; removing 13 NS units leaves the fixed pool of **111 scoreable positions**.

Table B.1 | Component usage classes and scoring rules

Scoring group	Positions	Requirement rule
CRC	36	Always required for the conformance assessment
RRC	13	Required when resource modelling is required
ERC	9	Required when EVM is required
KRC	7	Required when risk analysis is required
General optional pool	46	Optional scoreable components
NS, outside the denominator	13	Technically review where used; no scored point

If a conditional group is not required, its components remain available as optional positions; the denominator remains 111. Required totals for the eight combinations are 36, 49, 45, 43, 58, 56, 52 and 65 respectively for core only, resources, EVM, risk, resources/EVM, resources/risk, EVM/risk and all three. The corresponding optional pool is always 111 minus the required total.

Earn a point only for a component that is present and properly used. All required positions must be earned before reporting a conforming index:

Conformance index = 100 × (required points earned + optional points earned) / 111.

Missing one required point prevents an eligible index even when optional points produce a large raw total. A reviewer may continue diagnostically to understand the deficiencies, but that diagnostic total does not cure the failed gate. The index is not a probability of delivery, a percentage of activities correctly linked or a percentage of work complete. It has no universal 50% pass mark and no source-defined bronze/silver/gold bands. Resource capacity, interfaces, calendars, uncertainty and operational readiness still need substantive review.

The WBS ID entry illustrates why classification needs careful source reading. Its detailed header on printed page 136 says Required, while Table 4-1 and Appendix X3 allocate it to ERC. The entries below display that distinction and use the explicit X3 allocation for scoring. It would be incorrect to add it again to CRC and alter the published totals.

Component entries

The C001–C126 labels below are reference labels created for this book. They are not identifiers assigned by PMI. Definitions retain the source's spelling and wording; line wrapping and mathematical labels have been placed on continuous lines for reading. The discrepancies discussed later are explained outside the quotations rather than silently corrected within them.

C001 — Activity Actual Cost (AC)

Definition (PMI, 2019, p.98).

> The total cost of the work completed during a given time period. This value may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative. Actual cost may also include monetary costs of materials and other fixed costs.

Class: ERC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Records the cost actually incurred for the selected activity scope and reporting period; cumulative and period-specific values must be distinguished.

Good practice. Include actual cost when applying earned value management within the schedule.

Conditional or associated note. The source refers to The Standard for Earned Value Management and the synonym ACWP. It recognises that reliable actual cost may exist only at an aggregate activity level; do not invent a finer allocation.

Read with: Chapter 10, “Validate relationships between fields, not just individual entries”.

C002 — Activity Actual Duration

Definition (PMI, 2019, p.98).

> The total number of work periods in calendar units between the schedule activity actual start date and either the data date of the schedule model (if the schedule activity is in progress) or the activity actual finish date (if the schedule activity is complete).

Class: CRC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Measures the time since work began, ending at the data date for an unfinished activity or at actual finish for a completed activity. Specify whether the recorded unit is working time or elapsed time.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Preserve the original estimate while improving the forecast”.

C003 — Activity Actual Finish Date

Definition (PMI, 2019, p.98).

> The point in time at which a scheduled activity completed.

Class: CRC. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Records completion as an historical event.

Good practice. Populate actual finish for activities completed before the data date. The source describes actual dates as replacing their CPM early and late dates and associates actual finish with 100% completion.

Conditional or associated note. Check the selected activity duration or physical percentage-complete measure against the finish evidence.

Read with: Chapter 10, “Validate relationships between fields, not just individual entries”.

C004 — Activity Actual Start Date

Definition (PMI, 2019, p.99).

> The point in time at which a schedule activity began.

Class: CRC. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Records the point when activity progress actually began.

Good practice. Activities started before the data date need actual starts. The source describes these actuals as replacing CPM early and late start dates.

Conditional or associated note. The recorded initiation must precede the current data date; a forecast start is not an actual.

Read with: Chapter 10, “10.1 Establishing the reporting position and validating actuals”.

C005 — Activity Calendar

Definition (PMI, 2019, p.99).

> A calendar of working and nonworking periods assigned to the schedule activity, which defines the work periods and nonwork periods in calendar format. The activity calendar, on the schedule activities to which it is assigned, is used to replace the project calendar for schedule calculations. See also project calendar and resource calendar.

Class: O. **Origin:** Manual. **Format:** Date/time.

Purpose and behaviour. Specifies activity working and non-working periods. On assigned activities, this calendar replaces the project default for schedule calculation.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Distinguish project, activity and resource calendars”.

C006 — Activity Code

Definition (PMI, 2019, p.99).

> Values that identify characteristics of the work or in some way categorize the schedule activity that allows grouping, filtering, and ordering of activities in a way that best represents a group of activities. In some scheduling software, custom fields are used to hold this information.

Class: O. **Origin:** Manual/Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Stores one or several classification values against an activity. Attribute types may include alphabetic or alphanumeric values, dates and times.

Good practice. Use codes to organise, filter, sort, group and summarise schedule presentations.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 6, “Use stable identifiers and meaningful relationships between data”.

C007 — Activity Cost Category

Definition (PMI, 2019, p.100).

> A breakdown of the cost, such as labor cost, equipment cost, and material cost.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Adds accounting classifications within an activity cost account.

Good practice. Separate relevant categories, including direct and indirect costs and labour, material and equipment costs.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Reconcile packages and budgets without counting the work twice”.

C008 — Activity Cost Estimate

Definition (PMI, 2019, p.100).

> The projected cost of the schedule activity, which includes the cost for all resources required to perform and complete the activity, including all cost types and cost categories.

Class: O. **Origin:** Manual/Calculated. **Format:** Numeric.

Purpose and behaviour. Combines the estimated cost categories assigned to an activity. Its scope can include expenditure outside the planned-value measure.

Good practice. Build the activity estimate from its individual assigned categories rather than an unexplained total.

Conditional or associated note. Reconcile Activity Cost Category and Planned Value; the two measures need not have identical cost boundaries.

Read with: Chapter 4, “Connect duration assumptions with the activity cost estimate”.

C009 — Activity Cumulative Probability Risk Distribution

Definition (PMI, 2019, p.100).

> A table of dates and their associated cumulative probabilities of occurrence for schedule activity completion. Dates are derived using analytical techniques such as Monte Carlo calculations. When applied to the project end date, the value is equivalent to the project cumulative probability risk distribution.

Class: KRC. **Origin:** Manual. **Format:** Table of dates, numeric (fractional).

Purpose and behaviour. Stores completion dates with the cumulative probabilities produced by duration-risk analysis; it is a results table, not a second independent risk event.

Good practice. Use schedule risk analysis where schedule variation could materially affect project objectives.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 8, “8.5 Interpreting confidence, criticality and sensitivity”.

C010 — Activity Duration Percent Complete

Definition (PMI, 2019, p.101).

> The calculated percentage that the activity actual duration is of the activity total duration for a schedule activity that has work in progress.

Class: CRC; one activity-progress OR position. **Origin:** Calculated/Manual. **Format:** Numeric (fractional).

Purpose and behaviour. Expresses actual duration as a proportion of the current total expected duration.

Good practice. The source permits this as an approximate indication of progress without EVM but discourages treating elapsed span as a substitute for earned accomplishment. Duration progress says nothing directly about effort or accepted output.

Conditional or associated note. This and Activity Physical Percent Complete form one required alternative pair, not two scored positions.

Read with: Chapter 10, “Worked example: three percentages for one activity”.

C011 — Activity Early Finish Date

Definition (PMI, 2019, p.101).

> The earliest possible point in time when the uncompleted portion of the schedule activity can be completed based on the CPM forward pass of schedule model logic.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Gives the earliest finish generated by the forward pass for the activity's incomplete portion.

Good practice. Obtain the date from CPM calculation rather than replace it with an unsupported typed target.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The forward pass: satisfy the latest arriving prerequisite”.

C012 — Activity Early Start Date

Definition (PMI, 2019, p.101).

> The earliest possible point in time when the schedule activity can begin based on the CPM forward pass of schedule model logic.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Gives the earliest start derived from the network forward pass.

Good practice. Generate the value through schedule network analysis.

Conditional or associated note. Read the date together with duration and the applicable early-start logic.

Read with: Chapter 5, “The forward pass: satisfy the latest arriving prerequisite”.

C013 — Activity Effort

Definition (PMI, 2019, p.101).

> The number of units required to complete a schedule activity or work breakdown structure component. Activity effort is usually expressed as staff hours, staff days, or staff weeks. Not the same as duration.

Class: O. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Quantifies the work effort needed for an activity, distinct from its elapsed or working duration.

Good practice. Identify the resources and assign them to the work.

Conditional or associated note. Effort depends on the duration and resource assignment; the relationship requires explicit capacity and productivity assumptions.

Read with: Chapter 7, “Use the effort calculation as an explicit model”.

C014 — Activity ID

Definition (PMI, 2019, p.102).

> A short, unique numeric or text identification assigned to each schedule activity to differentiate that project activity from other activities.

Class: CRC. **Origin:** Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Differentiates each activity from the other records in the model.

Good practice. Use unique identifiers generated automatically or governed by a project numbering scheme. A reasoned coding structure can help identification, but the identifier should remain stable.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 6, “Use stable identifiers and meaningful relationships between data”.

C015 — Activity Label

Definition (PMI, 2019, p.102).

> A short phrase or label for each schedule activity used in conjunction with an activity identifier to differentiate that schedule model activity from other schedule activities. The activity label normally describes the scope of work of the schedule activity. Also known as activity description, activity name, and task name.

Class: CRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Provides the user-defined, readable description of the activity.

Good practice. Use an action verb with a specific, distinctive subject so that different activities can be understood without relying on their IDs alone.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Write names that remain clear outside their original display”.

C016 — Activity Late Finish Date

Definition (PMI, 2019, p.102).

> The latest possible point in time when the schedule activity can be completed without violating a schedule constraint or delaying the project end date.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Gives the activity's latest finish permitted by the backward pass and relevant completion requirement.

Good practice. Derive the value through CPM calculation.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The backward pass: respect the tightest downstream requirement”.

C017 — Activity Late Start Date

Definition (PMI, 2019, p.102).

> The latest possible point in time when the schedule activity can begin without violating a schedule constraint or delaying the project end date.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Gives the activity's latest start permitted by the backward pass.

Good practice. Derive the value through CPM calculation.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The backward pass: respect the tightest downstream requirement”.

C018 — Activity Most Likely Duration

Definition (PMI, 2019, p.103).

> The total number of work periods in calendar units assigned to perform the schedule activity, considering all of the variables that could affect performance; it is determined to be the most probable activity duration.

Class: KRC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Represents the most probable duration under normal expected conditions. The source applies duration-risk calculation to remaining work.

Good practice. Use the most likely value as an input to schedule risk calculations.

Conditional or associated note. Consider the optimistic, pessimistic and original durations together when analysing uncertainty.

Read with: Chapter 4, “Ask for consistent scenarios, not three unrelated guesses”.

C019 — Activity Note/Comment/Log

Definition (PMI, 2019, p.103).

> Documentation of additional supporting information for the activity.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Holds supporting narrative that does not fit the principal activity fields.

Good practice. Record reasons for creating an activity and explanations of delay, imposed constraints or other decisions requiring context.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 11, “11.6 Implementing an approved response and preserving accountability”.

C020 — Activity Optimistic Duration

Definition (PMI, 2019, p.103).

> The total number of work periods in calendar units assigned to perform the schedule activity, considering all of the variables that could affect performance; it is determined to be the shortest possible activity duration.

Class: KRC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Represents the shortest duration under the best assumed conditions. The risk assessment concerns work still remaining.

Good practice. Use the optimistic value in duration-risk calculations.

Conditional or associated note. Read it with the pessimistic, most likely and original duration values.

Read with: Chapter 4, “Ask for consistent scenarios, not three unrelated guesses”.

C021 — Activity Original Duration

Definition (PMI, 2019, p.104).

> The activity duration originally assigned to a schedule activity; this duration is typically not updated as progress is reported on the activity. Used for comparison with activity actual duration and activity remaining duration when reporting schedule progress, the activity original duration is normally developed with a reliance on historical data, specialists, resource availability, financial considerations, and volume of work to be performed.

Class: CRC. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Records the duration allocated before activity progress was reported. Exact handling of this field depends on the scheduling product.

Good practice. Retain the evidence and method used to estimate it so later comparisons and revisions remain explainable. The entry gives a general duration guideline of no more than two or three reporting cycles.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Preserve the original estimate while improving the forecast”.

C022 — Activity Pessimistic Duration

Definition (PMI, 2019, p.104).

> The total number of work periods in calendar units assigned to perform the schedule activity, considering all of the variables that could affect performance; it is determined to be the longest possible activity duration.

Class: KRC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Represents the longest duration under the worst assumed conditions. Duration risk is assessed for remaining work.

Good practice. Use the pessimistic value in schedule risk calculations.

Conditional or associated note. Read it with the optimistic, most likely and original duration values.

Read with: Chapter 4, “Ask for consistent scenarios, not three unrelated guesses”.

C023 — Activity Physical Percent Complete

Definition (PMI, 2019, p.104).

> An estimate, expressed as a percent, of the amount of work that has been completed on a schedule activity, measured in terms of either physical work progress or via the earning rules of earned value management.

Class: CRC; one activity-progress OR position. **Origin:** Manual. **Format:** Numeric (fractional).

Purpose and behaviour. Measures completed physical work against the total physical work expected.

Good practice. Update started activities using a measurement method selected at the outset and maintained consistently. The entry discusses quantities, fixed earning rules, weighted milestones and informed estimates, and favours evidence-based earned-value assessments over subjective judgement.

Conditional or associated note. This and Activity Duration Percent Complete share one required position. The conditional note says an earned-value technique is required; see the reconciliation note below because the definition also admits physical quantities.

Read with: Chapter 10, “Worked example: three percentages for one activity”.

C024 — Activity Remaining Duration

Definition (PMI, 2019, p.105).

> The total number of work periods in calendar units, either equal to the original duration for an activity that has not started or between the data date of the project schedule and the CPM early finish date of a schedule activity that has an activity actual start date. This represents the time needed to complete a schedule activity where the work is in progress. Note: Prior to actual start, activity remaining duration = activity duration.

Class: CRC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Estimates time needed from the data date to finish incomplete work; before start it equals the activity duration/original-duration convention described in the definition.

Good practice. Reassess remaining duration at each update when work has started but remains unfinished.

Conditional or associated note. Resource assignment can change the remaining-duration estimate.

Read with: Chapter 4, “Preserve the original estimate while improving the forecast”.

C025 — Activity Resource Actual Quantity

Definition (PMI, 2019, p.105).

> The unit to express the amount of a resource used for an activity since the activity actual start date.

Class: RRC. **Origin:** Manual/Calculated. **Format:** Numeric.

Purpose and behaviour. Measures the amount of a particular resource already used on an activity from actual start through the reporting position.

Good practice. When resources are used in the model, identify, assign and record their actual quantities.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Keep actual, remaining and total quantities distinct”.

C026 — Activity Resource-Leveled Finish Date

Definition (PMI, 2019, p.105).

> The point in time associated with the activity scheduled finish date of a resource-limited schedule activity in a resource-limited schedule.

Class: O. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Records the earliest finish allowed after resource limitations have been considered.

Good practice. Identify and assign resources; use levelling to address overallocations where they occur.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Resolve the conflict and trace the new controlling sequence”.

C027 — Activity Resource-Leveled Start Date

Definition (PMI, 2019, p.106).

> The point in time associated with the activity scheduled start date of a resource-limited schedule activity in a resource-limited schedule.

Class: O. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Records the earliest start allowed after resource limitations have been considered.

Good practice. Identify and assign resources; use levelling to address overallocations where they occur.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Resolve the conflict and trace the new controlling sequence”.

C028 — Activity Resource Remaining Quantity

Definition (PMI, 2019, p.106).

> The unit to express resources needed to complete an activity as of data date.

Class: RRC. **Origin:** Manual/Calculated. **Format:** Numeric.

Purpose and behaviour. Estimates resources still needed for the activity at the data date.

Good practice. Re-estimate outstanding resource quantities when an activity continues into another reporting cycle.

Conditional or associated note. Changes to resource assignments may also change remaining duration.

Read with: Chapter 7, “Keep actual, remaining and total quantities distinct”.

C029 — Activity Resource Total Quantity

Definition (PMI, 2019, p.106).

> The unit to express resources required to complete the activity regardless of availability or assignment.

Class: RRC. **Origin:** Manual/Calculated. **Format:** Numeric.

Purpose and behaviour. Records the quantity of each resource required by an activity; each resource/activity combination has its own value.

Good practice. Identify and assign resources and use the corresponding total-quantity record.

Conditional or associated note. The source associates the component with cost. Required quantity should not be confused with available capacity.

Read with: Chapter 7, “Keep actual, remaining and total quantities distinct”.

C030 — Activity Risk Criticality Index

Definition (PMI, 2019, p.106).

> The probability that the schedule activity will be on a critical path, calculated by dividing the number of times the activity is on a critical path during simulation by the number of iterations in that simulation.

Class: KRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Records the proportion of simulation iterations in which the activity belongs to a critical path; implementation can vary by tool.

Good practice. Use risk analysis where stakeholders judge exposure significant or where schedule variation matters materially to objectives.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 8, “Distinguish how often an activity is critical from its influence”.

C031 — Activity Scope Definition

Definition (PMI, 2019, p.107).

> Documented narrative describing the work represented by the activity.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Describes and bounds the work represented by an activity. It may be stored in a note/comment field or a separate custom field.

Good practice. Provide a scope description for each activity sufficient to define its boundary.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Keep identity, classification and scope information distinct”.

C032 — Activity Total Duration

Definition (PMI, 2019, p.107).

> The total number of work periods in calendar units to complete a schedule activity. For schedule activities in progress, it includes the activity actual duration plus the activity remaining duration. Also known as activity duration.

Class: CRC. **Origin:** Calculated/Manual. **Format:** Numeric.

Purpose and behaviour. Measures the activity's complete start-to-finish duration, combining actual and remaining duration while it is in progress.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. Read it with Actual Duration and Remaining Duration.

Read with: Chapter 4, “Reconcile the current total without confusing time and progress”.

C033 — Activity Work Percent Complete

Definition (PMI, 2019, p.107).

> An estimate, expressed as a percent of the amount of work that has been completed on a schedule activity. It is usually based on the activity duration percent complete and the profile of work hours assigned to the activity.

Class: O. **Origin:** Calculated/Manual. **Format:** Numeric (fractional).

Purpose and behaviour. Expresses completed work effort as a proportion of total work effort. The source definition describes a usual implementation based on duration progress and the assigned work-hours profile.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.2 Measuring progress without confusing time, effort and output”.

C034 — Actual Time (AT)

Definition (PMI, 2019, p.107).

> It is the number of periods executed.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Counts the time periods executed by the reporting position.

Good practice. Include actual-time measurement when earned schedule is used, alongside the corresponding earned-schedule measure.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.7 Earned schedule: translating accomplishment into a time comparison”.

C035 — As Late As Possible

Definition (PMI, 2019, p.108).

> A constraint placed on an activity that will cause it to be scheduled on its late start and finish dates.

Class: NS. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Schedules an activity at its calculated late dates under the current logic and constraints; exact behaviour is tool-dependent.

Good practice. Use this constraint sparingly and do not replace a necessary dependency with it.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “ASAP, ALAP and Expected Finish are different decisions”.

C036 — As Soon As Possible

Definition (PMI, 2019, p.108).

> A constraint placed on an activity that will cause it to be scheduled to finish on the earliest date after the project start date based on any predecessor activities and schedule logic.

Class: NS. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Schedules work at the earliest dates allowed by the network; the entry describes it as a flexible, tool-dependent constraint.

Good practice. This is normally the default and appropriate treatment for most activities.

Conditional or associated note. Read it with the project start date.

Read with: Chapter 5, “ASAP, ALAP and Expected Finish are different decisions”.

C037 — Baseline Schedule Model

Definition (PMI, 2019, p.108).

> A baseline schedule model is an instance of the scheduling components at the time the project plan was approved by the project stakeholders (the latest approved schedule model) and is used for comparison to other schedule model instances.

Class: CRC. **Origin:** Calculated. **Format:** Various.

Purpose and behaviour. Captures the approved set of scheduling components at an agreed comparison point; the fields preserved depend on the product.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The model's development supports establishing and approving this analysis point. Keep approval evidence and the identity of the retained instance.

Read with: Chapter 6, “6.6 Reviewing, approving and protecting the baseline”.

C038 — Budget at Completion (BAC)

Definition (PMI, 2019, p.109).

> The sum total of resource costs listed in the schedule model that is approved by management. BAC may be calculated by activity and then summed to various levels.

Class: ERC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Represents the authorised project budget, which can be built from approved activity resource costs and aggregated.

Good practice. Use resource assignments and costs to establish the time-phased budget.

Conditional or associated note. A management-approved BAC may be described as an approved baseline; distinguish the budget amount from the full approved schedule instance.

Read with: Chapter 10, “The common worked dataset”.

C039 — Change Request Identifier

Definition (PMI, 2019, p.109).

> The change request identifier is the primary key value for items in the program change log as related to the schedule model.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Links an authorised, configuration-controlled change to the affected schedule records.

Good practice. Apply the change-request identifier, often in a custom field, when the relevant configuration process approves the change.

Conditional or associated note. The entry cross-refers to the Practice Standard for Project Configuration Management and Activity Note/Comment/Log.

Read with: Chapter 11, “11.2 Preserving the evidence and identifying the authority”.

C040 — Control Account ID

Definition (PMI, 2019, p.109).

> An alphanumeric cost-accounting identifier typically assigned at the intersection of the work breakdown structure and organizational breakdown structure at the level where costs will be collected. Control accounts contain work packages.

Class: ERC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Maps scheduled work to the account in which its costs are collected.

Good practice. Include a control-account identifier when integrating EVM with the schedule.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 3, “Keep identity, classification and scope information distinct”.

C041 — Control Account Manager (CAM)

Definition (PMI, 2019, p.110).

> An alphanumeric designation of the single person accountable for the costs and achievement of the scope of work identified by the control account; this may be the name of an individual or a unique reference identifying the individual.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Identifies the single person accountable for the control account's costs and scope performance.

Good practice. Record the accountable manager when EVM is used. The field can contain a person's name or a unique reference that resolves to that person.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 3, “Establish one accountable owner without denying collaboration”.

C042 — Cost Performance Index (CPI)

Definition (PMI, 2019, p.110).

> EV/AC, calculated as time-phased values and used to measure the cost efficiency in a project. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Compares earned accomplishment with actual cost using compatible scope and reporting periods.

Good practice. Use CPI where earned value management is applied.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C043 — Cost Variance (CV)

Definition (PMI, 2019, p.110).

> EV – AC, calculated as time-phased values and used to measure cost performance in a project. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Shows earned value less actual cost for the chosen period or cumulative reporting interval.

Good practice. Use cost variance where earned value management is applied.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C044 — Cost Variance Percent (CV%)

Definition (PMI, 2019, p.111).

> 100 × (EV – AC) / (EV), calculated as time-phased values. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative. When EV = 0, CPI = 0, regardless of AC.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Expresses cost variance relative to earned value as a percentage.

Good practice. Use the measure where earned value management is applied; report the period and denominator clearly.

Conditional or associated note. The source refers to The Standard for Earned Value Management. See the zero-denominator reconciliation below.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C045 — Critical Path

Definition (PMI, 2019, p.111).

> Generally, but not always, the sequence of schedule activities determining the duration of the project. Generally, it is the longest path through the project. However, a critical path can end, as an example, on a schedule milestone that is in the middle of the schedule model and that has a finish-not-later-than imposed date schedule constraint. See also project critical path, specified critical path, and critical path method.

Class: CRC. **Origin:** Calculated. **Format:** Alphanumeric (list of activities).

Purpose and behaviour. Identifies the activity sequence controlling the relevant completion point under the calculated network and constraints.

Good practice. Use complete, defensible logic and practically estimated durations. Avoid open ends except the intended project boundaries and restrict constraints to events that cannot adequately be represented through activity logic.

Conditional or associated note. Relationships must be defined for the activities; a coloured list alone does not establish a credible critical path.

Read with: Chapter 5, “5.4 Interpreting critical paths and float”.

C046 — Data Date

Definition (PMI, 2019, p.111).

> A point in time when the status of the project is recorded. Any data to the left of the data date (earlier) is considered historical information. Any data to the right of the data date (later) is the forecast of remaining work. The data date is also the point at which scheduling and performance measurement analysis is conducted. Also known as as-of-date.

Class: CRC. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Separates recorded historical performance from the forecast of remaining work.

Good practice. Advance the data date on a regular reporting cycle, consistently with the status evidence being reported.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.1 Establishing the reporting position and validating actuals”.

C047 — Driving Resources

Definition (PMI, 2019, p.112).

> Resources that are considered to have a direct impact on activity duration during resource leveling.

Class: O. **Origin:** Manual. **Format:** Flag (determined by algorithm [Boolean]).

Purpose and behaviour. Marks a resource whose assignment is treated as affecting activity duration in resource levelling. Resources are only one possible duration driver.

Good practice. Consider the driving-resource designation when constructing the model.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Identify the resource that governs the duration”.

C048 — Earned Schedule (ES)

Definition (PMI, 2019, p.112).

> Identify the time at which the amount of earned value (EV) accrued should have been earned. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Finds the planned time at which the achieved earned value should have been earned.

Good practice. Use the earned-schedule measure where earned-schedule analysis is applied.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.7 Earned schedule: translating accomplishment into a time comparison”.

C049 — Earned Value (EV)

Definition (PMI, 2019, p.112).

> The time-phased value of the accomplished effort, independent of the cost needed to achieve the accomplishment; the cost that would be budgeted for the amount of completed work prior to its execution. When completed, EV = BAC. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: ERC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures completed scope in its budgeted value, independently of the actual cost incurred to achieve it.

Good practice. Use earned value where EVM is applied.

Conditional or associated note. The entry refers to The Standard for Earned Value Management and the synonym BCWP.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C050 — Earned Value Measurement Type

Definition (PMI, 2019, p.113).

> The alphanumeric designation of a specific measurement type for collecting earned value in the schedule as defined in the EVMS.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Stores the selected EVM earning rule for each relevant activity or WBS level; examples include fixed-formula rules and weighted milestones.

Good practice. For cost/schedule integration, ensure the schedule's stored method matches the method in the EVMS work package.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 10, “Establish earning rules before observing performance”.

C051 — Earned Value Weight

Definition (PMI, 2019, p.113).

> The percentage of EV allocated to a specific group of activities.

Class: O. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Allocates a work package's earned value to specified activities or activity groups as a percentage.

Good practice. Use a defined EV weight where percentage allocation is appropriate.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 10, “Establish earning rules before observing performance”.

C052 — Estimate at Completion (EAC)

Definition (PMI, 2019, p.113).

> AC + ETC, cumulative actual incurred costs (AC) plus anticipated costs to complete the remaining scope independent of budget. EAC is typically calculated for each activity and then summed to various levels. There are numerous methods to compute the value of additional costs estimated to complete the remaining scope.

Class: ERC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Forecasts total final cost as incurred actual cost plus the cost still required to complete the scope.

Good practice. Maintain an independent estimate of likely final cost; an authorised budget is not automatically that estimate.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.6 Forecasting cost and testing the efficiency required”.

C053 — Estimated Duration (ED)

Definition (PMI, 2019, p.114).

> AT + ETC(t); it is the sum of cumulative actual periods (AT) and anticipated periods needed to complete the remaining scope independent of authorized duration. ETC(t) is typically calculated for each activity and then summed to various levels. There are numerous methods to compute the value of additional periods estimated to complete the remaining scope.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Forecasts total duration as elapsed actual time plus the remaining time expected to complete.

Good practice. Maintain a forecast independent of the authorised duration.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Forecast duration with an explicit performance assumption”.

C054 — Estimate to Complete (ETC)

Definition (PMI, 2019, p.114).

> Anticipated costs to complete the remaining scope independent of budget and prior actual costs. ETC is typically calculated for each activity and then summed to various levels. There are numerous methods to predict the value of remaining costs for the remaining scope.

Class: ERC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Forecasts the cost of outstanding scope without treating past expenditure or the budget allowance as the estimate itself.

Good practice. Estimate the remaining cost independently of the approved budget.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.6 Forecasting cost and testing the efficiency required”.

C055 — Estimate to Complete Time (ETC(t))

Definition (PMI, 2019, p.114).

> It is the forecasted (anticipated) periods needed to complete the remaining scope independent of authorized duration. ETC(t) is typically calculated for each activity and then summed to various levels. There are numerous methods to compute the value of additional periods estimated to complete the remaining scope.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Forecasts the time needed to complete outstanding scope.

Good practice. Estimate the remaining time independently of the authorised duration.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Forecast duration with an explicit performance assumption”.

C056 — EVMS Work Package Identifier

Definition (PMI, 2019, p.115).

> The work package identifier is an alphanumeric designation of a specific work package in the EVMS.

Class: ERC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Identifies the EVMS work package associated with the scheduled activity.

Good practice. For cost/schedule integration, store a single work-package identifier for each activity. The source allows the EVMS package to include multiple WBS elements, so the mapping must be explicit.

Conditional or associated note. The entry refers to The Standard for Earned Value Management and the Practice Standard for Work Breakdown Structures.

Read with: Chapter 3, “Keep identity, classification and scope information distinct”.

C057 — Expected Finish

Definition (PMI, 2019, p.115).

> A date constraint placed on both the activity CPM early and late finish dates of an in-progress schedule activity that affects when the schedule activity can be scheduled for completion and is usually in the form of a fixed imposed date. This constraint requires the activity remaining duration to be set equal to the difference between the activity expected finish date and the data date to force the schedule activity to be scheduled to finish upon the imposed date.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Imposes a completion date on an activity that has already started and derives its remaining duration from expected finish minus data date. Product behaviour can vary.

Good practice. Use sparingly and do not substitute it for dependency logic.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “ASAP, ALAP and Expected Finish are different decisions”.

C058 — Finish Not Earlier Than

Definition (PMI, 2019, p.115).

> A date constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date. A finish not earlier than constraint prevents the activity from being scheduled to finish earlier than the imposed date. Not earlier than constraints impact only the CPM forward pass calculation; therefore, only the CPM early dates of a schedule activity.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Places a lower bound on activity finish. The definition confines its effect to the forward pass and early dates; product implementation needs checking.

Good practice. Use sparingly and retain the underlying network logic.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Compare the constraint families”.

C059 — Finish Not Later Than

Definition (PMI, 2019, p.116).

> A date constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date. A finish not later than constraint prevents the activity from being scheduled to finish later than the imposed date. Not later than constraints impact only the CPM backward pass calculation and, therefore, the CPM calculated late dates of a schedule activity.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Places an upper bound on activity finish. The definition confines its effect to the backward pass and late dates; product implementation needs checking.

Good practice. Use sparingly and retain the underlying network logic.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Compare the constraint families”.

C060 — Finish On

Definition (PMI, 2019, p.116).

> A date constraint placed on the schedule activity that requires the schedule activity to finish on a specific date. Schedule calculations do not override this constraint. Therefore, an imposed finish on sets the CPM forward pass early dates for all paths leading from and the CPM late dates on paths leading to the activity. This is also known as must finish on.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Fixes activity finish in both forward and backward calculations, producing zero activity total float while related activities may retain different float. For unfinished work, the source describes movement when data date passes the imposed finish.

Good practice. The source advises against using this CPM-overriding constraint and against replacing logic with constraints.

Conditional or associated note. The entry identifies Mandatory Finish Date as equivalent; the definition also uses the name must finish on.

Read with: Chapter 5, “Compare the constraint families”.

C061 — Finish to Finish

Definition (PMI, 2019, p.116).

> The logical relationship where completion of work of the successor activity cannot finish until the completion of work of the predecessor activity.

Class: O. **Origin:** Manual. **Format:** Alphanumeric (activity ID).

Purpose and behaviour. Prevents the successor from finishing before the predecessor finishes.

Good practice. Apart from intended first/last activities, test for a predecessor connection to the activity's start and a successor connection from its finish, not merely any relationship at either end.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Read the relationship from the predecessor's event to the successor's event”.

C062 — Finish to Start

Definition (PMI, 2019, p.117).

> The logical relationship where initiation of work of the successor activity depends upon the completion of work of the predecessor activity.

Class: CRC. **Origin:** Manual. **Format:** Alphanumeric (activity ID).

Purpose and behaviour. Prevents the successor from starting before the predecessor finishes.

Good practice. The source identifies FS as the usual relationship. Apart from intended first/last activities, test for a predecessor connection to start and a successor connection from finish.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Read the relationship from the predecessor's event to the successor's event”.

C063 — Free Float

Definition (PMI, 2019, p.117).

> The amount of time that a schedule activity can be delayed without delaying the CPM early start of immediately following schedule activities. See also total float, a similar but not equivalent term.

Class: CRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures permitted delay before an immediate successor's early start is affected. Its value can change with progress, durations or revised remaining-work logic.

Good practice. Review free float as an early indication of local activity or schedule slippage.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “5.4 Interpreting critical paths and float”.

C064 — Hammock Activity

Definition (PMI, 2019, p.117).

> An activity that spans between two points in a schedule and is generally used for carrying time-related and supporting resources.

Class: O. **Origin:** Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Spans two selected schedule points and can extend across different WBS packages.

Good practice. Use logical links to represent supporting resources required across those packages; the anchors determine the span.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Hammocks derive their span from related work”.

C065 — Lag

Definition (PMI, 2019, p.118).

> A modification of a logical relationship that directs a delay in the successor activity. For example, in a finish-to-finish dependency with a 10-day lag, the successor activity cannot finish until 10 days after the predecessor activity has finished. See also lead.

Class: O. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Adds a delay to a relationship's successor start or finish condition.

Good practice. Use sparingly for a fixed interval between activities. A lag does not consume resources and must not conceal work that should be represented by an activity or dependency.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “5.6 Using leads and lags transparently”.

C066 — Lead

Definition (PMI, 2019, p.118).

> A modification of a logical relationship that allows an acceleration of the successor activity. For example, in a finish-to-finish dependency with a 10-day lead, the successor activity can finish 10 days before the predecessor activity has finished. A negative lead is equivalent to a positive lag. See also lag.

Class: NS. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Allows the successor event earlier than the unmodified relationship, functioning as negative lag.

Good practice. Use rarely and only for a fixed interval. A lead does not carry resources and should not hide omitted work or substitute for proper logic.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Model genuine overlap instead of unexplained acceleration”.

C067 — Level of Effort Activity (LOE)

Definition (PMI, 2019, p.118).

> A group of schedule activities related to the same WBS package and displayed/reported as a single activity. LOE is used for work packages where progress cannot easily be measured.

Class: O. **Origin:** Calculated. **Format:** Alphanumeric.

Purpose and behaviour. The component entry treats LOE as an activity aligned with a WBS package.

Good practice. The entry discusses vertical traceability and the roll-up of WBS work; see the reconciliation below before applying that wording to support activities.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Level of effort represents support rather than a discrete product”.

C068 — Mandatory Finish Date

Definition (PMI, 2019, p.119).

> A date constraint placed on the schedule activity that requires the schedule activity to finish on a specific date. Schedule calculations do not override this constraint. Therefore, an imposed mandatory finish drives the CPM early dates for all paths leading from and the late dates on paths leading to the activity. Also known as must finish on.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Fixes an activity finish in both passes, setting that activity's float to zero and affecting early dates downstream and late dates upstream. Other activities may have different float; exact behaviour depends on the product.

Good practice. The source advises against this CPM-overriding constraint and against replacing logic with it.

Conditional or associated note. The entry identifies Finish On as equivalent.

Read with: Chapter 5, “Compare the constraint families”.

C069 — Mandatory Start Date

Definition (PMI, 2019, p.119).

> A date constraint placed on the schedule activity that requires the schedule activity to start on a specific date. Schedule calculations do not override this constraint. Therefore, an imposed mandatory start drives the CPM early dates for all paths leading from and the late dates on paths leading to the activity. Also known as must start on.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Fixes an activity start in both passes, setting that activity's float to zero and affecting early dates downstream and late dates upstream. Other activities may have different float; exact behaviour depends on the product.

Good practice. The source advises against this CPM-overriding constraint and against replacing logic with it.

Conditional or associated note. The entry identifies Start On as equivalent.

Read with: Chapter 5, “Compare the constraint families”.

C070 — Milestone

Definition (PMI, 2019, p.119).

> A significant point or event in the project. See also schedule milestone.

Class: CRC. **Origin:** Calculated. **Format:** Flag (determined by algorithm [Boolean]).

Purpose and behaviour. Identifies a significant event through a milestone indicator.

Good practice. Use zero duration and no resource assignment for the event itself. Include at least project start and finish milestones and distinguish them graphically, for example with a diamond.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “A milestone marks a condition, not the work required to create it”.

C071 — Planned Value (PV)

Definition (PMI, 2019, p.120).

> The time-phased value of the management-approved intended and necessary expenditures to achieve the defined scope. When the scope is completed, PV = BAC. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: ERC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Stores the time-phased approved budget for planned accomplishment.

Good practice. Use planned value where EVM is applied.

Conditional or associated note. The entry refers to The Standard for Earned Value Management and the synonym BCWS. The source also notes the label baseline plan; PV should not be mistaken for actual cash payments.

Read with: Chapter 10, “The common worked dataset”.

C072 — Probability Risk Distribution

Definition (PMI, 2019, p.120).

> Defines the probability that particular attributes or ranges of attributes will be, or have been, observed.

Class: KRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Represents the assumed probability distribution used in quantitative duration-risk analysis, with examples including normal, lognormal, uniform, triangular, beta and discrete distributions.

Good practice. The entry recommends a distribution for each activity and elicitation through participants and experts in interviews or workshops. It refers to The Standard for Risk Management in Portfolios, Programs, and Projects; see the modelling caveat below for fixed work.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 8, “8.3 Building evidence-based inputs and representing dependence”.

C073 — Project Actual Duration

Definition (PMI, 2019, p.120).

> The total number of work periods in calendar units between the project actual start date of the project and either the data date of the schedule model instance when the project is in progress or the project actual finish date when the project is complete.

Class: CRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures project time from actual start to the data date while the project is under way, or to actual finish once completed.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Validate relationships between fields, not just individual entries”.

C074 — Project Actual Finish Date

Definition (PMI, 2019, p.121).

> The point in time associated with the activity actual finish date of the last schedule activity in the project.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Rolls up the last activity actual finish as the project actual finish.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Validate relationships between fields, not just individual entries”.

C075 — Project Actual Start Date

Definition (PMI, 2019, p.121).

> The point in time associated with the activity actual start date of the earliest schedule activity in the project.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Rolls up the earliest activity actual start as the project actual start.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Validate relationships between fields, not just individual entries”.

C076 — Project Calendar

Definition (PMI, 2019, p.121).

> A calendar of working and nonworking periods that establish when schedule activities are worked and when schedule activities are idle. Typically defines holidays, weekends, and shift hours. The calendar initially assigned to schedule activities and resources. See also activity calendar and resource calendar.

Class: CRC. **Origin:** Manual. **Format:** Date/time.

Purpose and behaviour. Establishes the project's default working and non-working periods.

Good practice. Treat it as the primary calendar from which activity and resource defaults are established.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Distinguish project, activity and resource calendars”.

C077 — Project Cost Category

Definition (PMI, 2019, p.121).

> Accounting elements used to integrate traditional chart of account line items with the project cost accounting structure.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Provides project accounting classifications linked to cost accounts.

Good practice. Distinguish relevant direct, indirect, labour, material and equipment costs.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Reconcile packages and budgets without counting the work twice”.

C078 — Project Description

Definition (PMI, 2019, p.122).

> Documented narrative summary of the project scope statement.

Class: O. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Provides a short narrative description of the project.

Good practice. Summarise the scope of the whole project, rather than merely repeat its title.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Keep identity, classification and scope information distinct”.

C079 — Project Duration Percent Complete

Definition (PMI, 2019, p.122).

> An estimate, expressed as a percentage, of the entire project duration that has been completed on the project.

Class: CRC; one project-progress OR position. **Origin:** Calculated. **Format:** Numeric (fractional).

Purpose and behaviour. Expresses actual project duration as a share of total expected duration.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. This and Project Physical Percent Complete form one required alternative pair.

Read with: Chapter 10, “Aggregate compatible information and preserve its meaning”.

C080 — Project Early Finish Date

Definition (PMI, 2019, p.122).

> The point in time associated with the activity early finish date of the last schedule activity of the project.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Rolls up the early finish of the final activity from the forward pass.

Good practice. Derive the date from CPM calculation.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The forward pass: satisfy the latest arriving prerequisite”.

C081 — Project Early Start Date

Definition (PMI, 2019, p.122).

> The point in time associated with the activity early start date of the first schedule activity of the project.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Rolls up the early start of the first activity from the forward pass.

Good practice. Derive the date from CPM calculation.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The forward pass: satisfy the latest arriving prerequisite”.

C082 — Project Finish Constraint

Definition (PMI, 2019, p.123).

> A limitation or restraint placed on the project late finish date that affects when the project needs to finish and is usually in the form of a fixed imposed date.

Class: O. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Provides the backward-pass reference for the project and for successor-free activities without another backward-pass constraint. It may precede or follow the forward-pass forecast finish.

Good practice. Represent the customer's required finish, seek a feasible model with acceptable risk and non-negative float, and escalate an unachievable requirement to agree mitigation rather than conceal the conflict.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “An earlier required finish exposes negative float”.

C083 — Project Late Finish Date

Definition (PMI, 2019, p.123).

> The point in time associated with the activity late finish date of the last schedule activity of the project.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Represents the final activity's late finish. The source behaviour sentence names the forward pass; see the discrepancy note below.

Good practice. Derive the late date from CPM calculation with the correct backward-pass reference.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The backward pass: respect the tightest downstream requirement”.

C084 — Project Late Start Date

Definition (PMI, 2019, p.123).

> The point in time associated with the activity late start date of the first schedule activity of the project.

Class: CRC. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Rolls up the first activity's late start from the backward pass.

Good practice. Derive the date from CPM calculation.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The backward pass: respect the tightest downstream requirement”.

C085 — Project Name

Definition (PMI, 2019, p.124).

> A short phrase or label for each project, used in conjunction with the project identifier to differentiate a particular project from other projects in a program. Also known as project title.

Class: CRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Provides the short project label used with its identifier.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Keep identity, classification and scope information distinct”.

C086 — Project Physical Percent Complete

Definition (PMI, 2019, p.124).

> A calculation, expressed as a percent, of the amount of work that has been completed on the project, measured in terms of physical work progress.

Class: CRC; one project-progress OR position. **Origin:** Calculated. **Format:** Numeric (fractional).

Purpose and behaviour. Aggregates physical accomplishment at project level, normally through compatible earned-value measures.

Good practice. The entry calculates project physical percentage by dividing summarised earned-value units by the total project budget in those same units, following the EVM standard.

Conditional or associated note. The conditional note requires an earned-value technique and pairs this field with Project Duration Percent Complete as alternatives.

Read with: Chapter 10, “Aggregate compatible information and preserve its meaning”.

C087 — Project Remaining Duration

Definition (PMI, 2019, p.124).

> The total number of work periods in calendar units, either equal to the original duration for a project that has not started or between the data date of the schedule model and the project early finish date of a project that has at least one activity actual start date. This represents the time needed to complete a project where the work is in progress.

Class: CRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures the duration required from the data date to project early finish once the project has started; before start, the definition uses original duration.

Good practice. Reassess the remaining duration at each continuing reporting cycle.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Validate relationships between fields, not just individual entries”.

C088 — Project Resource Actual Quantity

Definition (PMI, 2019, p.125).

> The unit to express resources utilization for the project as of data date.

Class: RRC. **Origin:** Manual/Calculated. **Format:** Numeric.

Purpose and behaviour. Records resources used by the project up to the data date.

Good practice. Identify and assign the resources and report project actual quantity when resources are represented.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Keep actual, remaining and total quantities distinct”.

C089 — Project Resource-Leveled Finish Date

Definition (PMI, 2019, p.125).

> The point in time associated with the last activity scheduled finish date of a resource-limited schedule activity in a resource-limited schedule.

Class: O. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Records the earliest project finish after accounting for resource limitations, taken from the final scheduled activity.

Good practice. Identify and assign resources and level the model where overallocations occur.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Resolve the conflict and trace the new controlling sequence”.

C090 — Project Resource-Leveled Start Date

Definition (PMI, 2019, p.125).

> The point in time associated with the first activity scheduled start date of a resource-limited schedule activity in a resource-limited schedule.

Class: O. **Origin:** Calculated. **Format:** Date.

Purpose and behaviour. Records the earliest project start after accounting for resource limitations, taken from the first scheduled activity.

Good practice. Identify and assign resources and level the model where overallocations occur.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Resolve the conflict and trace the new controlling sequence”.

C091 — Project Resource Remaining Quantity

Definition (PMI, 2019, p.125).

> The unit to express resources needed to complete activity project as of data date.

Class: RRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Estimates resources still needed for the project at the data date.

Good practice. Renew the estimate of remaining resource quantities at each continuing reporting cycle.

Conditional or associated note. Resource assignments may also alter activity remaining duration.

Read with: Chapter 7, “Keep actual, remaining and total quantities distinct”.

C092 — Project Resource Total Quantity

Definition (PMI, 2019, p.126).

> The unit to express resource assignments across all activities of the project.

Class: RRC. **Origin:** Manual/Calculated. **Format:** Numeric.

Purpose and behaviour. Aggregates resource assignments across project activities, retaining meaningful resource types and units.

Good practice. Identify and assign resources and use project total quantity when resources are represented.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Keep actual, remaining and total quantities distinct”.

C093 — Project Start Constraint

Definition (PMI, 2019, p.126).

> A limitation or restraint placed on the project early start date that affects when the project can start and is usually in the form of a fixed imposed date.

Class: O. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Sets the project forward-pass reference and applies to predecessor-free activities without another forward-pass constraint.

Good practice. Represent the required start, assess resource availability and acceptable risk, and inform the stakeholder who imposed it if the schedule is not achievable so that mitigation can be agreed.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “The forward pass: satisfy the latest arriving prerequisite”.

C094 — Project Total Duration

Definition (PMI, 2019, p.126).

> The total number of work periods in calendar units to complete a project. For a project in progress, it includes the project actual duration plus the project remaining duration.

Class: CRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures the complete project span; for a project under way it includes actual plus remaining duration.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Reconcile the current total without confusing time and progress”.

C095 — Resource Assignment

Definition (PMI, 2019, p.126).

> The activity of allocating a resource to a specific schedule model element.

Class: RRC. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Allocates a resource to a particular schedule activity or model element.

Good practice. Identify the resource and make the assignment explicit.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Use the effort calculation as an explicit model”.

C096 — Resource Availability

Definition (PMI, 2019, p.127).

> The dates and number of work periods in calendar units that a given resource can be utilized according to the appropriate resource calendar.

Class: RRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Records the resource's available periods according to its calendar.

Good practice. Availability is a capacity input; this field does not itself report the resource's current or planned assignments.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Use the effort calculation as an explicit model”.

C097 — Resource Calendar

Definition (PMI, 2019, p.127).

> A calendar of working and nonworking periods assigned to the resource, which defines the work periods and nonwork periods in calendar format. Typically defines resource-specific holidays and resource availability periods. See also project calendar and activity calendar.

Class: RRC. **Origin:** Manual. **Format:** Date/time.

Purpose and behaviour. Defines the resource-specific working and non-working periods, including holidays and available periods.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Distinguish project, activity and resource calendars”.

C098 — Resource Description

Definition (PMI, 2019, p.127).

> A phrase that identifies a resource by type, role, or individual. Also known as resource name.

Class: RRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Describes a resource by its type, role, person or relevant domain.

Good practice. Provide a unique description for each identified resource.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Organise a resource breakdown structure and dictionary”.

C099 — Resource ID

Definition (PMI, 2019, p.127).

> A short, unique numeric or text description assigned to each specific resource to differentiate that resource from other resources. The resource ID is typically unique within any one project.

Class: RRC. **Origin:** Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Differentiates each assigned resource using an identifier unique within the project.

Good practice. Use a unique resource ID for every identified resource and govern any automatic generation consistently.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Organise a resource breakdown structure and dictionary”.

C100 — Resource Lag

Definition (PMI, 2019, p.128).

> The number of calendar units a resource is to wait after the activity start date before beginning work on the schedule activity.

Class: O. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Delays an individual resource's work relative to the activity's start.

Good practice. Use only for a fixed offset after identifying and assigning the resource; an uncertain release or resource-dependent operation needs appropriate explicit modelling.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Identify the resource that governs the duration”.

C101 — Resource Library/Dictionary

Definition (PMI, 2019, p.128).

> A documented tabulation containing the complete list, including resource attributes, of all resources that can be assigned to project activities. Also known as resource dictionary.

Class: RRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Lists the resources that may be assigned to schedule activities and their attributes.

Good practice. Identify the resources and organise the dictionary in a meaningful hierarchy or structure.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Organise a resource breakdown structure and dictionary”.

C102 — Resource Rates/Prices

Definition (PMI, 2019, p.128).

> The unit cost rate assigned to a specific resource, including known rate escalations.

Class: O. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Records each resource's unit cost, including known escalations.

Good practice. Use rates/prices where resources are assigned; retain the unit and effective period so quantity and price are compatible.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Cost the worked example under explicit assumptions”.

C103 — Resource Type

Definition (PMI, 2019, p.128).

> A unique designation that differentiates a resource by skills, capabilities, or other attributes. An individual resource has one resource type and many resources may have the same resource type.

Class: RRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Classifies a resource by skill, capability or another relevant attribute.

Good practice. Assign a type when a resource is identified. An individual resource has one type, while several resources may share that type.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 7, “Organise a resource breakdown structure and dictionary”.

C104 — Risk ID

Definition (PMI, 2019, p.129).

> A short, unique numeric or text identification assigned to each risk on the project’s risk register.

Class: KRC. **Origin:** Manual/Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Identifies a distinct risk-register record.

Good practice. Map a risk ID to affected schedule activities where relevant. The source refers to The Standard for Risk Management in Portfolios, Programs, and Projects.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 8, “Connect causes, events and consequences to the model”.

C105 — Schedule Model ID

Definition (PMI, 2019, p.129).

> A short, unique numeric or text identification assigned to each schedule model to differentiate that schedule model from others. Also known as project identifier.

Class: CRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Differentiates the scheduled project/model from other models.

Good practice. Use a unique identifier generated or assigned under a meaningful organisational numbering scheme.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 6, “Keep identity, revision and approval status separate”.

C106 — Schedule Model Instance

Definition (PMI, 2019, p.129).

> A designation of the instance of a schedule model. Examples include: as-of date, revision number, and agreed versioning codes, among others. Also known as schedule model version.

Class: CRC. **Origin:** Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Identifies the particular saved version represented by the schedule.

Good practice. Increment or otherwise advance the version designation consistently as changes produce successive instances.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 6, “6.1 Distinguishing the tool, model, instance and presentation”.

C107 — Schedule Model Level

Definition (PMI, 2019, p.130).

> A project team’s specified rule for the relative granularity of schedule activities in the overall schedule model.

Class: O. **Origin:** Manual. **Format:** Numeric.

Purpose and behaviour. Specifies schedule granularity or the level shown in a presentation.

Good practice. The source recommends six levels: 0 Project Summary (single project line); 1 Executive Summary (usually one page, major contractual milestones and summaries); 2 Management Summary (usually four or five pages, including area/equipment summaries); 3 Publication Schedule (monthly-report detail, major milestones and major engineering, procurement, construction and start-up work); 4 Execution Planning (construction/commissioning coordination, normally activities longer than one week with Level 4 and above providing the three-week look-ahead); 5 Detailed Planning (short-term field work, normally activities shorter than one week, with workarounds and critical areas developed further). These are stated conventions, not universal software depth rules.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 2, “Detail should follow purpose”.

C108 — Schedule Model Presentation

Definition (PMI, 2019, p.130).

> An output from schedule model instances used to communicate project-specific data for reporting, analysis, and decision making.

Class: CRC. **Origin:** Manual. **Format:** Graphical.

Purpose and behaviour. Presents data from an identified schedule instance for communication and decisions.

Good practice. Use a bar-chart view of activities; identify the output-generation date; describe the output and its principal elements; display progress and the current data date; and draw networks with enough space for relationship lines and as few crossings as practicable.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 13, “Select the view that answers the question”.

C109 — Schedule Performance Index (SPI)

Definition (PMI, 2019, p.131).

> EV/PV, calculated as time-phased values and used to measure a progress relative to the schedule. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Compares earned work with the work planned for the same reporting position.

Good practice. Use SPI where EVM is applied.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C110 — Schedule Performance Index Time (SPI(t))

Definition (PMI, 2019, p.131).

> It is the ratio of earned schedule and actual time and used to measure a progress relative to the schedule. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Compares earned schedule with actual time executed.

Good practice. Use SPI(t) where earned-schedule analysis is applied.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Interpolate within the planned-value profile”.

C111 — Schedule Variance (SV)

Definition (PMI, 2019, p.131).

> (EV−PV)/PV, calculated as time-phased values and used to measure a progress relative to the schedule. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures departure of earned accomplishment from planned accomplishment.

Good practice. Use schedule variance where EVM is applied.

Conditional or associated note. The source refers to The Standard for Earned Value Management. Its definition here contains a ratio; see the reconciliation below before using it as monetary SV.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C112 — Schedule Variance Percent (SV%)

Definition (PMI, 2019, p.132).

> 100 × (EV−PV)/(PV), calculated as time-phased values. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Expresses the earned-versus-planned difference as a percentage of planned value.

Good practice. Use schedule variance percentage where EVM is applied.

Conditional or associated note. The source refers to The Standard for Earned Value Management.

Read with: Chapter 10, “Calculate the indices and preserve their units”.

C113 — Schedule Variance Time (SV(t))

Definition (PMI, 2019, p.132).

> It is the difference between earned schedule (ES) and actual time (AT), and used to measure a progress relative to the schedule. These values may be calculated at any schedule model outline level and between various data dates. When the calculation is performed using the project start date and the most current data date, the values are called cumulative.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures the difference between earned schedule and actual time.

Good practice. Use SV(t) where earned-schedule analysis is applied.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Interpolate within the planned-value profile”.

C114 — Start Not Earlier Than

Definition (PMI, 2019, p.132).

> A date constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date. A start not earlier than constraint prevents the schedule activity from being scheduled to start earlier than the imposed date.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Places a lower bound on activity start; the source confines the effect to the forward pass and early dates.

Good practice. Use sparingly and retain the necessary activity logic.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Compare the constraint families”.

C115 — Start Not Later Than

Definition (PMI, 2019, p.132).

> A date constraint placed on the schedule activity that affects when a schedule activity can be scheduled and is usually in the form of a fixed imposed date. A start not later than constraint prevents the schedule activity from being scheduled to start later than the imposed date.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Places an upper bound on activity start.

Good practice. Use sparingly and retain the necessary activity logic.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Compare the constraint families”.

C116 — Start On

Definition (PMI, 2019, p.133).

> A date constraint placed on the schedule activity that requires the schedule activity to start on a specific date. Schedule calculations do not override this constraint. Therefore, an imposed start on constraint sets the early dates for all paths leading from and the late dates on paths leading to the activity.

Class: NS. **Origin:** Manual. **Format:** Date.

Purpose and behaviour. Fixes activity start in both passes, setting that activity's total float to zero while related activities can retain different values. The source describes the date as moving if data date passes it; tool behaviour needs checking.

Good practice. The source advises against using this CPM-overriding constraint and against replacing logic with it.

Conditional or associated note. The entry identifies Mandatory Start as equivalent.

Read with: Chapter 5, “Compare the constraint families”.

C117 — Start to Finish

Definition (PMI, 2019, p.133).

> The logical relationship where completion of the successor schedule activity is dependent upon the initiation of the predecessor schedule activity. See also logical relationship.

Class: NS. **Origin:** Manual. **Format:** Alphanumeric (Activity ID).

Purpose and behaviour. Prevents successor completion until the predecessor starts.

Good practice. Apart from intended first/last activities, test for a predecessor relationship to start and a successor relationship from finish; an SF link alone does not necessarily close both event boundaries.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Read the relationship from the predecessor's event to the successor's event”.

C118 — Start to Start

Definition (PMI, 2019, p.133).

> The logical relationship where initiation of the work of the successor schedule activity depends upon the initiation of the work of the predecessor schedule activity. See also logical relationship.

Class: O. **Origin:** Manual. **Format:** Alphanumeric (Activity ID).

Purpose and behaviour. Prevents successor start until the predecessor starts.

Good practice. Apart from intended first/last activities, test for a predecessor relationship to start and a successor relationship from finish.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “Read the relationship from the predecessor's event to the successor's event”.

C119 — Summary Activity

Definition (PMI, 2019, p.134).

> A group of related schedule activities aggregated at some summary level, and displayed/reported as a single activity at that summary level. See also subnetwork, subproject.

Class: O. **Origin:** Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Aggregates information inherited from subordinate activities.

Good practice. Use the roll-up for vertical traceability and summary reporting.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Summary activities aggregate information”.

C120 — Target Schedule Model

Definition (PMI, 2019, p.134).

> A target schedule model is an instance of the scheduling components used for comparison to other schedule models. A target schedule model may be selected from any available schedule model instance, for example, last update period.

Class: O. **Origin:** Calculated. **Format:** Various.

Purpose and behaviour. Captures an instance selected as a comparison target; it can be a previous update rather than the approved baseline.

Good practice. The source supplies no separate good-practice note for this entry.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 6, “Understand the target model and the comparison question”.

C121 — To Complete Performance Index (TCPI)

Definition (PMI, 2019, p.134).

> TCPI is remaining effort divided by remaining budget (or authorized remaining funds). TCPI BAC = (BAC – EVCUM)/(BAC – ACCUM) TCPIEAC = (EAC – EVCUM)/(EAC – ACCUM)

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. States the cost efficiency needed to achieve the selected BAC or EAC target.

Good practice. Use TCPI where EVM is applied.

Conditional or associated note. The source refers to The Standard for Earned Value Management; see the EAC-numerator reconciliation below.

Read with: Chapter 10, “Calculate TCPI as a requirement, not a prediction”.

C122 — To Complete Schedule Performance Index (TSPI)

Definition (PMI, 2019, p.135).

> TSPI is remaining duration divided by remaining estimated duration (or authorized remaining duration). TSPI = (PD – ES)/(PD – AT) TSPI = (PD – ES)/(ED – AT)

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. States the time efficiency needed to achieve the selected planned or estimated duration.

Good practice. Use TSPI where earned-schedule analysis is applied.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “Test the time performance required to meet a target”.

C123 — Total Float

Definition (PMI, 2019, p.135).

> The total amount of time that a schedule activity may be delayed from its activity CPM early start date or activity CPM early finish date without delaying the project CPM late finish date or violating a schedule constraint. Calculated using the critical path method approach and by subtracting (a) the activity CPM early finish date from the activity CPM late finish date or (b) subtracting the activity CPM early start date from the activity CPM late start date, with that difference expressed in calendar units. A total float value less than zero indicates: (a) the activity CPM late date is scheduled prior to the activity CPM early date and (b) the path that includes the activity cannot be completed in time to meet the CPM late finish of the project. A total float value of zero or greater indicates (a) the path that includes the activity can be completed in time to meet the CPM late finish of the project and (b) some schedule activities on that path may be able to be delayed. See also free float.

Class: CRC. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Measures the difference between activity late and early dates under the model's completion requirement. Float may change when actuals, remaining-work logic or durations change.

Good practice. The source proposes watching float for warning of completion slippage and applying Finish On to the finish milestone. That recommendation conflicts with the Finish On warning; see the reconciliation below.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 5, “5.4 Interpreting critical paths and float”.

C124 — Unit of Measure

Definition (PMI, 2019, p.135).

> A designation of the type of quantity being measured, such as work-hours, cubic yards, or lines of code.

Class: CRC. **Origin:** Manual. **Format:** Alphanumeric.

Purpose and behaviour. Identifies the quantity unit used by each relevant component.

Good practice. Apply units consistently across the model and exchanged data, including time, effort and physical output.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 4, “Separate duration from effort and elapsed time”.

C125 — Variance

Definition (PMI, 2019, p.136).

> The difference between two selected attributes expressed in appropriate units such as work days or currency.

Class: O. **Origin:** Calculated. **Format:** Numeric.

Purpose and behaviour. Quantifies the difference between selected dates, costs or durations and their named reference values.

Good practice. Review trends regularly for early signs of departure and the need for corrective action.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 10, “10.4 Comparing schedule instances and explaining movement”.

C126 — WBS ID

Definition (PMI, 2019, p.136).

> A short, unique numeric or text identification assigned to each work breakdown structure (WBS) element to differentiate a particular WBS from any other WBS element in a program.

Class: ERC; detailed header: Required; X3 allocation: ERC. **Origin:** Manual/Calculated. **Format:** Alphanumeric.

Purpose and behaviour. Maps each activity to its parent WBS element.

Good practice. Use the WBS structure consistently; the source refers to the Practice Standard for Work Breakdown Structures.

Conditional or associated note. The source supplies no separate conditional note or associated-component note for this entry.

Read with: Chapter 3, “Keep identity, classification and scope information distinct”.

Interpreting the source without reproducing its inconsistencies

Duration, effort and progress use different denominators

Activity Actual Duration measures time already used; Activity Remaining Duration forecasts time still needed; their sum gives Activity Total Duration for work in progress. Activity Original Duration preserves the original estimate under the product's defined handling. A ten-day original estimate, six working days actual and seven working days remaining produces a current total of thirteen working days. It does not mean that the activity is 60% physically complete.

Activity Work Percent Complete has a source definition describing a usual duration-percentage and work-hours-profile implementation. Some tools instead calculate a work measure from actual work divided by actual plus remaining work. State the convention rather than assume these implementations are equivalent. Under the latter convention, 18 actual person-hours and 12 remaining person-hours give 60%; three actual and three remaining working days give 50% duration progress. Four accepted units out of ten equal units give 40% physical progress. None can be substituted for another without explaining the work and measurement rule.

The Physical Percent Complete entries deserve particular care. The activity definition expressly permits physical quantities or EVM earning rules, while its conditional note says an earned-value technique is required. At project level the good-practice note uses summarised EV divided by the budget in matching units. The teaching interpretation is to preserve evidence-based physical measurement and define any aggregation or earning convention. Do not imply that a simple accepted-quantity ratio proves the existence of a complete EVMS, or average unlike activity percentages without valid weights.

The original-duration component gives a general guideline of two or three reporting cycles; the main text's more restrictive activity-sizing convention occurs in a different discussion. Both encourage reviewable work. Neither replaces judgement about discrete scope, measurable progress, reliable estimates or the appropriate rolling-wave horizon.

Field relationships require compatible scope and units

Suppose independent activity ACT-210 belongs to WBS element 1.2.3, control account CA-12 and EVMS work package WP-12-02. Its WBS ID records its scope parent, its Control Account ID identifies cost collection/control, and its EVMS Work Package Identifier identifies the package used for earning and integration. These identifiers

have distinct purposes even if an organisation chooses related coding. A control-account manager reference, CAM-07, must resolve to one accountable person. An activity's EVMS package field contains one value; any wider mapping between that package and WBS elements must be controlled rather than left ambiguous.

Earned Value Weight is distinct from Earned Value Measurement Type. The type might specify weighted milestones or a fixed earning rule; the weight allocates a package's value to activities or groups. For an illustrative £100,000 package, allocations of 20%, 30% and 50% distribute £20,000, £30,000 and £50,000. If the three corresponding, independently assessed completion measures are 0%, 50% and 100%, earned value is £0 + £15,000 + £50,000 = £65,000. The allocation weights total 100%; the earning assessments determine how much of those allocated values has been achieved. This is an explanatory example, not a prescribed earning rule.

Costs can normally be aggregated over compatible scope without counting the same amount twice. Durations cannot simply be added across parallel work. If two independent remaining activities of three and five working days start together and both must finish, the merge is five working days away, assuming adequate separate resources and a common calendar. The eight-day sum is not the network duration. This is why the ED and ETC(t) component wording about summing to levels must not be used to bypass schedule logic.

Project actual start and finish are catalogue roll-ups from the earliest and latest relevant activity actual dates. Define the model's project boundary before using those fields: a completed installation activity is not necessarily the completion of testing, commissioning or accepted operation. A future forecast date cannot be entered as an actual merely to make a roll-up look complete.

Relationships must control the intended events

The four relationship entries give an event-specific completeness test. Except at intended boundaries, an activity needs a predecessor relationship that controls its **start** and a successor relationship that carries its **finish** into subsequent work. In the source notation, these are a **?S predecessor** and an **F? successor**, where the other event can be start or finish. This is more precise than checking that a record has one incoming and one outgoing link. An incoming FF link can constrain finish without constraining start; an outgoing SS link can connect starts while leaving completion unconnected.

These are lower-bound relationship conditions, not promises that the successor starts or finishes immediately at the predecessor event. Calendars, other predecessors, resources and authorised constraints can postpone the successor further. In an FS-zero-lag network, free float can be calculated from the closest successor early start minus the activity early finish. Do not apply that simplified formula unchanged to mixed event relationships, calendar differences or other tool conventions.

Lags and leads do not receive resources. A fixed non-working interval may be represented by lag if its purpose and calendar are understood. A review requiring a named reviewer, variable duration and acceptance evidence normally needs an explicit activity. A resource lag is different again: it delays a particular assigned resource relative to the activity start, not the whole successor activity relative to a predecessor.

Constraints require calculation tests

The source describes not-earlier-than constraints as affecting early dates through the forward pass and not-later-than constraints as affecting late dates through the backward pass. Expected Finish can set remaining duration equal to imposed finish minus data date for an activity already under way. With a common working-day calendar, data date at day 6 and expected finish at day 10 produces four remaining working days under that described mechanism; it is not independent evidence that the outstanding work can be completed in four days.

Finish On, Start On and their Mandatory counterparts are described as overriding both passes and giving the constrained activity zero total float, while connected activities can have different float. The source advises against using these overriding constraints. It also warns that exact product behaviour varies. Retain the forecast and examine both the constraint's technical effect and the authority for the requirement.

There is a specific inconsistency: Total Float's good-practice note on printed page 135 recommends Finish On at the project finish milestone, but the Finish On entry on page 116 advises against that overriding constraint. Do not treat the later note as a universal instruction. A properly selected and tested finish requirement can support a backward-pass comparison without hiding the unconstrained forward forecast. For example, a forward forecast

at day 16 against a required finish at day 14 can expose negative float of two working days under the stated network assumptions; simply forcing the displayed finish to day 14 would obscure the conflict.

Project Late Finish Date on printed page 123 describes its behaviour as based on the forward pass. That wording conflicts with the late-date concept and the surrounding backward-pass treatment. The book uses the proper backward-pass reference for late dates and retains the source definition without changing it.

LOE, summary and hammock are different modelling questions

The LOE component on printed page 118 describes related WBS activities displayed as a single activity and recommends roll-up. That wording overlaps the Summary Activity component on page 134. The glossary's LOE definition on page 182 instead describes support measured by the passage of time. These should not be silently treated as identical.

In this book, **LOE** describes the nature and progress treatment of support work; a **summary** aggregates subordinate records for traceability and reporting; a **hammock** derives a span from selected anchors and may carry time-related support across WBS packages. A product can use one representation for particular support work, but its effect on dates, resources, progress and critical-path analysis still needs checking. A summary duration is an envelope of subordinate dates, not the arithmetic sum of all parallel durations.

Quantitative risk components record different objects

Probability Risk Distribution is an input assumption about uncertainty. Activity Cumulative Probability Risk Distribution stores output dates and their cumulative probabilities. Activity Risk Criticality Index records the frequency with which an activity is critical across simulation iterations; tied critical activities may each count, so activity criticality percentages need not sum to 100%. None of these fields, by itself, establishes that the uncertainty has been modelled well.

The source recommends distributions for each activity. In application, document the treatment of fixed or completed work and apply uncertainty to remaining work where justified. A genuinely fixed duration can remain deterministic; inventing variability merely to populate every record would misrepresent the evidence. Link a common risk cause through the model once in the appropriate way rather than independently duplicating its occurrence on every affected activity. Distinguish assumptions entered, analysis results stored and the model version used.

EVM and earned-schedule formula discrepancies

The Schedule Variance definition on printed page 131 contains **(EV−PV)/PV**, which is a ratio. The usual monetary or budget-unit schedule variance, also given by the source glossary on printed page 190, is **SV = EV−PV**. The corresponding percentage is **100 × (EV−PV)/PV**. The exact component quotation is retained above so the discrepancy is visible; the book's calculations use the measure with the correct name and unit.

The Cost Variance Percent entry on page 111 includes a statement about CPI being zero when EV is zero. It must not be used as a general zero-denominator rule. CPI is EV/AC: if EV is zero and AC is positive, CPI is zero; if AC is zero, the ratio is undefined. CV% = 100 × (EV−AC)/EV is undefined when EV is zero. Report an unavailable or undefined ratio honestly rather than manufacture a meaningful performance value.

The TCPI definition on page 134 prints **EAC−EV** in the numerator of its EAC-target expression. The remaining budgeted work is **BAC−EV**. Accordingly, the conventional target-specific expressions used in the chapter are **TCPI(BAC) = (BAC−EV)/(BAC−AC)** and **TCPI(EAC) = (BAC−EV)/(EAC−AC)**. The target changes the remaining funding denominator, not the budgeted value of unfinished scope. Inspect zero or negative remaining allowances before interpreting the result.

In the quoted TCPI expressions, CUM denotes cumulative values; BAC and EAC identify the selected target. The TSPI expressions compare remaining planned accomplishment time with the time allowance to planned duration or estimated duration. ED, ETC(t), AT and ES must use a consistent time basis. A ratio is dimensionless; SV(t) is expressed in time units; monetary SV is expressed in budget units. Preserve these distinctions at completion as well as during progress reporting.

Reading all five Appendix X4 illustrations

The following reconciliation uses the visible worksheets and the governing counts in Table 5-1 and Appendix X3. It recalculates from the printed integer points and rounds the final eligible index to one decimal place.

Table B.2 | Interpreting the five source conformance illustrations

Source illustration	What it establishes	Required result	Optional points	Eligible conclusion
X4-1, p.160	Base structure before the requirement questions and assessment are completed	Not yet assessed	Not yet assessed	No result has been entered
X4-2, p.161	Resources required; EVM and risk optional	49/49	10	59/111 = 53.2%
X4-3, p.162	Resources, EVM and risk all required	65/65	9	74/111 = 66.7%
X4-4, p.163	Resources and risk required; EVM optional	56/56	39	95/111 = 85.6%
X4-5, p.164	Required-component gate failed	47/56	34	81 diagnostic raw points; no eligible index

The base illustration is a structure for deciding requirements, not a completed 86% assessment. In X4-2, the ten optional points consist of five general optional points and five EVM points. In X4-3, the required total is 36 + 13 + 9 + 7 = 65. In X4-4 it is 36 + 13 + 7 = 56, and optional points comprise 30 general optional points plus nine EVM points.

In X4-5 the visible entries are 33 CRC, seven RRC and seven KRC points, totalling 47 out of 56 required. Its 25 general optional and nine EVM points add 34 diagnostic points but cannot repair missing required components. The visible worksheet therefore supports no formal index.

The source contains inconsistent presentation details. Its introductory rounding and worksheet rounding differ for X4-3 and X4-4; the calculations above retain their integer point totals. Some optional-resource cells show 11 rather than the governing 13, and a lower 46-point optional block is labelled as though it were another core-required block. The X4-5 introduction describes three missing resource points, while the visible seven out of thirteen implies six. These inconsistencies do not change the fixed categories or gate.

The PDF's extracted text layer also contains stale values in some visibly blank score cells. The visible X4-1 base and X4-5 failed-gate result fields should not be turned into completed indices using those hidden values. A credible assessment reports what was actually assessed, the applicable requirements, unresolved exceptions and the evidence supporting the decision.

Reference

Project Management Institute (2019) *Practice Standard for Scheduling*. Third Edition. Newtown Square, PA: Project Management Institute. Component structure and entries: printed pp.93–136; conformance assessment: pp.137–141; component-category index: Appendix X3, pp.151–157; worked assessment illustrations: Appendix X4, pp.159–164. Relevant glossary reconciliation: LOE, p.182; Schedule Variance, p.190.

APPENDIX C

Appendix C: Full-Length Practice Examination

170 original questions | 210 minutes | One best answer

This is original learning material, not an official PMI examination or a predictor of certification success. All 170 questions are marked for this practice exercise. The quotas approximate the published domain weights.

Allow 210 minutes and record one answer per question separately. Each scenario is independent. Use its stated scope, units, calendar and assumptions. Award one practice point for each correct answer, with no deduction for an incorrect answer; this is a practice marking convention, not a description of PMI scoring.

Table C.1 | Practice examination coverage by domain

Domain	Questions	Practice share
1. Schedule Strategy	24	14.1%
2. Schedule Planning and Development	53	31.2%
3. Schedule Monitoring and Controlling	59	34.7%
4. Schedule Closeout	10	5.9%
5. Stakeholder Communications Management	24	14.1%

Questions

Question 1

A team has selected critical-chain scheduling and identified a resource-feasible controlling sequence plus a non-controlling branch feeding into it. Which conceptual arrangement best distinguishes the protection offered by feeding and project buffers during schedule development?

A. Place every buffer at project start because buffers represent initial mobilisation.

B. Protect the branch merge with a feeding buffer and overall completion with a project buffer.

C. Place the project buffer on every activity and remove all feeding-branch protection.

D. Use feeding buffers only as dates for ordering shared equipment.

Question 2

A valid CPM model meets the target date when activities run in parallel. A subsequent check confirms that two overlapping activities need the same sole specialist, who cannot split time. What should determine the schedule recommendation to the sponsor?

A. The sum of every activity's total float, treated as additional specialist capacity.

B. The preferred target date with the specialist assigned simultaneously to both tasks.

C. The recalculated resource-feasible sequence and its resulting controlling path and completion date.

D. The original CPM finish because valid logic already proves deliverability.

Question 3

Three testing teams are individually available, but they share one calibrated test rig. Each test occupies the rig continuously and cannot be split. Their draft activities overlap. What is the best way to develop a feasible first schedule?

A. Accept the overlaps because labour resources are available for every activity.

B. Increase the rig's allocation percentage without changing its physical capacity.

C. Divide every test duration by three because three teams are available.

D. Model the rig's finite availability and sequence its competing uses with the activity logic.

Question 4

A team must install 120 identical units. Verified productivity is 0.5 units per person-hour. Four qualified people each provide six hours daily to this task. Assuming constant productivity, sufficient access and no interruptions, what working duration follows?

A. Sixty working days under the stated assumptions.

B. Five working days under the stated assumptions.

C. Forty working days under the stated assumptions.

D. Ten working days under the stated assumptions.

Question 5

A project's finish date has remained unchanged for three updates, but two major interface paths have lost most of their float. Existing escalation rules consider only changes to the finish date. The scheduler is reviewing the schedule management plan. Which change is most useful?

A. Replace finish reporting with a single average float measure.

B. Escalate every reduction in activity float directly to the sponsor.

C. Add agreed indicators for threatened interfaces and declining delivery margin alongside finish variance.

D. Reduce the acceptable finish variance to zero for every activity.

Question 6

A client needs to understand how a subcontractor's specialist availability affects the handover forecast. The subcontractor's commercial rates are confidential, but resource dates may be shared. What report best maintains useful visibility within the agreed information restrictions?

A. Send the complete cost-loaded native file because the client needs confidence.

B. Remove all subcontractor information from the handover report.

C. Present an unexplained project finish to avoid discussion of commercial details.

D. Show the relevant availability, milestone effect and response without disclosing restricted rates.

Question 7

Two parallel outdoor activities are exposed to the same storm season and use the same access road. A risk simulation currently samples their weather delays independently. The team has evidence that closures affect both together. What model improvement is most appropriate?

A. Add each activity’s worst-case delay to every simulation iteration.

B. Keep independent sampling because the activities have different schedule identifiers.

C. Represent the shared weather and access effects using justified dependence assumptions.

D. Remove weather risk because it affects both paths in a similar way.

Question 8

A laboratory refurbishment WBS includes installed equipment and rooms ready for use. The approved scope also requires operator training and regulatory submission, but neither appears in any work package. Before defining the activity list, what should the scheduler do?

A. Add a generic contingency activity without changing the work-package structure.

B. Hide the additional work inside the final equipment installation activity.

C. Reconcile the missing deliverables into the WBS with clear boundaries and ownership.

D. Treat the missing requirements as external because they are not physical assets.

Question 9

A weekly update confirms that fabrication is underway, but neither the supplier nor site records establish its actual start date. The schedule requires actual dates to be supported and traceable. What is the most appropriate treatment while the missing evidence is investigated?

A. Use the reporting date as the actual to avoid an empty field.

B. Choose the earliest possible start to protect the current completion forecast.

C. Use the planned start as the actual because production has begun.

D. Flag the uncertainty and seek evidence before confirming the actual date.

Question 10

A sponsor's summary hides a small external-interface activity that controls a major milestone. The full schedule shows the link correctly, but the summary appears to suggest that the milestone depends only on internal delivery. Which presentation change is most appropriate?

A. Retain the summary because the omitted activity has a low cost.

B. Remove the dependency from the full schedule to match the summary.

C. Expose the controlling interface and its status while retaining an appropriate summary level.

D. Add every detailed activity to the sponsor's report.

Question 11

A senior manager asks the scheduler to replace a late forecast with the contractual target in a client briefing. The verified model supports the later date, and no recovery action has been authorised. What communication approach is most defensible?

A. Label the target a forecast while retaining the later date internally.

B. Withdraw every forecast until recovery actions are fully certain.

C. Show target and forecast distinctly, explaining the gap and decisions needed for recovery.

D. Show only the target because contractual expectations take precedence in communication.

Question 12

The customer, sponsor, project manager and team have reviewed a complete, feasible schedule, resolved the recorded conditions and authorised its baseline. The approved version and effective date are confirmed. What should the scheduler do next under the agreed configuration procedure?

A. Continue seeking consensus because baseline decisions can never be considered complete.

B. Delete the supporting estimate basis because approval makes assumptions irrelevant.

C. Record and preserve the approved baseline, then issue its controlled reporting position.

D. Replace the approved version with an unreviewed scenario that finishes earlier.

Question 13

A contractor's planner has completed a credible schedule and the project manager supports it. The contract reserves baseline acceptance to the client's named representative. That decision has not yet occurred. How should the schedule management arrangements classify and use the model meanwhile?

A. Capture it as the approved baseline but leave acceptance metadata blank.

B. Treat project-manager support as equivalent to contractual baseline acceptance.

C. Identify it as a proposed baseline and follow the specified acceptance route.

D. Prevent all planning use until contractual acceptance has occurred.

Question 14

A reviewer can open a proposed schedule but cannot tell why one activity uses a seven-day calendar, why another has a long duration, or which supplier assumption supports a release milestone. What documentation would most directly address these gaps?

A. An explanatory basis of schedule linked to the model, estimates, settings and assumptions.

B. A list of software commands without identifying the project-specific decisions.

C. A new milestone summary that removes the uncertain activities from view.

D. A larger printed bar chart with the same unexplained dates.

Question 15

A 4D presentation shows every installed asset appearing on its planned date. The underlying schedule omits regulatory approval, software integration and operator preparation because these lack model geometry. What is the best correction before accepting the schedule model?

A. Accept the schedule because complete geometric coverage proves complete delivery scope.

B. Treat the missing work as complete because the final physical model is visible.

C. Add the non-geometric work and dependencies, then retain traceable links between schedule and visual objects.

D. Create dummy physical objects and leave their approval logic outside the schedule.

Question 16

Two events affect different parallel paths before a common completion milestone. Separate analyses show that either event alone could delay completion, but the combined network has not been calculated. What should the scheduler do before reporting their total effect on the milestone?

A. Use the larger event’s duration without checking the common successor.

B. Calculate the combined network effect and examine path changes and overlap.

C. Divide the summed delays equally between the two responsible work packages.

D. Add the separately calculated completion delays as the definitive total.

Question 17

An operations manager joins a project approaching phased handover. Existing reports serve construction supervisors and show installation dates, but not training, support readiness or restrictions on use. What should the scheduler agree with the project manager and the new stakeholder?

A. A readiness-focused view and reporting arrangements linked to the same controlled schedule position.

B. A separate handover forecast maintained outside the controlled scheduling process.

C. Removal of construction details from all existing team reports.

D. The full construction activity listing as the only acceptable common report.

Question 18

Two trades progress through repeated rooms, and the following trade is faster. Immediate starts behind each completed room would repeatedly stop its crew. The manager has approved a continuous-flow strategy where feasible. What should the planner examine first?

A. The total room count alone, because location sequence does not affect duration.

B. A single project finish constraint to prevent the following crew from stopping.

C. Overlapping both trades in each room without checking access or safety.

D. The release pattern and buffered start that permits uninterrupted following-trade work.

Question 19

An executive resource chart shows adequate total engineering capacity throughout the month. The detailed schedule nevertheless has a shortage of certified protection engineers for a controlling test. The chart is numerically correct. What communication change would best support the resource decision?

A. Combine all engineering skills into one resource to match the chart.

B. Expose the specialist shortage and its milestone effect alongside the aggregate capacity view.

C. Remove the aggregate chart because every summary is misleading.

D. Report that the test is adequately resourced because total capacity is sufficient.

Question 20

A delivery partner distrusts the schedule after several of its access concerns were omitted from earlier reports. Those concerns remain relevant, and the next planning workshop can revise assumptions within approved scope. Which action best supports a productive working relationship?

A. Invite the partner to test access assumptions and trace the agreed consequences into the controlled model.

B. Ask the partner to endorse the forecast before attending the workshop.

C. Avoid discussing earlier concerns to preserve a positive meeting atmosphere.

D. Give the partner unrestricted authority to change all programme dates.

Question 21

A remaining activity needs sixteen working hours and starts on Friday at 09:00. Its only calendar is Monday to Friday, 09:00-17:00, with eight uninterrupted working hours daily and no holidays. There are no other constraints. When does it finish?

A. Saturday at 01:00 after sixteen continuous elapsed hours.

B. Monday at 17:00 after two complete working shifts.

C. Tuesday at 09:00 after two complete working shifts.

D. Friday at 17:00 after one complete working shift.

Question 22

An experienced operations team has misunderstood the word release in a schedule briefing: the project means software available for testing, while operations means approved for live use. Both events exist in the model. What communication action best prevents further confusion?

A. Retain the terminology because it is familiar to the project team.

B. Use distinct event labels and confirm the acceptance conditions with both teams.

C. Treat the earlier testing date as the operational commitment.

D. Remove the testing event from the operations presentation.

Question 23

A future commissioning package has an agreed scope and budget but insufficient design detail for credible activity estimates. Near-term installation work is well defined. How should the scheduler develop the plan while preserving a meaningful basis for control?

A. Retain a bounded planning package and progressively detail it as reliable information becomes available.

B. Exclude commissioning until all technical decisions are complete and accepted.

C. Invent detailed future tasks now to make every part equally granular.

D. Treat future decomposition as automatic authority to replace the approved baseline.

Question 24

A team must complete 144 identical remaining units. A single crew can sustain six units per productive crew-hour and has six productive task-hours each working day. Assume constant productivity, uninterrupted supply and no other constraints. What remaining duration should support the forecast?

A. Four working days, based on twenty-four productive crew-hours.

B. Six working days, using the hourly production rate as days.

C. Twenty-four working days, treating productive hours as daily durations.

D. Eight working days, allowing three productive crew-hours each day.

Question 25

An assurance check flags an incomplete activity with no predecessor. Its owner says it represents an externally delivered permit expected next month, but no permit milestone or status evidence is recorded. What is the scheduler's best response to this finding?

A. Confirm the external dependency and model its evidence-based interface appropriately.

B. Exempt it automatically because external work never belongs in the model.

C. Link it to the nearest earlier activity to eliminate the diagnostic flag.

D. Assign today as its fixed start and close the finding immediately.

Question 26

Installation started before its FS predecessor, design approval, was complete. Some preparatory installation was valid, but the responsible engineer confirms further installation cannot proceed until approval. The update contains genuine actual starts. How should the remaining schedule represent this situation?

A. Preserve actuals and retain the approval dependency for remaining installation.

B. Delete the predecessor because installation has already acquired an actual start.

C. Override all remaining logic to preserve the installation team's requested finish.

D. Move the installation actual start after the forecast approval date.

Question 27

All authorised work is accepted, and the entire planned-value budget has accrued. Final EV and PV are each 900,000 monetary units; AC is 1,000,000. Completion was six weeks later than the approved finish. Which statement belongs in the final report?

A. SPI is 0.90 and CPI 1.00 because schedule delay caused the overrun.

B. CPI is 1.11, indicating that the late finish improved cost efficiency.

C. SPI is 1.00 and CPI 0.90; the six-week late finish remains reportable.

D. SPI is 1.00, so the six-week difference is no longer relevant.

Question 28

A milestone remains on its approved date, but the checked schedule shows its available float falling from twelve days to one over successive updates. The agreed status colour still appears green because the date has not moved. What should the accompanying narrative explain?

A. The unchanged date now has less delivery margin and may require an earlier response.

B. The milestone is fully secure because its baseline date is unchanged.

C. The baseline should be revised by eleven days to restore the original margin.

D. The project is eleven days late because eleven days of float disappeared.

Question 29

An assurance reviewer receives a PDF of the latest forecast but cannot reproduce its dates from the archived native file because calendars and calculation settings are missing. What should the scheduler add to strengthen the controlled update record?

A. Record the reviewer's concern without changing the archive contents.

B. Keep only the latest native file because earlier versions are obsolete.

C. Retain the matching model, settings, calendars and evidence with version links.

D. Replace the PDF with a screenshot showing only the final completion date.

Question 30

A ten-day FS lag links delivery of a control panel to installation. The owner explains that this period actually includes inspection, software configuration and approval by different teams. These tasks now have uncertain remaining effort. How should the schedule be improved?

A. Replace the lag with a fixed installation date and a narrative note.

B. Shorten the lag until installation meets the required milestone.

C. Represent the identifiable work and approvals as accountable activities with logic.

D. Keep the lag because adding activities would increase the model size.

Question 31

A package was planned to finish design before procurement began. Engineers have now confirmed that an independently approved equipment specification can safely release procurement before the remaining design closes. What is the best way to evaluate this proposed overlap?

A. Replace all finish-to-start design relationships with start-to-start links using arbitrary leads.

B. Model the verified release gate and residual dependencies, then assess time, risk and rework consequences.

C. Keep the original sequence because any overlap between design and procurement is invalid.

D. Assume the overlap saves the entire remaining design duration without recalculating.

Question 32

A controls report records earned value of £100,000, actual cost of £110,000 and planned value of £95,000 at one agreed cut-off. The scheduler is checking the report before release. Which statement correctly describes the earned value cost variance?

A. Minus £10,000: earned work cost more than budgeted.

B. Minus £15,000: earned work cost more than budgeted.

C. Plus £5,000: earned work cost less than budgeted.

D. Plus £10,000: earned work cost less than budgeted.

Question 33

A scheduling tool provides project, activity and resource calendars, but its documentation shows that activity settings can override some resource restrictions. The team needs a reliable model of a specialist's availability. What should it establish before relying on calculated dates?

A. Assume the tool always intersects every calendar and accept its dates without checking.

B. Verify the effective calendar rules with a small representative calculation and record the settings.

C. Use the project calendar alone because individual availability belongs outside scheduling.

D. Put all activities on continuous working time so calendar differences disappear.

Question 34

A coating requires forty-eight uninterrupted elapsed hours to cure after application, including nights and weekends. Inspection then requires an available weekday inspector. How should the planner represent these different time requirements when developing the activity sequence?

A. Represent curing on the required elapsed-time basis and inspection with its verified working availability.

B. Apply the inspector's weekday calendar to curing because both belong to one package.

C. Schedule inspection immediately after application because curing and inspection use different resources.

D. Treat curing as zero duration because it consumes no labour.

Question 35

The approved monthly forecast gives an estimate at completion of £210,000 and actual cost of £84,000 at the same reporting cut-off. Both include the same authorised scope. What remaining expenditure is implied by this forecast, before considering any new changes?

A. £84,000 remains to be spent under this forecast.

B. £294,000 remains to be spent under this forecast.

C. £126,000 remains to be spent under this forecast.

D. £210,000 remains to be spent under this forecast.

Question 36

An estimator has included a named permit risk as a separate probabilistic delay at its release gate. Another team proposes adding the same permit delay independently to every downstream duration distribution. What is the best response before simulation?

A. Map the common event once and model its affected dependencies without duplicate independent additions.

B. Remove the permit event entirely because downstream durations already contain uncertainty.

C. Use identical fixed lags on all successors instead of documenting the risk.

D. Accept every addition because more risk allowances always improve confidence calibration.

Question 37

At the reporting date, a project has planned value of £80,000, earned value of £72,000 and actual cost of £90,000. All three figures cover the same authorised scope and cut-off. What is the cost-based schedule variance?

A. Minus £10,000, indicating less work earned than planned.

B. Minus £18,000, indicating less work earned than planned.

C. Plus £8,000, indicating more work earned than planned.

D. Minus £8,000, indicating less work earned than planned.

Question 38

An activity needs 24 working hours and starts Thursday 5 November 2026 at 09:00. Its calendar is Monday to Friday, 09:00-17:00 without breaks. Friday 6 November is closed. With no other restrictions, when does it finish?

A. Wednesday 11 November 2026 at 09:00.

B. Tuesday 10 November 2026 at 17:00.

C. Tuesday 10 November 2026 at 09:00.

D. Monday 9 November 2026 at 17:00.

Question 39

A project uses consistently weighted earned value measures. At the reporting date, planned value is £50,000, earned value is £45,000 and actual cost is £60,000. Which schedule performance index should appear in the cost-based earned value report?

A. 0.75, calculated from earned value divided by actual cost.

B. 1.11, calculated from planned value divided by earned value.

C. 1.20, calculated from actual cost divided by planned value.

D. 0.90, calculated from earned value divided by planned value.

Question 40

A sponsor has five minutes to decide between two verified recovery options. Their resource needs, costs and completion effects are known. The scheduling team has prepared twenty pages of detailed network output. What should lead the briefing?

A. A general description of scheduling methodology before presenting the choices.

B. The preferred finish date without explaining the resource or cost implications.

C. A concise comparison of outcomes, trade-offs and the requested decision, with supporting detail available.

D. The complete network printout so the sponsor can derive the alternatives independently.

Question 41

A project completes all approved scope four weeks later than its approved finish. At final reporting, earned value equals planned value and the cost-based SPI is 1.00. A manager says this proves delivery was on time. What should the scheduler explain?

A. The actual finish should be moved to the baseline finish for consistency.

B. Final SPI can equal one despite lateness; compare actual and baseline dates.

C. SPI of one overrides the date comparison when all scope is complete.

D. Planned value must be reduced until SPI shows the four-week delay.

Question 42

A subcontractor reports a cable package 90% complete, but signed installation records support 70% and testing has not started. The agreed progress rule weights installation and testing separately. Which action best establishes a defensible update before the report is released?

A. Keep the previous percentage until the entire package has been accepted.

B. Use the subcontractor percentage because the delivery team owns the work.

C. Reconcile quantities and tests against the agreed rule with the subcontractor.

D. Average the two percentages to reflect both available sources equally.

Question 43

A recovery option saves four days if ordered by Wednesday; after that, the supplier cannot provide it. The weekly steering meeting is Friday. Cost, availability and the forecast effect are already confirmed, but the project manager lacks purchase authority. What should the scheduler communicate?

A. Assume approval because the option improves the forecast.

B. Describe the option in the next report without identifying its expiry.

C. Request an authorised decision before Wednesday, with the option's benefit, cost and expiry explicit.

D. Wait until Friday because that is the established steering timetable.

Question 44

A treatment unit may enter service only after accepted performance tests, authorised operating procedures and completed operator training. The sponsor wants a milestone called 'Ready for service'. How should that milestone be incorporated while the first schedule is developed?

A. Connect it only to installation because subsequent acceptance work is administrative.

B. Link it to the necessary acceptance work and define its authorised completion conditions.

C. Place it on the target date and omit predecessors to preserve flexibility.

D. Give it the same duration as testing to represent all readiness work.

Question 45

On one working calendar, trade A finishes areas 1-4 at day boundaries 2, 4, 6 and 8. Trade B needs one day per area, must follow A in each area and must work continuously through the areas. What is B's earliest possible start in area 1?

A. Day 5, allowing uninterrupted work through area 4.

B. Day 8, allowing uninterrupted work through area 4.

C. Day 4, allowing uninterrupted work through area 4.

D. Day 2, allowing uninterrupted work through area 4.

Question 46

A scarce specialist must be ready when a critical-chain activity starts. The planning method uses a resource buffer as an advance warning or readiness signal, rather than as scheduled work. How should the scheduler interpret this resource buffer?

A. A mobilisation alert that supports readiness without automatically adding activity duration.

B. Extra execution time that must always be inserted before the specialist's activity.

C. A second specialist assignment that doubles the available productive capacity.

D. A substitute for confirming whether the specialist can meet the required date.

Question 47

A design submission is linked to fabrication by a three-day lag. Review actually requires a named engineer, may generate comments and has an acceptance decision. During planning, what representation best exposes the work and its potential scheduling effect?

A. Replace the lag with a fabrication date constraint to stabilise the display.

B. Model the review and acceptance explicitly, retaining a justified sequence into fabrication.

C. Increase the lag to absorb possible comments without identifying an owner.

D. Delete the review allowance because fabrication already has a responsible contractor.

Question 48

A work-package owner proposes replacing an agreed milestone-based earning rule with a time-elapsed measure halfway through delivery because the current report looks poor. No change has been authorised. What should the scheduler recommend for the next controlled performance update?

A. Adopt the time measure immediately because it produces smoother progress trends.

B. Retain the agreed rule and assess any proposed change through controlled review.

C. Apply the new rule retrospectively without preserving the previous reported basis.

D. Average both measures and call the result the official earned value.

Question 49

The monthly update has reconciled actuals, recalculated logic and incorporated approved changes. However, the report still references the previous model version and one material resource assumption has not been reviewed. What is the best action before the controlled release?

A. Change only the file name and leave the report references untouched.

B. Approve the assumption implicitly by publishing the forecast without qualification.

C. Issue immediately because actual progress data have already been checked.

D. Resolve or explicitly qualify the assumption and reconcile the report version.

Question 50

A project has BAC £300,000, EV £120,000, AC £150,000 and PV £150,000. Management explicitly chooses EAC = AC + (BAC - EV)/(CPI × SPI), assuming both cumulative indices influence remaining costs. What EAC does this particular model produce?

A. £375,000, extending cost efficiency without schedule influence.

B. £468,750, applying both indices to the entire budget.

C. £330,000, completing remaining work at budgeted rates.

D. £431,250, using the stated composite forecasting formula.

Question 51

A project has budget at completion of £160,000, earned value of £60,000 and actual cost of £70,000. Investigation concludes that the past overspend will not recur and remaining work can be completed at its originally budgeted cost. What estimate at completion follows?

A. £160,000, retaining the original budget without adjustment.

B. £170,000, combining actual cost with budgeted remaining work.

C. £230,000, combining actual cost with the full budget.

D. £186,667, extending the cumulative cost performance index.

Question 52

A milestone's approved baseline is day 50, its previous forecast was day 54 and its current forecast is day 57. All values use one working-day calendar and origin. Which statement most accurately communicates the current position to management?

A. The forecast is seven days beyond baseline and has moved three days since the previous report.

B. The milestone has slipped seven days since the previous report.

C. The approved baseline has moved three days since the previous forecast.

D. The current variance is four days because that was the earlier forecast gap.

Question 53

A receiving department has repeatedly challenged handover dates after reports are issued. Its staffing and training constraints were not discussed during planning. The dates are still being developed and no commitment has been approved. How should the scheduler improve engagement?

A. Exclude the department from schedule reviews until a baseline is approved.

B. Issue the proposed dates more frequently without changing the consultation process.

C. Ask the sponsor to require acceptance of the delivery team's dates.

D. Involve the department in defining readiness dependencies and reviewing the handover assumptions.

Question 54

At time boundary day 10, unfinished activity A takes three days then B takes four. Parallel activity C takes six days. Final activity D takes two days after both B and C finish. All links are FS0, resources distinct, and every day works. When is completion forecast?

A. Day 25, adding all four remaining activity durations.

B. Day 18, using activity C and the final activity.

C. Day 19, using the longer remaining branch and final activity.

D. Day 17, using the longer branch without final activity.

Question 55

A programme requires subcontractor schedules to support integrated analysis, while commercial rates must remain restricted. The scheduler is defining file-access arrangements before the first submissions. Which approach best combines usable scheduling information with the stated confidentiality requirement?

A. Define controlled exchanges and access rights that preserve needed logic while restricting commercial fields.

B. Accept only milestone PDFs because native files may contain sensitive information.

C. Let each subcontractor decide independently what information to remove.

D. Provide unrestricted native files to everyone involved in integration.

Question 56

The sponsor has authorised choosing between two verified execution strategies within an agreed cost ceiling. One uses more budget to protect an essential operational date; the other preserves budget but misses that date. The first meets the ceiling. What should the scheduler recommend?

A. Escalate the decision again because every cost increase requires sponsor approval.

B. Average the two completion dates to create a compromise strategy.

C. Recommend the lowest-cost strategy regardless of the agreed operational priority.

D. Recommend the date-protecting strategy and document its cost and resource assumptions.

Question 57

The delivery strategy covers eighteen months. Near-term construction is well defined, but detailed design for later areas will be released progressively. Management wants dependable monthly forecasts without continually rewriting speculative activity detail. Which policy offers the best balance?

A. Omit later areas until their design information is complete.

B. Detail the near-term work and establish controlled rules for later planning-package elaboration.

C. Require identical activity durations and detail throughout the eighteen months.

D. Freeze the initial detailed model to preserve reporting consistency.

Question 58

A weekly planning meeting considers a work package whose drawings, materials, access and prerequisite inspection are confirmed. The responsible trade has agreed the crew and can deliver it within the week. What is the most useful next planning action?

A. Postpone commitment until every remaining project risk has been eliminated.

B. Make and record the achievable commitment, then coordinate execution and check completion.

C. Remove the package from the master schedule because the trade now owns it.

D. Increase the package's duration automatically because weekly planning requires contingency.

Question 59

A product team plans short iterations while a facilities team uses a predictive construction schedule. Their outputs must integrate before a regulated service launch. What arrangement best connects the methods without requiring every team to use identical planning detail?

A. Maintain separate plans and reconcile them only after both teams declare completion.

B. Require every backlog item to become a fixed-date contractual commitment immediately.

C. Connect team plans through agreed integration conditions, releases and authorised programme milestones.

D. Replace the launch milestone with the average completion percentage of both teams.

Question 60

A pump is installed and energised, but its agreed activity completion criteria also require a successful witnessed performance test. The test has been postponed. The supplier asks for the activity to be marked complete to match its invoice. What should the scheduler do?

A. Replace the original finish criterion with installation in this update.

B. Retain the incomplete status and model the outstanding witnessed test.

C. Mark the activity complete because invoicing confirms commercial progress.

D. Mark the activity complete because physical installation is finished.

Question 61

Before mobilisation, package owners propose reporting effort spent, physical quantities and subjective percentage complete using one common progress column. The project intends to use earned value and duration forecasts. Which policy decision is most important before configuring the reports?

A. Define each progress measure, its evidence and its relationship to forecast and earned value.

B. Standardise all packages on hours spent divided by their original hours.

C. Allow each owner to select a measure without identifying it.

D. Use the average of the three proposed measures for reporting.

Question 62

The updated schedule forecasts a later commissioning milestone after a supplier delay and resource reassignment. The sponsor needs to choose between two recovery options, but the draft report contains only hundreds of activity dates. What analysis should the scheduler add?

A. Provide more activity rows without identifying the reason for the milestone movement.

B. Report the percentage complete and omit the supplier and resource effects.

C. Replace the forecast with the preferred option before its assumptions are checked.

D. Explain the driving variance and compare feasible options, assumptions and consequences.

Question 63

A client requires native schedule exchanges between two approved applications. A demonstration transfers activity names and dates successfully, but the project uses several calendars and special calculation settings. Procurement asks whether the demonstration is sufficient to select the tool. What should the scheduler recommend?

A. Accept the tool because the displayed activity dates match.

B. Require both parties to exchange PDF reports instead of models.

C. Select the application with the largest available component catalogue.

D. Test representative logic, calendars and recalculation results before accepting the exchange capability.

Question 64

During planning, a team expects product requirements to evolve through user feedback. An external approval milestone and its evidence requirements are already agreed. Which approach best combines adaptation with a credible schedule for the wider programme?

A. Remove the approval milestone because adaptive delivery cannot include external commitments.

B. Refine near-term backlog work while maintaining visible dependencies and evidence for the approval milestone.

C. Treat every future backlog item as immutable because one approval milestone exists.

D. Change the approval requirements whenever the team reprioritises an iteration backlog.

Question 65

A commissioning milestone depends on energisation by a utility. The project's internal work is nearly complete, but the utility has only acknowledged the application and has not confirmed access or a switching slot. What is the best treatment in the next update?

A. Mark energisation complete because the application has been acknowledged.

B. Assume the baseline switching date remains confirmed unless formally cancelled.

C. Describe the dependency as a risk without reflecting it in forecast logic.

D. Retain the utility interface and qualify the forecast using its unresolved conditions.

Question 66

A planner manually changes several displayed finish dates in an exported spreadsheet to match a recovery promise. The native schedule still calculates later dates from remaining logic. The spreadsheet is about to become the official update. What is the scheduler's best corrective action?

A. Hide the affected rows until the native model eventually reaches the promise.

B. Issue the spreadsheet because stakeholder commitments determine the official forecast.

C. Adjust the native dates manually without checking their underlying drivers.

D. Reconcile the report to a supported model or clearly label a separate scenario.

Question 67

At actual time seven weeks, earned value is £140,000. Cumulative planned value was £120,000 at week five and £160,000 at week six. Assume linear interpolation between those points. What earned schedule and time-based schedule performance index follow?

A. Earned schedule 5.5 weeks; time-based index approximately 1.27.

B. Earned schedule 6.0 weeks; time-based index approximately 0.86.

C. Earned schedule 6.5 weeks; time-based index approximately 0.93.

D. Earned schedule 5.5 weeks; time-based index approximately 0.79.

Question 68

A project combines a stable equipment installation with software whose features will be prioritised after demonstrations. Both streams share a fixed integration test. The contract permits different planning methods but requires an integrated forecast. Which scheduling approach best meets these conditions?

A. Plan both streams as fixed detailed activities through final delivery.

B. Use detailed installation logic, iterative software planning and explicit integration dependencies.

C. Use software iterations as the sole project reporting structure.

D. Keep separate forecasts and reconcile their finish dates at integration.

Question 69

A service project plans to introduce earned value reporting. Labour timesheets are reliable, but work packages lack agreed acceptance measures and time-phased budgets. The sponsor wants meaningful performance information rather than rapid dashboard deployment. What should the scheduling strategy establish first?

A. A uniform earning rate based on elapsed calendar time.

B. Agreed scope, budget phasing and objective earning rules linked to scheduled work.

C. A rule that every recorded labour hour earns its actual cost.

D. A dashboard combining timesheets with the latest finish forecast.

Question 70

A draft activity is labelled 'Electrical works' and spans installation, inspection and defect correction across several independently released rooms. Supervisors cannot identify a single start condition or objective finish. What is the best development action before estimating its duration?

A. Attach a percentage estimate while leaving its execution boundaries unchanged.

B. Decompose it into manageable activities with explicit boundaries, owners and completion evidence.

C. Assign a fixed duration now and refine the meaning after baseline approval.

D. Rename it as a milestone so that uncertain work requires no duration.

Question 71

A released milestone report contains a transposed date. The controlled model is correct, and one recipient is about to book mobilisation using the incorrect report. The reporting procedure permits the scheduler to correct such publication errors. What should the scheduler do?

A. Seek baseline-change approval before correcting the publication error.

B. Issue the corrected report promptly, notify affected recipients and identify the superseded version.

C. Change the model date to match the report already received.

D. Wait for the next scheduled update to avoid multiple reports.

Question 72

A critical supplier offers a delivery date that depends on an unapproved production slot and a material allocation decision next week. The project needs a recommendation today, and no stronger evidence is available. How should the scheduler incorporate this information into forecast analysis?

A. Use only confirmed internal activities to develop the main completion forecast.

B. Record the offered date as confirmed because it is the latest supplier statement.

C. Use the original baseline date until the supplier’s conditions are resolved.

D. Model the conditions and plausible outcomes, making the recommendation explicitly conditional.

Question 73

A controlled planning package is approaching its agreed detail window. Its scope remains authorised, but the team now has sufficient design information to define activities and resource needs. What should the scheduler do when replacing the package with detailed remaining work?

A. Use arbitrary equal durations so the detailed activities exactly reproduce old dates.

B. Retain the summary package until execution ends to avoid changing the model.

C. Treat every new activity as additional scope requiring a new project objective.

D. Develop traceable detail and assess its impacts under the agreed control process.

Question 74

Before baseline approval, analysis shows that a qualified additional crew can safely shorten the controlling installation work. Access, supervision, equipment and funding are confirmed, and the manager has authorised the option. What should the scheduler do next?

A. Delay modelling until the additional crew has physically completed its first shift.

B. Retain the original duration because a draft model cannot reflect authorised decisions.

C. Incorporate the feasible assignment, recalculate the network and present the supported baseline proposal.

D. Assume the project finish improves by the full activity reduction without recalculation.

Question 75

A work package report shows 60% of accepted units delivered, 80% of budgeted effort consumed and 40% of its forecast duration elapsed. All three figures are correctly calculated. What should the scheduler do when preparing the performance narrative?

A. Label each measure and use the agreed physical-progress basis consistently.

B. Average the three percentages to create a single authoritative completion figure.

C. Use the largest percentage because it includes the most advanced evidence.

D. Use duration elapsed as physical progress because dates are the scheduler's responsibility.

Question 76

A subcontractor has genuinely started an activity before its modelled prerequisite is complete. The remaining work still requires that prerequisite, and the agreed scheduling settings retain this logic. Management asks why the activity has an actual start but a later forecast continuation. What should the scheduler explain?

A. The actual start must be removed because it conflicts with the model.

B. Actual progress is retained, while remaining work is forecast according to the still-required dependency.

C. The later continuation proves that the recorded actual work did not occur.

D. Starting the activity automatically eliminates every remaining dependency.

Question 77

An assurance finding identifies an unsupported supplier lead time on a near-critical path. The activity owner adds a note saying the issue is resolved but provides no revised quotation, capacity confirmation or estimate basis. What should the scheduler do with the finding?

A. Keep it open pending proportionate evidence and review of the schedule impact.

B. Close it if the unchanged lead time still supports the target date.

C. Transfer the finding to the risk register and close the assurance action.

D. Close it because the activity owner is responsible for the estimate.

Question 78

A project has issued a detailed schedule management plan, but newly appointed activity owners misunderstand how to report remaining work. They can reliably identify completed quantities and upcoming constraints. What mobilisation action would best support their effective participation?

A. Have the planner infer all remaining work without involving owners.

B. Require owners to complete formal scheduling certification before supplying progress.

C. Provide a focused briefing using examples of status evidence, remaining estimates and reporting responsibilities.

D. Ask owners to confirm that they have downloaded the plan.

Question 79

A schedule risk analysis indicates that 80 per cent of simulated finishes occur on or before day 120. The analysis includes specified responses but excludes a possible scope extension. A board member interprets day 120 as a guaranteed commitment. How should the scheduler respond?

A. Clarify the conditional model result, included responses and excluded scope before discussing commitment.

B. Increase the percentile label while leaving the analysis unchanged.

C. Confirm the guarantee because the result represents a high confidence level.

D. Describe day 120 as the deterministic critical-path finish.

Question 80

A project has budget at completion of £240,000, earned value of £96,000 and actual cost of £120,000. The forecasting assumption is that the cumulative cost efficiency achieved so far will continue for all remaining work. What is the resulting estimate at completion?

A. £300,000, using the continuing cumulative cost efficiency.

B. £288,000, applying actual expenditure to earned value.

C. £360,000, adding the full budget to actual cost.

D. £264,000, using the original remaining-work budget instead.

Question 81

The current critical path has stable work and experienced resources. A parallel branch has only two days of total float and includes uncertain specialist testing. The sponsor asks what deserves attention in the next update. Which monitoring approach is most useful?

A. Monitor only zero-float activities because other work cannot delay completion.

B. Monitor both branches, testing uncertainty and the possibility of path switching.

C. Monitor both branches equally without examining their different sources of uncertainty.

D. Allocate all contingency to the current critical path and ignore the branch.

Question 82

A comparable cable installation achieved 30 metres per crew-day, including its normal preparation. The new package contains 270 metres and uses one equivalent crew. Validated access differences reduce expected productivity by 25 per cent. What duration should the estimate use?

A. Six working days for the adjusted productivity.

B. Nine working days for the adjusted productivity.

C. Eleven working days for the adjusted productivity.

D. Twelve working days for the adjusted productivity.

Question 83

A schedule assessment records 55 of 56 applicable required components satisfied and 55 optional points, giving a raw total of 110. One required component remains unsatisfied. The assessment uses a required-component gate before any component index. What is the appropriate reporting treatment?

A. Report 100% because optional points compensate for the missing requirement.

B. Report 99.1% conformance because the raw score is 110.

C. Report the failed gate; do not publish a conforming index.

D. Report a passing index if the omitted component seems minor.

Question 84

A proposed scheduling application offers advanced optimisation but cannot retain the approved baseline history or provide the required access controls. Another application meets these mandatory needs with simpler analysis. Both can model the project's essential logic. Which selection is most defensible?

A. Purchase both tools and leave responsibility for version control undecided.

B. Select the compliant application unless an approved solution closes the other tool's mandatory gaps.

C. Select advanced optimisation because forecasting capability outweighs record-management requirements.

D. Relax the access controls because only qualified planners will use them.

Question 85

A verified permit decision will miss tomorrow's release point unless an executive authorises an available alternative. The scheduler has confirmed the cost and time consequences, and the decision exceeds project-manager authority. The next routine report is in ten days. What should happen now?

A. Adopt the alternative immediately because its time benefit has been verified.

B. Escalate the decision promptly with the verified options, consequences and latest useful decision time.

C. Request another general status update before communicating the decision need.

D. Wait for the routine report so all stakeholders receive one consistent message.

Question 86

On a common working-day calendar, A starts at day 2 and lasts five days. B lasts four days and has only one predecessor relationship: start-to-start with A plus three days of lag. Resources are sufficient. What is B's earliest finish?

A. Day 11, following an earliest start at day 7.

B. Day 6, following an earliest start at day 2.

C. Day 14, following an earliest start at day 10.

D. Day 9, following an earliest start at day 5.

Question 87

The organisation permits approved baseline revisions after major scope changes. Its previous projects retained only the latest approved file, making original commitments difficult to explain. Which configuration policy would best correct this weakness while allowing legitimate revision?

A. Preserve every working file without distinguishing approved versions.

B. Retain identified original and revised baselines with approvals and a traceable change history.

C. Prohibit baseline changes even when revised scope is formally authorised.

D. Overwrite the original baseline after recording its finish date in minutes.

Question 88

A schedule passes all applicable required-component checks and achieves a high component index. A separate resource review shows two critical activities require the same unavailable crane. What conclusion should accompany the assurance report and recommendation on the completion milestone?

A. Component conformance is favourable, but crane feasibility still needs resolution.

B. Recalculate the component index by subtracting a penalty for the crane.

C. The high component index proves the milestone is achievable as reported.

D. The crane conflict can be ignored because it is outside component scoring.

Question 89

A network uses one working calendar and starts at day 0. Activity A takes three days, followed by parallel B of four days and C of six days. D takes two days after both finish. All relationships are finish-to-start with zero lag; resources are sufficient. When does D finish?

A. At day 11 on the common working calendar.

B. At day 13 on the common working calendar.

C. At day 15 on the common working calendar.

D. At day 9 on the common working calendar.

Question 90

An imposed contractual finish produces eight working days of negative total float on the controlling chain. The scheduler has checked the calendars, logic and remaining estimates. A sponsor asks whether the project can still meet the obligation. What is the most useful response?

A. Explain the modelled shortfall, feasible response options and any approval needed to meet the obligation.

B. Report the contractual finish without discussing the forecast or required response.

C. Report that negative float proves the project will finish exactly eight days late.

D. Move the contractual constraint to the forecast and report zero float.

Question 91

An approved resequencing change moves outdoor work into winter and creates a new shared-resource interface. The previous risk simulation still uses summer productivity and independent resource availability. What should be completed before its old P80 date is reused in the next report?

A. Rename the old simulation output to match the revised schedule version.

B. Retain the old P80 because the approved completion milestone has not changed.

C. Update the risk inputs and dependencies, rerun analysis and review sensitivity.

D. Shift the old P80 by the deterministic difference without examining changed risks.

Question 92

A contract requires completion by a particular Friday, but the unconstrained draft network forecasts the following Tuesday. The logic, durations and calendars have been verified. Which modelling approach best preserves an honest basis for developing feasible responses?

A. Force every unfinished activity to finish before Friday using hard constraints.

B. Delete external predecessors because their dates are outside the team's control.

C. Retain the calculated forecast and represent the contractual requirement for comparison.

D. Reduce durations proportionally until the model displays the contractual Friday.

Question 93

A new installation has uncertain inspection durations and no directly comparable historical distribution. The sponsor needs an evidence-based view of milestone risk before commitment. Which strategy is most defensible when establishing the schedule analysis approach?

A. Present a simulation percentile before agreeing the underlying risk assumptions.

B. Use the most likely duration because historical distributions are unavailable.

C. Develop documented expert estimates and risk assumptions, then test their influence on the forecast.

D. Assume every uncertain duration has the same triangular distribution.

Question 94

Before demobilisation, an archived native schedule opens successfully on another computer. However, the imported calendars and calculation settings are missing, and recalculation produces different dates. What is the most appropriate conclusion from this archive test?

A. The archive passed because the native file is readable.

B. The recalculated dates should replace the original issued results without explanation.

C. A checksum of the incomplete file will resolve the calculation difference.

D. Retrievability passed, but reproducibility remains incomplete and the missing configuration must be addressed.

Question 95

A remote supplier promises a configuration file by Friday afternoon in its local time zone. The receiving team requires it before a Friday morning test in another region. No common cut-off has been agreed. What should the scheduler establish with the parties?

A. The supplier's local date as the programme's default interpretation.

B. A one-day buffer without confirming the actual handover requirement.

C. A shared Friday milestone without recording the time zone.

D. A precise delivery time with an agreed time zone linked to the receiving test requirement.

Question 96

Accepted work completed before month end has earned value recorded, but its supplier invoice will arrive next month. The organisation’s policy requires appropriate accruals for incurred costs. What should the scheduler and cost controller do before interpreting this month’s cost performance index?

A. Advance next month’s planned value to match the invoice timing.

B. Treat the absent invoice as proof that the work incurred no cost.

C. Reconcile accrued actual costs with earned work at the same cut-off.

D. Exclude the earned value until the supplier sends its invoice.

Question 97

The planner has prepared a technically feasible weekend-working scenario for discussion. It improves completion but needs client access approval and additional funding. Senior managers will compare it with the current authorised plan tomorrow. How should the scenario be presented?

A. Exclude it from discussion until every potential approval has been obtained.

B. Present its finish as the current forecast because the model calculates successfully.

C. Label it as an unapproved option and identify the decisions and assumptions required for adoption.

D. Replace the approved baseline before requesting access and funding decisions.

Question 98

A planning package contains routine coordination throughout installation and a separate inspection that authorises energisation. Someone proposes classifying everything as level of effort because the same manager oversees it. What is the most appropriate modelling distinction?

A. Replace the inspection with a summary label that cannot affect energisation.

B. Give every coordination day an energisation milestone to make the support measurable.

C. Classify inspection as support because a management role owns its execution.

D. Represent coordination support appropriately while keeping the inspection as identifiable work with acceptance consequences.

Question 99

A schedule uses different activity calendars and several justified finish constraints. A report ranks activities solely by total float and labels the lowest value as the delivery-driving path. What additional work should the scheduler perform before relying on that conclusion?

A. Accept the ranking because minimum float identifies every driving path unambiguously.

B. Convert every activity to one calendar without consulting delivery owners.

C. Trace driving relationships and calendar effects to the relevant completion milestone.

D. Delete the justified constraints so that the float ranking becomes simpler.

Question 100

A contract requires prompt notice of certain schedule events, while the internal change board meets monthly. A developing event may require notification before its final time impact is known. Which planning arrangement best reconciles the two processes?

A. Use the monthly progress report as the sole notification mechanism.

B. Define timely contractual notification separately from later analysis and internal change approval.

C. Treat every notification as automatic approval of a revised baseline.

D. Delay notification until the change board approves the quantified impact.

Question 101

The contract requires a monthly summary programme, but delivery teams need detailed weekly coordination and look-aheads. A manager proposes maintaining separate manually edited schedules for these audiences. What reporting strategy should the scheduler recommend?

A. Allow independent dates where the audience and report purpose differ.

B. Generate appropriate levels from controlled data with traceable interfaces and common reporting references.

C. Use the contractual summary as the only schedule for all planning.

D. Require every monthly report to display the full activity network.

Question 102

An activity owner challenges a forecast because an approved shutdown calendar was omitted. The scheduler confirms the omission, and the normal update procedure authorises correcting it. The current report has not been released. What is the best immediate response?

A. Correct the calendar assignment, recalculate and explain the resulting forecast movement in the release.

B. Escalate the factual correction for a new scope decision.

C. Preserve the known error until the following reporting cycle.

D. Change the approved shutdown dates to retain the current forecast.

Question 103

A planning team has aligned its WBS with the organisation responsible for delivery. Someone proposes creating a control account at every matrix intersection, including intersections containing no authorised work. Which response best supports a useful control structure?

A. Place all control accounts at project level to eliminate delegated responsibility.

B. Use only the resource hierarchy because it replaces scope and accountability.

C. Select meaningful management points where defined scope, responsibility and budget are integrated.

D. Create every possible intersection because matrix completeness determines schedule reliability.

Question 104

A package uses a two-person crew for six working days and another two-person crew for three days. People cost £350 per person-day; fixed setup costs are £1,600. No other costs apply. What total direct planned cost should be time-phased?

A. £4,750 across the periods in which work is planned.

B. £7,900 across the periods in which work is planned.

C. £6,300 across the periods in which work is planned.

D. £10,500 across the periods in which work is planned.

Question 105

A schedule model assessment confirms all 56 applicable required components are satisfied. Its score is 56 required points plus 27 optional points. For this assessment, the fixed maximum is 111 and the required-component gate has passed. What component index should be reported?

A. 74.8%, calculated from eighty-three points divided by 111.

B. 83.0%, treating the points total as a percentage directly.

C. 100.0%, because every applicable required component is satisfied.

D. 48.6%, dividing optional points by the required-component count.

Question 106

A complete discrete forecast assigns probability 0.25 to finishing on day 18, 0.50 to day 20 and 0.25 to day 24. Define P80 as the earliest date with cumulative completion probability at least 80%. Which reported date meets that definition?

A. Day 24, because cumulative probability first reaches 80% there.

B. Day 18, because it is the earliest modelled completion date.

C. Day 20, because it is the most probable completion date.

D. Day 21, because interpolation gives an intermediate completion date.

Question 107

A programme issues a revised interface date, and the receiving manager acknowledges the email. Later discussion suggests the manager still plans staffing around the previous date. The date itself is verified and authorised. What should the scheduler do to establish useful understanding?

A. Confirm the manager's interpretation and agree the consequent staffing and interface actions.

B. Revise the approved date to match the manager's previous staffing plan.

C. Treat the email acknowledgement as proof that all consequences are understood.

D. Send the same attachment again without further explanation.

Question 108

A project depends on a utility connection delivered by another organisation. The project team cannot control that organisation's internal activities, but must demonstrate how connection availability affects commissioning. Which scheduling policy most directly addresses the dependency without overstating control?

A. Maintain an owned external-interface milestone, agreed information exchanges and impact-linked project logic.

B. List the connection only in meeting minutes outside the model.

C. Copy the utility's entire internal schedule and treat it as project-controlled work.

D. Apply a fixed commissioning constraint and exclude the utility dependency.

Question 109

A project has an approved scope, schedule and budget, but its proposed performance baseline spreads all budget equally across calendar months. Planned work and resource demand vary substantially. What should be corrected before the baseline is used for performance measurement?

A. Use expected invoice dates as the sole definition of planned work accomplishment.

B. Time-phase the authorised budget consistently with the planned work and agreed measurement structure.

C. Set planned value equal to the first forecast of actual expenditure.

D. Retain equal monthly amounts because a baseline must always form a straight line.

Question 110

A team supplies optimistic, most likely and pessimistic remaining durations of two, five and fourteen working days. For this exercise, use the conventional PERT mean (O + 4M + P)/6 and standard deviation (P - O)/6. Which pair is correct?

A. Mean seven working days; standard deviation two working days.

B. Mean five working days; standard deviation three working days.

C. Mean six working days; standard deviation two working days.

D. Mean six working days; standard deviation four working days.

Question 111

An international project combines continuous equipment testing with weekday engineering work. Both teams use durations labelled days, but their working-day lengths differ. Before baseline development, which convention should the scheduling strategy establish to avoid misleading duration comparisons?

A. Allow each report recipient to interpret a day locally.

B. Convert all durations to elapsed days and remove working calendars.

C. Define working-time units, calendar assignments and conversion conventions for each relevant work type.

D. Require every activity to use the engineering weekday calendar.

Question 112

A contractor will repeat similar work across twenty floors. Handover between trades and maintaining crew continuity matter as much as individual activity dates. The client also requires contractual milestone reporting. Which strategy best responds to both needs?

A. Give every floor the same start date to show production targets.

B. Replace contractual milestones with a single average production-rate chart.

C. Use a location-based flow view linked to the controlled milestone and dependency model.

D. Report only milestone dates because repeated work needs little coordination.

Question 113

An activity has optimistic, most likely and pessimistic durations of four, seven and sixteen working days. Use the conventional PERT weighted mean and approximate standard deviation. Which pair should be carried into the stated estimate calculation?

A. Mean nine days and standard deviation two days.

B. Mean eight days and standard deviation four days.

C. Mean eight days and standard deviation two days.

D. Mean seven days and standard deviation twelve days.

Question 114

A project finished within its revised baseline, but activity owners report repeated reconciliation work and missed early warnings at interfaces. Closeout feedback has so far measured only dashboard satisfaction. What additional evaluation would provide the most useful learning?

A. Examine data flows, interface visibility and decision timing with contributors and report users.

B. Ask only senior recipients whether the dashboard looked professional.

C. Replace the scheduling tool before investigating how the reporting process operated.

D. Conclude the scheduling approach was effective because the revised finish was achieved.

Question 115

An overall earned value indicator looks close to plan because a large supervision package earns steadily with time. Several discrete commissioning activities are late and drive completion. What additional analysis should the scheduler provide to avoid a misleading assessment of schedule performance?

A. Remove supervision from the baseline without seeking the relevant approval.

B. Use the aggregate indicator alone because all authorised work is included.

C. Treat supervision progress as evidence that commissioning is similarly advanced.

D. Separate discrete-work trends and explain the completion-driving commissioning delays.

Question 116

A starts at day 1 and lasts six working days. B lasts four days and has a finish-to-finish relationship from A with two days of lag. On a common calendar, with no other restrictions, what is B's earliest start?

A. Day 5, allowing B to finish at day 9.

B. Day 3, allowing B to finish at day 7.

C. Day 9, allowing B to finish at day 13.

D. Day 7, allowing B to finish at day 11.

Question 117

After an approved acceleration, a previously near-critical branch now determines project completion. Another day can be removed from the original branch at additional cost, but no downstream dates would change. What is the most useful next step in recovery analysis?

A. Keep reporting the original critical path until the next baseline revision.

B. Split the extra reduction equally across both branches without recalculation.

C. Buy the additional reduction because the original branch was previously critical.

D. Evaluate the new driving branch and remaining feasible completion improvements.

Question 118

The monthly schedule has a status date of 30 June. A supervisor submits an actual finish of 3 July for an activity that was incomplete on 30 June. The reporting procedure requires a frozen month-end position. What should the scheduler do?

A. Record the June position and retain July evidence for the next update.

B. Enter the July actual finish because it is now confirmed.

C. Move the status date for that activity without changing the report date.

D. Record completion on 30 June to preserve the agreed reporting cycle.

Question 119

A project originally planned to finish in week 24. An authorised scope addition moved the baseline to week 28, and accepted completion occurred in week 31. All dates share one origin. What comparison should the final schedule account present?

A. Four weeks of lateness, equal to the approved baseline movement.

B. Seven weeks of delivery inefficiency, because the original baseline is always decisive.

C. Seven weeks against the original reference and three against the revised reference, with context.

D. Three weeks only, because the authorised revision replaced all earlier commitments.

Question 120

A resource-levelled forecast finishes later than the unlevelled network because a shared specialist cannot perform two activities simultaneously. Management asks why the forecast moved even though durations and technical relationships did not change. What explanation and record are most appropriate?

A. Show the capacity constraint, levelling decisions and their effect on completion.

B. Describe the change as a software error and restore the unlevelled dates.

C. Change the approved baseline immediately so the two schedules agree.

D. Add an unrelated technical dependency to conceal the resource allocation decision.

Question 121

On one working calendar, P and Q start independently at day 0 and last five and two working days respectively. Both precede R, which lasts three days. All relationships are finish-to-start with zero lag, resources are sufficient, and the backward pass uses the earliest project finish. What is Q's total float?

A. Five working days against the day-eight finish.

B. Two working days against the day-eight finish.

C. Three working days against the day-eight finish.

D. Six working days against the day-eight finish.

Question 122

A completed package required 480 labour-hours for 80 accepted units. Its records include unusual access delays and specialist support. A future-project estimator requests the rate for a similar package. What closeout contribution would best support responsible reuse?

A. Provide only the original estimate to avoid transferring poor performance.

B. Remove all difficult observations so that the database represents efficient performance.

C. Provide six elapsed hours per unit as the standard duration for future estimates.

D. Provide six labour-hours per accepted unit with effort boundaries and the recorded operating conditions.

Question 123

A project is formally terminated after completing two of its four planned phases. The stopping decision cancels the remaining phases but leaves equipment return obligations. Which final schedule treatment most accurately represents the approved outcome and continuing responsibilities?

A. Preserve completed actuals, identify cancelled scope and transfer the continuing return obligations explicitly.

B. Report the original project as fully delivered because its contract has ended.

C. Enter actual finishes for all phases on the termination date.

D. Retain all cancelled phases as unchanged forecasts in the final account.

Question 124

The completed schedule account satisfies the agreed technical review, and all supporting records are available. Contractual schedule acceptance remains with a named client representative who has not yet decided. The project manager asks whether internal review is enough to complete that obligation. What is appropriate?

A. Ask the archive administrator to accept it when storing the records.

B. Submit the complete account for the named representative's formal acceptance under the agreed process.

C. Record contractual acceptance using the project manager's technical endorsement.

D. Treat the absence of comments as acceptance without checking the agreed procedure.

Question 125

A manager suggests using a previous warehouse's installation duration for a new site with similar quantities. The new site has shorter access windows and a less experienced crew. Which estimating response best uses the available historical evidence?

A. Discard the historical evidence because any difference makes comparison invalid.

B. Copy the historical duration because equal quantities imply equal working duration.

C. Adjust the analogy for material differences and document the reasoning and uncertainty.

D. Halve the historical duration to allow for learning without examining its conditions.

Question 126

A draft network makes approval depend on testing, testing depend on release, and release depend on that same approval. The team explains that failed tests sometimes require redesign. What is the most defensible way to correct the initial schedule model?

A. Delete whichever relationship produces the longest apparent project duration.

B. Replace the entire loop with three independent fixed-date milestones.

C. Keep the circular links because iteration requires a computational loop in the network.

D. Clarify the distinct release and acceptance stages and represent defined rework scenarios without circular dependencies.

Question 127

On one working calendar, two independent activities start together at day 0 and both must finish before acceptance. A lasts four or eight working days, each with probability one-half; B always lasts six. Resources are separate and acceptance adds no time. What is the expected acceptance time?

A. Eight working days from the common start.

B. Seven working days from the common start.

C. Twelve working days from the common start.

D. Six working days from the common start.

Question 128

A monthly dashboard shows a large improvement in schedule performance. Review finds that several prior actual finishes were corrected and progress quantities reclassified; no additional work was completed during that correction. How should the scheduler explain the change?

A. Reset the baseline so the corrected dashboard starts without an explanation.

B. Describe the full improvement as accelerated production achieved this month.

C. Preserve the published trend and disclose corrections only in an appendix.

D. Separate correction effects from genuine delivery progress and retain the audit trail.

Question 129

On one working calendar, G runs from day 3 to 5 and precedes H, which runs from day 5 to 6. H precedes F, whose earliest start is day 14. These are zero-lag finish-to-start links. How much combined delay can G and H absorb without delaying F?

A. Eight working days shared by the two activities.

B. Nine working days including H's execution time.

C. Eleven working days measured from G's start.

D. Sixteen working days, eight for each activity.

Question 130

Two installation packages contain very different quantities and budgets. The dashboard averages their completion percentages equally, although the agreed project measure uses budget-weighted earned value. The average appears healthier than the weighted result. What should the scheduler recommend for the controlled report?

A. Select whichever measure best matches the sponsor's expected completion date.

B. Retain equal weighting because every package is one schedule activity.

C. Apply the agreed weighting and explain the difference from the simple average.

D. Change the weights each month to reflect which packages appear most important.

Question 131

A project has budget at completion of £200,000, earned value of £80,000 and actual cost of £100,000. The sponsor asks what future cost efficiency is required to finish within the original budget. What to-complete performance index answers that question?

A. 1.20, using remaining budgeted work divided by remaining funds.

B. 0.83, using remaining funds divided by remaining budgeted work.

C. 1.00, using remaining funds divided by remaining funds available.

D. 0.80, using earned value divided by actual cost incurred.

Question 132

A client confirms that an access window shown as available next month will now be closed for maintenance. The closure affects remaining work but does not authorise a baseline change. What is the scheduler's best immediate treatment in the controlled forecast?

A. Leave the calendar unchanged until a revised baseline is authorised.

B. Apply the supported calendar exception and explain its forecast effects.

C. Move affected actual dates to compensate for the future closure.

D. Add an arbitrary lag without recording the specific access restriction.

Question 133

Two projects share a specialist laboratory. Automatic levelling in their separate schedules gives each project the same preferred booking period. Before either baseline is approved, what management arrangement should the scheduler seek through the planning strategy?

A. A statement that the first approved baseline owns every available slot.

B. Agreed cross-project allocation priorities and decision authority, reflected in both schedules.

C. A longer duration allowance in every activity using the laboratory.

D. Independent levelling in each tool using its default activity order.

Question 134

A disputed delay occurred while design responses, access restrictions and contractor resource shortages overlapped. The scheduler is asked to support a factual analysis before any contractual decision. Which initial approach best preserves a defensible basis for that work?

A. Add each party's claimed delay days without checking overlap or logic.

B. Reconstruct contemporaneous status, logic and events before analysing their effects.

C. Treat the current critical path as proof of every historical cause.

D. Assign the entire delay to whichever event was reported first.

Question 135

An activity has used six of its original ten planned working days. A specialist reports that the difficult final testing stage now needs seven further days because several defects remain. What should the scheduler use to prepare the next forecast?

A. Record completion at the original finish and list defects separately.

B. Retain four remaining days because the original duration was ten.

C. Set remaining duration from elapsed days as a percentage of plan.

D. Evaluate the seven-day estimate against defects, resources and remaining scope.

Question 136

A risk review finds that activity-duration distributions already include expected weather interruption, while a separate weather event adds the same interruption again. A management buffer also exists but has a documented different purpose. What should the scheduler do before issuing confidence dates?

A. Retain both weather allowances as a conservative interpretation of uncertainty.

B. Remove unintended double counting and document what each risk allowance covers.

C. Replace the distributions with deterministic durations to avoid explaining overlap.

D. Delete every buffer because simulation already accounts for all uncertainty.

Question 137

A resource library lists qualified welders, a hired crane and welding consumables using one undifferentiated 'units' field. The team wants to test both concurrency and material readiness. What improvement best supports meaningful schedule development and resource analysis?

A. Assign the same daily maximum to people, equipment and total consumable stock.

B. Define resource types, units and availability distinctly, separating renewable capacity from consumable quantities.

C. Remove materials because only labour can influence an activity's feasible start.

D. Treat all listed resources as permanently available once entered in the library.

Question 138

At status boundary day eight, a single remaining FSO chain needs ten working days. Every day is working, and there are no other restrictions. A backward pass is anchored to required completion at day sixteen while retaining the early calculation. What does the chain show?

A. Forecast day ten with six working days of available total float.

B. Forecast day sixteen with zero total float because it is required.

C. Forecast day eighteen with plus two working days total float.

D. Forecast day eighteen with minus two working days total float.

Question 139

After a verified update, the calculated completion forecast is three weeks later than the approved baseline. No scope change or baseline revision has been authorised. A manager asks the scheduler to make the baseline match the forecast before reporting. What is the best response?

A. Remove the delayed activities from the comparison and report unaffected work.

B. Keep the old forecast until a new baseline is approved.

C. Report the variance and retain the approved baseline pending authorised change.

D. Replace the baseline because a current forecast must always match it.

Question 140

On one working calendar, P and Q each require the sole two-person crew; their durations are three and two days. Independent R uses another resource for six days. All can start at day 0 and must finish before completion. Which arrangement preserves the earliest project finish without overallocating the crew?

A. P days 0-3, Q days 6-8, R days 0-6.

B. P days 0-3, Q days 3-5, R days 0-6.

C. P days 0-3, Q days 0-2, R days 0-6.

D. P days 2-5, Q days 5-7, R days 0-6.

Question 141

The authorised scope has been accepted and its actual finish verified. The proposed final EVM report omits a material supplier cost that finance confirms has been incurred but not invoiced. What should the scheduler do when preparing the closeout performance account?

A. Reverse the accepted actual finish until the supplier submits an invoice.

B. Use the approved budget as actual cost for the final report.

C. Exclude the cost permanently because no invoice existed at physical completion.

D. Reconcile the cost cut-off with finance and identify provisional measures until the incurred cost is represented.

Question 142

A work package has earned value of £84,000, actual cost of £100,000 and planned value of £90,000. The data use an agreed accounting cut-off and objective progress measures. What cost performance index should the scheduler calculate for the package?

A. 0.93, meaning £0.93 of earned value per pound spent.

B. 0.90, meaning £0.90 of earned value per pound spent.

C. 0.84, meaning £0.84 of earned value per pound spent.

D. 1.19, meaning £1.19 of earned value per pound spent.

Question 143

A complete network on one calendar forecasts completion at day 16. The backward pass uses a required finish of day 14, while the forward forecast remains unchanged. On its controlling path, what total float should the scheduler expect?

A. Zero days, with the forecast forced to day 14.

B. Minus sixteen days, measured from the required finish.

C. Plus two days, with the forecast still at day 16.

D. Minus two days, with the forecast still at day 16.

Question 144

On one working calendar from day 0, A takes two days, then releases B of four days and C of three days. Both need one shared crew and cannot overlap. D takes two days after both, then E takes one. With zero-lag finish-to-start logic and other resources available, what is the earliest finish?

A. Day 9 after sequencing the shared-crew activities.

B. Day 12 after sequencing the shared-crew activities.

C. Day 11 after sequencing the shared-crew activities.

D. Day 10 after sequencing the shared-crew activities.

Question 145

A team made ten equally counted weekly commitments and completed seven by the agreed cut-off. The other three remain incomplete. Its plan reliability measure is completed commitments divided by total commitments, without weighting for quantities or value. What should the report state?

A. 70% commitment reliability; physical progress requires a separate measure.

B. 30% commitment reliability; physical progress requires a separate measure.

C. 100% commitment reliability if the remaining items finish next week.

D. 70% physical completion; remaining quantities follow directly from it.

Question 146

A proposed recovery option shortens two parallel activities by assigning the same specialist crew to each full time. The resource manager confirms only one crew is available during that period. The option appears to meet the target date. What should happen next?

A. Recalculate feasible crew assignments and compare resulting recovery options.

B. Keep the dates and treat the resource conflict as a delivery issue.

C. Recommend the option because both shortened activities finish before the target.

D. Double the crew calendar hours without checking availability or productivity.

Question 147

A project plans to assess schedule conformance before baseline approval. Management suggests accepting any model with a high overall score, even if a required component is missing. What acceptance rule should the scheduling policy establish?

A. Require applicable mandatory conditions to be met before interpreting the conformance index.

B. Set the passing score equal to the software vendor's standard rating.

C. Use the number of populated catalogue fields as the acceptance score.

D. Allow optional components to compensate for any missing required component.

Question 148

Two parallel packages must both finish for a zero-duration acceptance milestone. Each has an 80 per cent probability of finishing by day 20. Their completion events are independent, resources are sufficient, and no other work controls acceptance. What is the probability of achieving acceptance by day 20?

A. Eighty per cent under the stated independence assumption.

B. Ninety-six per cent under the stated independence assumption.

C. Sixty-four per cent under the stated independence assumption.

D. Forty per cent under the stated independence assumption.

Question 149

A small specialist team performs several technically independent activities, and its availability repeatedly determines delivery. Management is considering critical-chain methods rather than continuing its current CPM-based approach. What is the strongest basis for choosing the scheduling approach?

A. Choose critical chain because its use guarantees a shorter finish.

B. Retain CPM because independent activities cannot form resource conflicts.

C. Select whichever method produces the earliest unconstrained finish.

D. Compare resource treatment, buffer governance and operational suitability using the project's conditions.

Question 150

A change board approves additional testing to mitigate an identified integration risk, its funding and a revised contractual milestone. The decision identifies the affected work packages and takes effect this reporting period. What should the scheduler do before releasing the revised controlled schedule and baseline comparison?

A. Add the testing after release and explain any resulting changes later.

B. Change only the milestone date because the board approved the outcome.

C. Delete the earlier baseline to prevent comparison with superseded information.

D. Integrate the approved impacts and retain traceable links to the decision.

Question 151

A team limits In Progress to three items. Two are being worked and a third is blocked awaiting a decision. A fourth item is ready to pull. Under the team's agreed rule that blocked items remain work in progress, what should happen?

A. Increase the limit informally whenever a ready item would otherwise wait.

B. Pull the fourth item because blocked work no longer consumes work-in-progress capacity.

C. Keep the fourth item ready and address the blockage before exceeding the agreed limit.

D. Move the blocked item to Done so the team can maintain its throughput.

Question 152

Two work tranches are technically ready, but an authorised funding arrangement permits the second tranche to start only from month four. The constraint is confirmed and additional funding is unavailable. What should the scheduler do when preparing the resource-constrained baseline proposal?

A. Hide the second tranche in a summary task with its original early dates.

B. Start both tranches immediately because technical readiness overrides an approved funding restriction.

C. Treat the funding date as an actual start before execution has occurred.

D. Represent the funding restriction transparently, sequence feasible work and recalculate its milestone consequences.

Question 153

Two contractors disagree about an interface date. Their underlying work sequence is accepted, but one forecast assumes a single crew and the other assumes two. Both crew arrangements are technically possible, and the resource manager can decide availability. How should the scheduler facilitate resolution?

A. Compare the two explicit resource scenarios and obtain the resource manager's allocation decision.

B. Choose the forecast supplied by the contractor with the larger package.

C. Adopt the earlier date because it preserves more programme float.

D. Average the proposed dates and seek agreement on the midpoint.

Question 154

A package contains one hundred identical components, each earning acceptance only after installation and testing. Before baselining, the team needs an objective physical-progress rule. Which approach best matches the stated deliverable and supports reliable later performance interpretation?

A. Count every delivered component as complete even when installation has not started.

B. Measure accepted components against the total, with the evidence and counting boundary agreed.

C. Average each person's opinion of progress without retaining acceptance records.

D. Use elapsed activity duration as an automatic measure of accepted physical quantity.

Question 155

Activities use one working-day calendar and finish-to-start relationships with zero lag. B starts at day 3 and lasts four days. Its only successor D cannot start until day 9 because of another predecessor. How much free float does B have?

A. Four working days before delaying D's early start.

B. Six working days before delaying D's early start.

C. Two working days before delaying D's early start.

D. Nine working days before delaying D's early start.

Question 156

Several supervisors will supply weekly progress, one planner will calculate the integrated schedule, and a change board controls baseline revisions. Previous projects confused factual updates with approved changes. What should the schedule management plan make explicit for this project?

A. Require the change board to approve every factual actual-start entry.

B. Separate data provision, checking, forecast calculation and baseline approval responsibilities.

C. Give the planner authority to approve any change entered into the model.

D. Allow each supervisor to revise baseline dates for their own package.

Question 157

A contract permits handover with specified minor documentation outstanding. The authorised client representative has accepted that arrangement, and operations has accepted the remaining actions with due dates. How should the scheduling professional complete the handover record?

A. Remove the transferred actions because their owner is outside the project.

B. Record the accepted boundary and transfer details while retaining the outstanding work's actual status.

C. Reject handover until every activity in the original model is complete.

D. Mark the documentation complete because authorised handover has occurred.

Question 158

The team has retained the final model and its latest baseline but plans to discard earlier accepted updates and change records to simplify closeout. The contract requires a reconstructable schedule history. Which closeout action best meets that requirement?

A. Retain all files anonymously to avoid choosing which versions matter.

B. Keep only the final model because it contains the actual dates.

C. Replace earlier versions with a retrospective narrative prepared at closeout.

D. Retain indexed baselines, relevant updates and decision records under the agreed archive controls.

Question 159

An update contains many newly added mandatory dates that preserve promised finishes despite longer remaining durations. The scheduler finds no approved access restrictions or contractual basis for most of them. What is the best corrective analysis before issuing a credible forecast?

A. Replace remaining durations with shorter values to match the imposed dates.

B. Retain milestone constraints and assume the resulting activity dates are feasible.

C. Retain every date because fixed finishes make the report easier to read.

D. Investigate the dates, remove unsupported constraints and recalculate supported logic.

Question 160

Supervisors report progress on Fridays, procurement updates arrive on Mondays, and the sponsor expects the consolidated forecast on Tuesdays. All parties have agreed to these timings. What should the schedule management plan specify so the release remains interpretable?

A. A separate undisclosed data date for each reporting function.

B. The report-publication date as a substitute for the data date.

C. Automatic acceptance of every late input after the report is issued.

D. A common status cut-off and explicit treatment of late or differently dated inputs.

Question 161

A review ends with agreement on current actuals but unresolved disagreement about future access. The access authority will decide next week. The report must be released today, and the approved process allows a clearly stated provisional assumption. What should the narrative record?

A. The provisional access assumption, competing position, owner, decision date and forecast sensitivity.

B. Unqualified agreement with the forecast because the actuals were accepted.

C. No forecast information until every future assumption becomes certain.

D. The average access date as though all parties had approved it.

Question 162

An incomplete activity in a checked network has early start day four, early finish day nine, late start day seven and late finish day twelve. All boundaries use one working-day calendar. What is its total float under this backward-pass anchor?

A. Three working days, from late start minus early start.

B. Eight working days, from late finish minus early start.

C. Five working days, from early finish minus early start.

D. Two working days, from early finish minus late start.

Question 163

A congested plant room is scheduled with two electricians. An estimate assumes that doubling the crew will halve duration, although only one cabinet can be accessed safely at a time. What should govern the revised duration estimate?

A. A direct inverse relationship between headcount and duration for every installation.

B. The number of people available, regardless of the workfront's access restrictions.

C. The feasible workfront capacity and evidenced productivity of the proposed crew arrangement.

D. The existing duration divided by two because resource costs have doubled.

Question 164

An AI tool proposes a draft activity network from scope documents. It looks plausible, but includes unreferenced approval durations and assumes unlimited specialist resources. What should the scheduler do before recommending this model for baseline review?

A. Seek sponsor approval of the finish date before examining the resource assumptions.

B. Replace uncertain durations with fixed dates so the proposal appears stable.

C. Treat the generated network as assured because its dependency diagram is internally consistent.

D. Validate scope, logic, estimates, calendars and capacity against evidence, then record corrections and assumptions.

Question 165

A task starts on a Monday at 09:00 and requires twenty working hours. Its calendar permits work Monday to Friday from 09:00 to 17:00, with no breaks or holidays. Resources remain available throughout. What is its earliest finish?

A. Wednesday at 12:00 on that calendar.

B. Thursday at 09:00 on that calendar.

C. Tuesday at 17:00 on that calendar.

D. Wednesday at 13:00 on that calendar.

Question 166

A controls supplier's software release enables another contractor's integration test. Both schedules use a milestone named 'Release', but one means code issued and the other means code accepted after verification. What should be resolved before their schedules are integrated?

A. Remove the interface dependency because separate contracts govern each supplier.

B. Rename both milestones identically and assume their definitions are equivalent.

C. Use the earlier date because it offers the programme more flexibility.

D. Agree the handover condition, verification work, owners and matching interface references.

Question 167

A team proposes starting equipment installation before design coordination finishes to recover a late milestone. Some interfaces are stable, while connection details remain unresolved. What analysis best supports a recommendation on whether and how to overlap these activities?

A. Preserve the entire FS relationship until every design detail has approval.

B. Replace the dependency with a fixed date matching the requested recovery.

C. Overlap the full activities because earlier starts necessarily improve completion.

D. Identify releasable scope, interface conditions and rework risks before modelling overlap.

Question 168

The dashboard combines schedule status through Friday with actual cost through the previous month-end. Both datasets are valid, and the accounting team cannot close the later costs before the meeting. How should the scheduler communicate the combined position?

A. Discard the current schedule update until later accounting data is available.

B. State both cut-offs, explain the limitation and avoid presenting mismatched performance measures as fully aligned.

C. Label every measure with Friday's date to give the dashboard one reporting point.

D. Assume the cost position has not changed since month-end.

Question 169

During mobilisation, different suppliers use approved, forecast and target interchangeably in their submissions. All have competent planners, but the integrated report repeatedly mixes desired dates with expected dates. Which strategy-level action most directly prevents the recurring problem?

A. Agree submission definitions, status identifiers and validation rules, then brief all contributors.

B. Let the integration planner infer meaning from each supplier's context.

C. Remove targets from every report to simplify the vocabulary.

D. Adopt the terminology used by the supplier with the largest contract.

Question 170

A draft schedule meets the client's date for equipment delivery, but the signed requirement defines that milestone as equipment delivered, installed and performance-tested. Installation and testing currently finish later. What is the best response during schedule development?

A. Align the milestone with its full contractual condition and evaluate the resulting delivery gap.

B. Use the transport arrival date because it is the first measurable event.

C. Keep the same date and explain the additional obligations only after delivery.

D. Remove testing from the model because the supplier controls its execution.

Answer key

Table C.2 | Practice examination answer key

Question	Answer	Question	Answer
1	B	86	D
2	C	87	B
3	D	88	A
4	D	89	A
5	C	90	A
6	D	91	C
7	C	92	C
8	C	93	C
9	D	94	D
10	C	95	D
11	C	96	C
12	C	97	C
13	C	98	D
14	A	99	C
15	C	100	B
16	B	101	B
17	A	102	A
18	D	103	C
19	B	104	B
20	A	105	A
21	B	106	A
22	B	107	A
23	A	108	A
24	A	109	B
25	A	110	C
26	A	111	C

Question	Answer	Question	Answer
27	C	112	C
28	A	113	C
29	C	114	A
30	C	115	D
31	B	116	A
32	A	117	D
33	B	118	A
34	A	119	C
35	C	120	A
36	A	121	C
37	D	122	D
38	B	123	A
39	D	124	B
40	C	125	C
41	B	126	D
42	C	127	B
43	C	128	D
44	B	129	A
45	A	130	C
46	A	131	A
47	B	132	B
48	B	133	B
49	D	134	B
50	D	135	D
51	B	136	B
52	A	137	B
53	D	138	D
54	C	139	C

Question	Answer	Question	Answer
55	A	140	B
56	D	141	D
57	B	142	C
58	B	143	D
59	C	144	B
60	B	145	A
61	A	146	A
62	D	147	A
63	D	148	C
64	B	149	D
65	D	150	D
66	D	151	C
67	D	152	D
68	B	153	A
69	B	154	B
70	B	155	C
71	B	156	B
72	D	157	B
73	D	158	D
74	C	159	D
75	A	160	D
76	B	161	A
77	A	162	A
78	C	163	C
79	A	164	D
80	A	165	D
81	B	166	D
82	D	167	D

Question	Answer	Question	Answer
83	C	168	B
84	B	169	A
85	B	170	A

Answer explanations

1. Answer B - Critical-chain buffer placement

A feeding buffer protects the controlling sequence from variation in an incoming branch; a project buffer protects overall completion after the final work in that sequence. Their placement and sizing require a reasoned method. Buffer labels alone neither create capacity nor guarantee the required delivery date.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 5; original teaching scenario.

2. Answer C - Resource feasibility and critical paths

CPM dates calculated without resource restrictions do not establish resource feasibility. Incorporating the sole specialist may require sequencing activities, alter controlling paths and change the finish. The recommendation should reflect that feasible model and any supported alternatives, rather than preserve an unattainable parallel assumption.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching scenario.

3. Answer D - Equipment capacity in a resource model

The test rig is a renewable capacity constraint independent of labour availability. Its assignments and calendar must represent the single physical unit, and competing tests must be sequenced accordingly. Sufficient people do not make simultaneous exclusive use of the same equipment feasible.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 6; original teaching scenario.

4. Answer D - Effort and working duration

The quantity requires 120 divided by 0.5, or 240 person-hours. Daily task capacity is four multiplied by six, or 24 person-hours. Dividing effort by capacity gives ten working days. This result depends on the stated productivity, access and availability assumptions.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 3; original teaching example.

5. Answer C - Performance thresholds

A stable finish can conceal declining resilience. Proportionate indicators for controlling interfaces and available margin can reveal emerging decisions before the finish moves. This complements date variance; it does not justify treating every float movement as an executive issue or relying on an average.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

6. Answer D - Confidential stakeholder reporting

The decision requires availability and its scheduling consequences, not necessarily the restricted rates. A targeted report can preserve visibility while respecting agreed access boundaries. Providing all commercial data is excessive; removing every dependency detail would make the forecast harder to understand and challenge.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 2

7. Answer C - Common-cause schedule risk

A shared cause can make activity outcomes dependent, affecting the distribution of completion dates and path switching. Represent that dependence using evidence-based assumptions and test sensitivity. Independent sampling is not justified merely by separate activity identifiers, while imposing simultaneous worst cases answers a different question.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.11.

8. Answer C - WBS completeness and scope boundaries

The WBS should account for the approved scope, including non-physical deliverables. Reconciling training and regulatory submission with appropriate work packages gives later activities a traceable scope basis. Neither contingency nor an unrelated installation activity explains what must be delivered, accepted and owned.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 1; original teaching scenario.

9. Answer D - Uncertain actual dates

An actual date is a factual record, not a convenient substitute for uncertainty. Seek reliable evidence, flag the unresolved status and follow the controlled provisional-data procedure if one exists. Inventing a planned, reporting or favourable date can corrupt later analysis and traceability.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

10. Answer C - Filtered summary visibility

A concise view still needs to show the information essential to its decision. The controlling interface matters regardless of activity cost. Adding all detail may obscure the message, but hiding or removing the dependency misrepresents why the milestone is or is not achievable.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 2

11. Answer C - Pressure to conceal a forecast

A target expresses the desired outcome, while the forecast reflects current assumptions. Both can be communicated without concealing their difference. An accurate briefing should explain what decisions could close the gap; relabelling a target or withholding all information does not create a credible recovery plan.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

12. Answer C - Baseline consensus and controlled release

The necessary review and authority have been obtained, so the baseline should be recorded, preserved and released through the agreed controls. Its supporting basis remains useful for interpretation and future comparisons. Approval does not authorise an unreviewed replacement or eliminate ongoing forecasting.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 11; original teaching scenario.

13. Answer C - Baseline approval authority

Technical readiness and internal support do not replace the stated approval authority. A proposed model may support planning and review if its status is clear. Baseline classification should follow the applicable acceptance process, preserving the distinction between a useful proposal and an approved reference.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 1; PMI (2019), Section 3.1

14. Answer A - Basis of schedule and reproducibility

The basis should explain the project-specific choices behind the calculated dates, with traceable evidence and limitations. Linking it to the model and version lets a reviewer assess assumptions and reproduce the intended calculation. More presentation detail alone does not explain calendars, estimates or interfaces.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

15. Answer C - 4D model and non-geometric work

A visual construction sequence cannot establish completeness for work that has no geometry. Approvals, integration and preparation may control usable delivery and belong in the activity network. Mapping should support the schedule's scope and logic, rather than make geometry the test of inclusion.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 2; original teaching scenario.

16. Answer B - Non-additive delay effects

Separate event effects need not add when parallel paths, common successors and path switching are involved. Calculate the combined network and examine timing and overlap using appropriate evidence. This establishes a scheduling effect; allocation of contractual responsibility requires additional contract-specific analysis.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.1.

17. Answer A - Changing communication needs

A new stakeholder may need a different view of the same controlled facts. Readiness information can be tailored without creating an independent forecast or depriving delivery teams of useful detail. Agreeing the arrangements supports continuing visibility and clarifies which conditions matter to the handover decision.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 2

18. Answer D - Location-based production strategy

Location-based planning makes the interaction between trade rates and available workfronts visible. A later continuous start may avoid repeated waiting while respecting predecessor releases. The appropriate start depends on the release pattern and constraints, rather than room count or a forced project finish.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

19. Answer B - Resource summary interpretation

An accurate aggregate can conceal the particular skill that controls delivery. Showing the specialist requirement connects the summary to the decision without discarding useful overall information. Resource totals cannot establish interchangeability, and changing coding to match a chart would not make the required competence available.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 4

20. Answer A - Restoring stakeholder confidence

A constructive response makes the stakeholder's relevant knowledge visible in the planning process and shows how it affects decisions. Requiring endorsement first or suppressing concerns does not restore trust. Participation should remain within agreed responsibilities; it does not require unrestricted control over the programme.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 1

21. Answer B - Calendar-aware remaining duration

Friday provides eight working hours, leaving eight. The calendar excludes the weekend, so work resumes on Monday at 09:00 and finishes at 17:00. Sixteen working hours are not sixteen elapsed hours; the finish follows the explicitly stated working periods.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

22. Answer B - Audience understanding

The problem is a shared word referring to different events. Distinct labels and explicit conditions allow both audiences to interpret the dates correctly. Removing relevant information or presenting testing availability as an operational commitment conceals the difference rather than establishing common understanding.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 1

23. Answer A - Rolling-wave development

Rolling-wave planning provides detail where it can be supported while retaining future scope, budget and interfaces in planning packages. Later decomposition must reconcile with those boundaries. It is a planning technique, not permission to omit future work or bypass baseline change requirements.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 2; original teaching scenario.

24. Answer A - Quantity-based remaining duration

The remaining quantity requires 144/6 = 24 productive crew-hours. At six productive task-hours each working day, that is 24/6 = four working days. The result depends on the stated productivity, supply and availability assumptions; it is not a universal duration for this quantity.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 2. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.3.

25. Answer A - Missing dependency versus legitimate exception

A diagnostic flag prompts investigation; it is not resolved by arbitrary logic. Establish the actual external prerequisite, its ownership, evidence and uncertainty, then represent the interface appropriately. A documented legitimate exception may be possible, but an unsupported permit assumption needs attention before closure.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.5.

26. Answer A - Out-of-sequence remaining logic

Actual events should remain truthful, while remaining logic must represent the confirmed delivery dependency. Installation having started does not prove its remaining work can proceed independently. Preserve the actual start, model the required approval for remaining work and document the out-of-sequence treatment.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.6.

27. Answer C - Final EVM interpretation

At completed baseline scope, EV divided by PV is one even when delivery finished late. EV divided by AC is 0.90, indicating adverse cost performance. The final report should retain the actual finish comparison; conventional SPI does not express the six-week delay.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 4

28. Answer A - Stable date with growing exposure

Consumed float can reveal reduced resilience before a forecast milestone moves. The narrative should explain that change and any resulting decisions. Float consumption is not automatically equivalent to finish delay, and revising the baseline simply to recreate margin would obscure rather than manage the developing position.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

29. Answer C - Reproducible schedule records

Reproducibility requires the model and the settings, calendars and evidence used for that release, linked through clear version records. A readable report alone may not explain how dates were calculated. Retain enough controlled information to recreate the update and trace subsequent changes.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.7.

30. Answer C - Hidden work in lag

Identifiable work involving different owners and uncertain effort is better represented by explicit activities and approvals, with durations and dependencies that can be updated. A lag alone conceals status, resources and risk. The model should remain proportionate, but visibility matters for these consequential tasks.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.7.

31. Answer B - Fast-tracking with a release gate

The confirmed release creates a defensible basis for selective overlap. Model the actual gate and remaining dependencies, then evaluate the resulting schedule and exposure. Fast-tracking is not a blanket change of relationship types, and its benefit depends on what still controls completion.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching scenario.

32. Answer A - Earned value cost variance

Cost variance is earned value minus actual cost: £100,000 minus £110,000 equals minus £10,000. The completed work cost more than its budgeted value. Planned value supports the schedule comparison; substituting it here would mix two different performance questions.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

33. Answer B - Calendar calculation rules

Calendar interactions depend on the tool and selected settings. A representative calculation checks how working time and resource availability actually affect dates. Recording that configuration helps others reproduce the intended model; a universal intersection rule cannot safely be assumed across applications.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

34. Answer A - Elapsed waiting and working calendars

Curing is a real temporal dependency even if it requires no continuous labour. Its elapsed-time requirement differs from the inspector's working availability. Representing those separately preserves the physical condition for inspection and lets the calendar determine when the inspection can actually occur.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

35. Answer C - Estimate to complete

Estimate to complete is estimate at completion minus actual cost: £210,000 minus £84,000 equals £126,000. This is the remaining expenditure implied by the forecast. It is not automatically an approved additional budget, and its validity depends on the forecast's scope and assumptions.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

36. Answer A - Uncertainty and double counting

A common event should retain its identity and dependency effects in the risk model. Independently adding the same delay to several durations can distort probability and count one cause repeatedly. General duration uncertainty may remain, but its boundary must be reconciled with the named event.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 10; original teaching scenario.

37. Answer D - Earned value schedule variance

Schedule variance is earned value minus planned value: £72,000 minus £80,000 equals minus £8,000. Actual cost belongs in cost variance, not this calculation. The negative result indicates less budgeted work accomplished than planned; it does not directly measure days of delay.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

38. Answer B - Working calendar with closure

Thursday supplies eight working hours. Friday and the weekend supply none, so sixteen hours remain. Monday supplies eight and Tuesday supplies the final eight. The finish is Tuesday at 17:00; the closure changes elapsed time without changing the required working hours.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching example.

39. Answer D - Schedule performance index

The cost-based schedule performance index is earned value divided by planned value, so £45,000 divided by £50,000 equals 0.90. The project has earned less budgeted work than planned. This ratio alone does not identify the critical path or establish the completion date.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

40. Answer C - Choosing decision-relevant detail

The sponsor needs a clear decision comparison grounded in the verified analysis. Supporting detail should remain available for challenge, but should not obscure the outcomes and trade-offs. A preferred date without consequences is incomplete, while a general methodological introduction uses time without resolving the choice.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

41. Answer B - Completion and cost-based SPI

When all approved work is complete, cumulative earned value and planned value can both equal BAC, making cost-based SPI equal one. This does not erase late completion. Compare actual and approved finish dates and use appropriate time-based measures to explain the schedule outcome.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.12.

42. Answer C - Reconciling progress evidence

The agreed measurement rule determines what earns progress. Reconcile the subcontractor report with supported quantities and test evidence, then record the resulting status and unresolved issues. Averaging incompatible measures or accepting an unsupported headline percentage would obscure the package's actual position.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

43. Answer C - Decision deadline versus reporting deadline

The useful decision deadline precedes the routine meeting. Communicating that deadline and the verified trade-off allows the authorised person to act while the option exists. A favourable forecast effect does not imply approval, and a report that omits expiry can arrive too late to support a choice.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 4

44. Answer B - Acceptance milestone definition

The milestone represents an achieved condition, while tests, procedures and training are scheduled work. Linking their accepted completion makes readiness calculable and inspectable. A target date can remain a comparison requirement, but it cannot substitute for the work and authority required for service.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 2; original teaching scenario.

45. Answer A - Location-based continuous crew flow

If B starts at time s, its area starts are s, s+1, s+2 and s+3. These must be at least 2, 4, 6 and 8 respectively. The strongest requirement is s+3 at least 8, so B must start at day 5.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching example.

46. Answer A - Critical-chain resource readiness signal

Under the stated convention, the resource buffer prompts action to make the specialist ready when needed. It is not an additional block of work or proof that capacity exists. Availability and mobilisation arrangements must still support the resource-feasible sequence and its required dates.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 6; original teaching scenario.

47. Answer B - Visible work rather than unexplained lag

Explicit review work can carry its resource, calendar, completion condition and dependencies. A lag alone hides those attributes and can conceal the reason for movement. Equivalent timing is possible only under equivalent assumptions; replacing the lag does not by itself improve the estimate.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

48. Answer B - Changing earning rules

Consistent earning rules support meaningful comparison. A proposed change needs a defensible reason, appropriate approval and transparent treatment of historical comparability. Adopting a more favourable measure without control would change the meaning of earned progress and obscure the performance issue prompting the request.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.8.

49. Answer D - Controlled update release

A controlled release should correspond to the reviewed model and disclose material assumptions affecting its forecast. Resolve the outstanding review or record an explicitly authorised qualification, then reconcile the version references. Verified actuals alone do not establish that the full forecast is ready for release.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.6-3.3.7.

50. Answer D - Composite EAC assumption

CPI and SPI are each 0.80. Remaining budgeted work is £180,000; dividing by 0.80 × 0.80 gives £281,250. Adding £150,000 actual cost produces £431,250. The formula is justified here by the explicit assumption, not by a universal forecasting rule.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

51. Answer B - EAC with remaining work at budgeted rates

Budgeted remaining work is £160,000 minus £60,000, or £100,000. Adding actual cost of £70,000 gives an estimate at completion of £170,000. The calculation retains the incurred overspend while accepting the explicitly stated assumption that future work returns to budgeted rates.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

52. Answer A - Explaining movement between reports

Day 57 is seven working days after the day-50 baseline and three after the day-54 previous forecast. These comparisons serve different purposes. Forecast movement does not itself change an approved baseline, and repeating the previous gap would conceal the latest deterioration.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

53. Answer D - Building stakeholder participation

The recipient holds information needed to make the handover credible. Early involvement can reveal readiness dependencies and build informed support before commitment. More frequent distribution cannot substitute for participation, and forcing agreement or delaying consultation risks preserving assumptions that the receiving organisation cannot meet.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 1

54. Answer C - Remaining network forecast

The A-B branch needs seven working days, while C needs six. D starts after the longer branch and adds two days, giving nine remaining days. Adding nine to the day-10 status boundary gives day 19, under the stated logic, resource and calendar assumptions.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.1.

55. Answer A - Information access strategy

Configuration arrangements should support authorised access without exposing unrelated commercial data. Agreed exchange content and permissions can preserve the logic needed for integration. Uncontrolled access breaches the requirement, while arbitrary deletion or milestone-only reporting may prevent meaningful schedule analysis.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 1; PMI (2019), Section 3.1

56. Answer D - Strategic trade-offs and delegated authority

The stated priority and delegated authority already establish the decision basis. A feasible strategy that protects the essential date within the ceiling can be recommended with its assumptions. Unnecessary escalation delays action, and averaging alternatives does not create a technically achievable compromise.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 2; PMI (2019), Section 3.1

57. Answer B - Activity granularity

Rolling-wave detail can reflect increasing knowledge while retaining the full scope and its interfaces. The policy needs rules for elaboration and change control. Omitting later work understates the project, while speculative uniform detail or a frozen model does not improve forecast credibility.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

58. Answer B - Lean make-ready and commitment

The necessary make-ready conditions are satisfied, so the team can make an explicit, achievable commitment and coordinate delivery. Further investigation without a material unanswered question would add little. Short-term commitments remain connected to wider milestones and require follow-up on actual completion.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching scenario.

59. Answer C - Hybrid release and programme alignment

Different delivery methods can coexist when their interfaces and higher-level commitments are explicit. Shared integration conditions connect iterative product work to construction and launch readiness. Alignment does not require identical granularity, but isolated plans or unqualified backlog dates cannot establish a credible integrated milestone.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 8; original teaching scenario.

60. Answer B - Completion criteria and acceptance

Completion follows the agreed scope and acceptance criteria, not the invoice or a partial physical achievement. The outstanding witnessed test should remain visible in status and remaining logic. A change to the measurement rule or scope requires its own controlled justification and approval.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

61. Answer A - Progress policy

Effort consumption, accepted physical progress and duration progress answer different questions. Their definitions and evidence must be agreed before combining reports or deriving earned value. A uniform column heading cannot make unlike measures comparable, and averaging them would obscure their meaning.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

62. Answer D - Explaining forecast variance

Decision-useful analysis connects the verified position to its driving causes and the consequences of feasible alternatives. Compare resource assumptions, risks and milestone effects so the sponsor can choose. More dates or a single percentage do not explain the change or validate a recovery recommendation.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.3 and 3.3.6.

63. Answer D - Tool interoperability

Matching displayed dates does not demonstrate that transferred models calculate consistently. A representative exchange should test the scheduling behaviours the project needs, including calendars and settings. Selection should reflect functional requirements and reproducibility, rather than a superficial demonstration or a field-count comparison.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

64. Answer B - Adaptive planning within authorised boundaries

Adaptive detail can evolve without erasing external obligations. The team should maintain a traceable relationship between work, accepted outcomes and the approval evidence. Reprioritisation within authorised boundaries is different from changing those boundaries; material changes to commitments require the applicable decision process.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 8; original teaching scenario.

65. Answer D - External interface status evidence

Acknowledging an application is not confirming the operational slot or completing energisation. Keep the external interface visible, seek the missing evidence and model the effect of unresolved conditions on the forecast. Internal physical progress cannot substitute for an external prerequisite controlling commissioning.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

66. Answer D - Manual forecast-date overrides

A controlled forecast should reconcile to the supported schedule model and its assumptions. A separate recovery scenario can be useful if explicitly identified and evaluated. Unexplained manual overrides create conflicting records and conceal the difference between an achievable forecast and an untested commitment.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.6-3.3.7.

67. Answer D - Earned schedule interpolation

Earned value is halfway between the planned values at weeks five and six, so earned schedule is 5.5 weeks. Dividing this by actual time of seven weeks gives approximately 0.79. The interpolation assumes a linear planned-value segment and consistent scope and measurement.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.12.

68. Answer B - Mixed delivery approaches

The different levels of scope certainty support different planning approaches, while the shared test requires coordinated interfaces. An integrated forecast can combine them. Uniform detail is not inherently better, and separate forecasts without managed dependencies leave integration readiness uncertain.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 2; PMI (2019), Section 3.1

69. Answer B - EVM implementation strategy

Reliable actual costs alone cannot establish earned value. Planned value requires a time-phased budget, and earning needs defined work and suitable completion evidence. Elapsed time or money spent may be useful data, but neither automatically measures the budgeted value of completed work.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

70. Answer B - Activity definition and completion evidence

The broad label combines work with different access and acceptance conditions. Decomposition should make each activity sufficiently clear to estimate, sequence, resource and later status. This is not an instruction to maximise detail: boundaries should reflect meaningful control and completion evidence.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 2; original teaching scenario.

71. Answer B - Correction after issue

The authorised correction should reach those who may act on the error immediately, with clear version status. The model and baseline are not the source of this mistake. Delaying the correction or changing correct underlying data would turn a publication problem into a delivery or control problem.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

72. Answer D - Conditional supplier forecast

The offered date is conditional evidence, not a confirmed commitment. Model credible alternatives or uncertainty, identify the unresolved decisions and explain their milestone consequences. This enables a decision with visible limits; neither silently accepting the date nor omitting the dependency improves credibility.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.11.

73. Answer D - Rolling-wave detail in an update

Rolling-wave elaboration develops authorised scope as information matures. Maintain traceability to the planning package, establish credible logic and resources, and assess any resulting forecast or baseline implications through the agreed process. More detail does not automatically mean scope growth or justify artificial dates.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.2-3.3.4.

74. Answer C - Approved additional capacity during planning

The required evidence and authority are already available, so the decision should be incorporated into the draft. Recalculation is still necessary because another path or interface may then control completion. The resulting proposal should retain the estimate basis and consequences for baseline review.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching scenario.

75. Answer A - Different meanings of progress

Quantity, effort and elapsed duration measure different aspects of work. Label them clearly and apply the agreed basis for physical progress or earned value. Averaging or choosing the most favourable figure creates a measure without a defensible meaning and can distort remaining-work forecasts.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

76. Answer B - Out-of-sequence progress communication

Historical facts and the forecast for remaining work have different roles. The genuine start should be preserved, while the required dependency still governs continuation under the stated settings. Deleting actuals or assuming that an early start removes all prerequisites would misrepresent the situation.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

77. Answer A - Closing assurance findings

Closure should depend on evidence that addresses the finding and its implications, not merely an assertion. Seek a proportionate estimate basis or supplier confirmation, assess the resulting schedule effect and record the review. A favourable target date does not validate an unsupported assumption.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.

78. Answer C - Team participation and capability

Effective participation requires understanding the information expected and why it matters. A practical briefing can connect the owners' work knowledge to agreed reporting definitions. Receipt of a document is insufficient, while removing owners or imposing unrelated qualifications can weaken the flow of useful evidence.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 5; PMI (2019), Section 3.1

79. Answer A - Communicating a risk percentile

A percentile describes modelled outcomes under stated assumptions, including the scope and responses analysed. It does not guarantee real delivery or authorise a commitment. Clear communication should connect the result to those assumptions and the decision being considered, rather than change labels to reassure recipients.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

80. Answer A - EAC assuming continuing cost efficiency

Cumulative cost performance index is £96,000 divided by £120,000, or 0.80. Under the stated continuing-efficiency assumption, estimate at completion is £240,000 divided by 0.80, giving £300,000. An alternative forecast using original remaining rates would answer a different assumption.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

81. Answer B - Near-critical path monitoring

Small float combined with uncertainty can make a near-critical branch a future driver of completion. Monitor its evidence, resources, risks and forecast movement alongside the current critical path. Artificially changing float or limiting attention to today’s zero-float activities weakens the analysis.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.1 and 3.4.11.

82. Answer D - Parametric estimating

Reducing 30 metres per crew-day by 25 per cent gives 22.5 metres per crew-day. The duration is 270 divided by 22.5, or twelve working days. Reducing productivity requires division by the new rate; simply adding 25 per cent to nine days is incorrect.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 3; original teaching example.

83. Answer C - Conformance required-component failure

The applicable required-component gate has failed, regardless of the optional points or raw total. The assessor should identify the missing requirement and its correction; a conforming component index is not justified. Optional features cannot compensate for an unsatisfied applicable required component.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, Appendix X4.

84. Answer B - Tool selection and governance

Tool capability must be assessed against mandatory governance as well as analytical needs. Advanced features do not offset missing required controls. A justified alternative remains possible if its gaps are addressed and approved, but buying tools or assuming user competence does not resolve those gaps.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

85. Answer B - Urgent escalation

The facts and decision boundary are already established, and waiting would remove a useful option. Prompt escalation should focus on the choice the executive can authorise. Verification of a benefit does not confer authority to commit expenditure, while another general update would not resolve the decision.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 4

86. Answer D - Start-to-start relationship

The relationship requires B to start no earlier than three days after A starts. A starts at day 2, so B can start at day 5. Adding B's four-day duration gives day 9. A's finish is not the relationship's controlling event.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching example.

87. Answer B - Baseline configuration control

A valid revision should not erase the original reference or its approval history. Identified versions and linked decisions support comparison and reconstruction. Prohibiting all revision ignores authorised scope change, while unclassified file collections or a single remembered finish date do not preserve adequate context.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 1; PMI (2019), Section 3.1

88. Answer A - Conformance versus feasibility

Component conformance and resource feasibility answer different questions. A favourable index does not supply an unavailable crane or prove the forecast is deliverable. Retain the valid assessment, identify the unresolved conflict and evaluate feasible assignments or alternatives before recommending an unconditional milestone.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, Appendix X4 and section 3.4.10.

89. Answer A - Forward pass and controlling path

A finishes at day 3. B finishes at day 7 and C at day 9. D must wait for the later predecessor, so it runs from day 9 to day 11. The controlling sequence is A, C and D.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 5; original teaching example.

90. Answer A - Negative float message

The checked model indicates a shortfall against the imposed date under current assumptions. Communication should connect that finding to feasible choices and authority. Negative float is not a guarantee of the eventual outcome, and changing the reference or concealing the forecast does not resolve the delivery problem.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

91. Answer C - Refreshing risk analysis after change

A confidence date is conditional on the model, data and assumptions used to calculate it. Changed seasonality and resource dependence can alter its distribution. Update and validate those assumptions, rerun the analysis and explain the changed exposure before reusing or replacing the reported percentile.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.11.

92. Answer C - Required dates and dynamic forecasts

The model should expose the difference between the requirement and the calculated outcome. Preserving valid logic supports analysis of actual response options. Hard constraints or unsupported duration reductions can hide the gap while leaving the underlying delivery problem unresolved and its consequences untested.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 9; original teaching scenario.

93. Answer C - Analysis strategy under uncertainty

Limited historical data does not remove uncertainty or justify arbitrary distributions. Structured expert input and explicit assumptions can support proportionate analysis, with sensitivity checks exposing important judgements. A numerical percentile is only as meaningful as the model and evidence from which it is produced.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 2; PMI (2019), Section 3.1

94. Answer D - Archive reconstruction test

Opening a file demonstrates access, not the ability to reproduce its scheduling behaviour. Missing calendars and settings explain why further archive work is needed. Checksums can detect changes to a file, but cannot supply absent configuration or establish that the reconstructed model matches the issued position.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 5

95. Answer D - Time-zone interfaces

A common day label can conceal incompatible handover times across regions. An explicit time zone and required receipt time make the interface testable. A buffer may later be justified, but it does not replace agreement on what the supplier must deliver and when the receiver needs it.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 4

96. Answer C - Consistent cost and progress cut-off

Earned value and actual cost must be compared on a consistent scope and cut-off basis. Work incurred but not yet invoiced may require accrual under the stated policy. Reconcile with the cost controller so that payment timing does not create a misleading efficiency signal.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1.

97. Answer C - Unapproved scenario communication

A scenario can inform decisions before it is authorised, provided its status and dependencies are explicit. Technical feasibility alone does not make it the current agreed forecast or baseline. Withholding all options until approval would prevent managers from comparing the very choices they must decide.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

98. Answer D - Discrete work and level of effort

Classification should reflect the nature and control purpose of the work rather than the owner's job title. Ongoing coordination can be represented as support, while the inspection has a distinct completion condition and downstream consequence. Its required execution and acceptance must remain visible in the model.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 2; original teaching scenario.

99. Answer C - Criticality with different calendars

Different calendars and constraints can complicate interpretation of total float. Trace the relationships actually driving the relevant milestone and examine calendar and constraint effects. Float remains useful, but a numerical ranking alone may not fully explain the sequence determining the forecast finish.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.1-3.4.4.

100. Answer B - Contract and change procedures

Notification, impact assessment and approval serve different purposes and may have different timing requirements. The scheduling arrangements should preserve each process and its authority. Waiting for full quantification may miss a stated obligation; notifying an event does not itself authorise a baseline revision.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 4; PMI (2019), Section 3.1

101. Answer B - Schedule levels and reporting

Audience-specific detail is legitimate, but independently edited dates create conflicting accounts. Controlled data can support summary and detailed views while retaining common milestones and interfaces. Neither a single high-level chart nor maximum detail in every report satisfies all planning and communication needs.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

102. Answer A - Confirmed calendar correction

The discrepancy has been checked and the procedure already permits correction. Recalculating before release restores the model's agreed basis, while explaining the movement prevents misunderstanding. Another approval cycle is unnecessary under the stated authority, and altering the shutdown dates would not correct the omission.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

103. Answer C - Control accounts and responsibility

Control accounts are selected management points for integrating scope, responsibility and budget. The existence of a WBS-organisation intersection does not itself justify an account, particularly where no work exists. The structure should support practical control without obscuring ownership or creating empty administrative units.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 1; original teaching scenario.

104. Answer B - Time-phased planned cost

The first assignment consumes twelve person-days and the second six, giving eighteen person-days. At £350 each, labour costs £6,300. Adding £1,600 setup produces £7,900. Time-phasing allocates this planned cost to work periods; it does not determine when invoices are paid.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 12; original teaching example.

105. Answer A - Conformance index after the required gate

The required gate has passed, so the component index can be calculated. Total points are 56 + 27 = 83; 83/111 × 100 gives approximately 74.8%. Passing required components permits the index calculation but does not automatically produce a perfect score or prove deliverability.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, Appendix X4.

106. Answer A - Discrete completion-date percentile

Cumulative probability is 25% at day 18 and 75% at day 20. It reaches 100% at day 24, the first supported date meeting at least 80%. Interpolating an unsupported outcome would change the explicitly discrete distribution used in this question.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.11.

107. Answer A - Closing the communication loop

Acknowledgement demonstrates receipt, not necessarily understanding or action. Confirming interpretation connects the authorised date to the receiving team's decisions. Repeated distribution alone may preserve the misunderstanding, while changing a verified date to match an outdated staffing plan would conceal the coordination problem.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 1

108. Answer A - Programme integration strategy

An external dependency remains relevant even when its work is outside the project's control. A managed interface with an identified owner, reliable information exchanges and explicit links supports integration. Copying unowned detail or imposing a date does not create control over the external party.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 4; PMI (2019), Section 3.1

109. Answer B - Performance measurement baseline integration

The performance measurement baseline connects authorised scope and its budget with the time-phased plan for accomplishing work. Uniform monthly spreading would misrepresent an uneven plan unless it were justified by that work. Invoice timing and forecast expenditure answer different questions from planned accomplishment.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 12; original teaching scenario.

110. Answer C - PERT expected duration

The weighted mean is (2 + 4 × 5 + 14)/6 = 6 working days. The conventional standard deviation is (14 - 2)/6 = 2 working days. These are estimates from the stated approximation, not guaranteed bounds on actual completion.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.3.

111. Answer C - Calendar conventions

Calendar assignments and time-unit conventions determine how a duration becomes a date. Continuous tests and weekday work may need different calendars. Clear conventions preserve those real conditions; forcing one calendar or leaving the meaning of a day to the reader can distort comparisons.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

112. Answer C - Location-based method selection

Location-based planning can expose trade movement, handovers and crew continuity, while linked milestones retain contractual visibility. The methods can complement each other. Simultaneous target starts do not prove feasibility, and an average rate alone does not show every required interface or completion event.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 2; PMI (2019), Section 3.1

113. Answer C - Three-point PERT calculation

The weighted mean is (4 + 4 × 7 + 16) divided by 6, which equals eight days. The approximate standard deviation is (16 - 4) divided by 6, or two days. These formulas alone do not establish a normal project-finish distribution.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 3; original teaching example.

114. Answer A - Evaluation of scheduling approach

Outcome alone does not establish process quality. Feedback from contributors and users can explain reconciliation burdens and missed warnings, revealing improvements to information flow and decision support. Dashboard appearance and a tool replacement cannot substitute for understanding why the scheduling approach did or did not help.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 2

115. Answer D - Level-of-effort masking

Time-related level-of-effort progress can make an aggregate indicator appear healthy while discrete deliverables remain late. Examine the discrete work and current driving logic as well as the total measure. The appropriate response is transparent analysis, not an unauthorised baseline change or unsupported inference.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

116. Answer A - Finish-to-finish relationship

A finishes at day 7. The finish-to-finish relationship means B cannot finish before day 9. Subtracting B's four-day duration gives an earliest start of day 5. The lag governs the two finish events, rather than postponing B's start until A finishes.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching example.

117. Answer D - Critical path switching during recovery

Recovery decisions should follow the current driving logic after each change. Shortening a branch that no longer controls completion may provide float but no immediate completion benefit. Reassess the new critical and near-critical work, feasibility, cost and risk before recommending further acceleration.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 4. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.1.

118. Answer A - Status-date integrity

A frozen update must represent conditions at its stated cut-off. Record the supported June status and preserve the later completion evidence for the appropriate subsequent update. Mixing a July actual into a June position distorts progress and comparisons, even when the later event is genuine.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1-3.3.2.

119. Answer C - Original and revised references

The final result is seven weeks after the original reference and three after the revised one. Both comparisons are useful, but the original spans authorised scope change. The differences alone do not assign inefficiency or responsibility; the final account needs the change context.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 2

120. Answer A - Resource levelling transparency

Resource feasibility can change dates without changing technical durations or relationships. Explain the shared capacity, levelling priorities and resulting sequence, retaining a traceable basis for the forecast. Concealing the resource decision as logic or silently changing the baseline would weaken control and comparability.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 2. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.10.

121. Answer C - Backward pass and total float

R starts at day 5 and finishes at day 8. In the backward pass Q must finish by day 5, so its latest start is day 3. Its earliest start is day 0; total float is therefore three working days.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 5; original teaching example.

122. Answer D - Reusable productivity evidence

The recorded ratio is six labour-hours per accepted unit, not an elapsed duration. Its usefulness depends on understanding the included effort and conditions. Preserving context lets future planners assess comparability; deleting adverse evidence or substituting the original estimate prevents learning from the actual experience.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 3

123. Answer A - Early termination

Termination changes what will be delivered but does not retrospectively complete cancelled work. The final account should distinguish genuine actuals, authorised cancellation and surviving obligations. This supports an honest explanation of the outcome and provides continuing owners with a clear basis for managing remaining responsibilities.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 2

124. Answer B - Final acceptance authority

Technical review supports the acceptance decision but does not replace its designated authority. With the evidence ready, the appropriate next action is to obtain that decision through the stated process. Storage, internal endorsement or silence cannot automatically satisfy a separately assigned contractual acceptance obligation.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 1

125. Answer C - Analogous duration estimates

Analogy is useful when the earlier work and its conditions are understood. Access and crew capability can materially affect productive time and output. Adjusting for those differences, while recording the evidence and uncertainty, is more defensible than copying the duration or rejecting all comparison.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 3; original teaching scenario.

126. Answer D - Circular logic and rework

The current loop prevents a valid precedence calculation and may confuse different approval stages. Clarify the real sequence, including what authorises testing and what constitutes final acceptance. Possible rework can then be modelled through explicit scenarios or defined additional work, rather than circular logic.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

127. Answer B - Expected duration at a parallel merge

Acceptance occurs at the later finish. When A takes four days, B controls and acceptance occurs at day 6; when A takes eight days, acceptance occurs at day 8. Their equally weighted mean is seven days, not the maximum of mean durations.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 10; original teaching example.

128. Answer D - Apparent improvement from data correction

Correcting erroneous data may be necessary, but its effect should be distinguished from work newly accomplished. Preserve the original and corrected records, explain the basis and reconcile the trend. Otherwise stakeholders may mistake a measurement correction for a real improvement in delivery performance.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.7.

129. Answer A - Shared float along a path

The path ends at day 6 and F starts at day 14, leaving eight working days between them. A delay to G can propagate through H and consume that same allowance. Adding their individual total floats would count shared flexibility twice.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 5; original teaching example.

130. Answer C - Progress weighting and comparability

The controlled measure should follow the agreed weighting and consistent earning rules. Equal averaging can misrepresent progress when packages differ substantially in size or value. Explain the discrepancy transparently; changing weights to improve the result would undermine comparability and the credibility of performance trends.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

131. Answer A - To-complete performance index

To finish within BAC, TCPI is (BAC - EV)/(BAC - AC). Remaining budgeted work is £120,000 and remaining funds are £100,000, giving 1.20. This required future efficiency is a feasibility challenge, not evidence that the original budget will necessarily be achieved.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

132. Answer B - Calendar exception update

The forecast should reflect confirmed future access restrictions using an appropriate calendar exception or clearly modelled access constraint. Recalculate and explain the effect while preserving the authorised baseline. A forecast update is not permission to rewrite actual events or silently change the comparison reference.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.2.

133. Answer B - Resource-priority policy

Local calculations cannot resolve competing claims on a shared resource unless common allocation rules and authority exist. Agreed priorities should inform both schedules. Default activity ordering, blanket duration allowances or an assumed ownership rule do not establish a feasible programme-level resource commitment.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 4; PMI (2019), Section 3.1

134. Answer B - Delay records and attribution

Start with reliable contemporaneous records, the schedule position at relevant times and the actual event sequence. Analyse how events affected work and completion before attributing consequences. Overlap alone does not establish contractual concurrency or entitlement, and today's critical path may differ from historical drivers.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.7.

135. Answer D - Remaining duration reassessment

Remaining duration should reflect a supported estimate of remaining work, including defects and resource availability. Elapsed time does not establish physical progress or prove that the original duration remains achievable. Evaluate the specialist's evidence, update the forecast and explain the variance.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 1. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.1.

136. Answer B - Contingency double counting

Risk allowances should have clear boundaries so the same effect is not counted unintentionally twice. Reconcile the distributions and event model while preserving separately justified allowances. More contingency is not automatically more credible; the forecast must represent the intended uncertainty model transparently.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.11.

137. Answer B - Resource dictionary and consumable stock

People and equipment usually provide renewable capacity over working periods, while consumables require quantities and replenishment assumptions. A useful dictionary states the relevant units, availability and calendars or supply conditions. Treating unlike resources identically can hide both concurrency conflicts and material shortages.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 6; original teaching scenario.

138. Answer D - Negative float and required completion

The early forecast is day eight plus ten remaining days, or day eighteen. Anchoring the backward pass at day sixteen produces total float of minus two working days. This exposes a two-day conflict with the requirement; it does not automatically shorten the work.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.2.

139. Answer C - Forecast versus baseline

A forecast describes the current expected outcome; the approved baseline remains the reference for measuring deviation. Record and explain the variance and evaluate responses. Replacing the reference without authorisation would hide performance, while withholding the forecast would conceal information needed for a decision.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 6. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.3-3.3.5.

140. Answer B - Resource smoothing within available float

R fixes the earliest possible completion at day 6. Sequencing P and Q during days 0-5 respects the sole crew and leaves completion unchanged. Running them simultaneously exceeds capacity, while placing Q beyond day 6 unnecessarily extends the project.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching example.

141. Answer D - Cost cut-off at closeout

Physical acceptance and accounting completeness are different matters. The performance account should reflect a consistent cost basis and disclose provisional measures while finance resolves the incurred amount. Changing genuine actual dates or substituting budget for cost would not correct the reporting boundary problem.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 4

142. Answer C - Cost performance index

Cost performance index equals earned value divided by actual cost: £84,000 divided by £100,000 equals 0.84. Each pound spent has produced £0.84 of budgeted completed work. This is a cost-efficiency measure and should not be presented as a direct measure of time efficiency.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

143. Answer D - Negative float and required completion

The required finish is two days earlier than the calculated completion, producing minus two days of total float on the controlling path under these assumptions. Negative float signals an unmet requirement; it does not demonstrate a feasible two-day reduction or move the forecast itself.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 5; original teaching example.

144. Answer B - Resource-constrained finish

A occupies days 0-2. The shared crew then needs seven days for B and C in either order, finishing at day 9. D finishes at day 11 and E at day 12. Unconstrained parallel execution would violate the stated resource limit.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching example.

145. Answer A - Plan reliability versus physical progress

Seven completed commitments divided by ten promised commitments gives 70% plan reliability. It says how reliably commitments were met, not what proportion of the total project's quantities, effort or value is complete. Later completion does not retrospectively satisfy this reporting cut-off.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3.

146. Answer A - Recovery resource feasibility

An option is not feasible merely because its unrestrained dates meet a target. Reconcile simultaneous demand with confirmed capacity, recalculate the schedule and compare realistic alternatives. Additional crews, changed sequencing or calendars may help, but each requires evidence of availability and likely productivity.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 4. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.10.

147. Answer A - Assurance acceptance criteria

The standard's required-component gate cannot be replaced by a favourable aggregate score. Applicable requirements must be satisfied before the index is interpreted. Optional information and populated fields may add value, but cannot compensate for an unmet mandatory condition or establish overall delivery feasibility.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Sections 5.1-5.2 and Appendix X3

148. Answer C - Milestone confidence at an independent merge

Both completion events must occur, so their independent probabilities multiply: 0.8 × 0.8 equals 0.64. An individual package's confidence cannot simply be assigned to the merge milestone. Common risks or correlated durations would require a different joint model.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 10; original teaching example.

149. Answer D - Method selection under resource constraints

Method selection should reflect how work is controlled, including scarce resources and the organisation's ability to manage buffers. Neither method guarantees superior delivery. An unconstrained early finish can be infeasible, and technical independence does not mean that activities can use the same scarce team simultaneously.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 2; PMI (2019), Section 3.1

150. Answer D - Implementing an authorised change

Approved changes must be integrated consistently into scope, logic, resources and relevant baselines, with the decision and previous versions retained. Changing only a headline date can leave the underlying model inconsistent. Traceability explains what changed, when it took effect and under whose authority.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 5. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.4-3.3.8.

151. Answer C - Kanban work-in-progress capacity

The blocked item remains within the stated work-in-progress limit, so capacity is already full. The team should address the blockage or use its explicit policy for changing limits. Reclassifying unfinished work or ignoring the limit would misrepresent flow and weaken the agreed control.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching scenario.

152. Answer D - Funding availability as a planning constraint

The confirmed funding restriction affects what can feasibly be undertaken and should be represented with a documented basis. Recalculation shows its effect on milestones and resource use. Technical readiness alone does not remove the constraint, and a planned date cannot be recorded as an actual.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 7; original teaching scenario.

153. Answer A - Disagreement about crew assumptions

The disagreement concerns an identifiable resource assumption rather than an unexplained difference in dates. Comparing controlled scenarios lets the authorised resource decision resolve it. An average or preference for an earlier date does not establish which crew arrangement will actually be available.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 1

154. Answer B - Progress measurement designed before execution

For identical components with the specified acceptance condition, accepted quantity divided by total quantity provides a clear physical measure. Its evidence and boundary should be agreed before use. Duration, delivery and effort may be useful separate measures, but they do not establish the same accomplishment.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 12; original teaching scenario.

155. Answer C - Free float at a merge

B finishes at day 7. Its free float is the successor's earliest start, day 9, minus B's earliest finish, day 7: two days. This calculation uses the specified zero-lag finish-to-start relationship and the same working-time units throughout.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 5; original teaching example.

156. Answer B - Update responsibilities

Actual records, forecast recalculation and baseline change approval are distinct responsibilities. Defining them prevents routine updates from becoming unauthorised changes without burdening the change board with every factual entry. The planner's technical role does not itself confer approval authority over scope or baselines.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

157. Answer B - Transferred residual obligations

The authorised arrangement permits the transition, but it does not make unfinished documentation an accomplished fact. Retaining status, owners and due dates preserves accountability. Insisting on universal completion ignores the stated agreement, while deleting the actions loses the record of what continues after handover.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 1

158. Answer D - Archive completeness

Reconstruction requires identifiable versions and the contemporaneous reasons for important changes, not merely final dates. An indexed archive can meet the stated requirement while distinguishing authority and chronology. A retrospective narrative may help interpretation but cannot replace the missing records on which it should rely.

Domain 4: Schedule Closeout. Source focus: PMI-SP ECO Domain 4 Task 5

159. Answer D - Artificial date constraints

Unsupported mandatory dates can mask the consequences of remaining work and distort float. Investigate their purpose, retain justified constraints and correct unsupported ones through controlled review. Recalculate with credible durations and logic so that the forecast exposes the delivery problem instead of concealing it.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.4.

160. Answer D - Information cut-off policy

Publication timing does not by itself establish the status represented by the model. A defined cut-off and agreed handling of late or differently dated information make the consolidated position understandable. Inputs arriving on different days can still be reconciled under a transparent reporting policy.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 3; PMI (2019), Section 3.1

161. Answer A - Recording unresolved disagreement

The approved process permits a qualified forecast, so the unresolved issue should be visible rather than disguised as consensus. Recording ownership, timing and sensitivity lets recipients understand its significance. Agreement on actuals does not settle future access, and averaging positions does not create an authorised assumption.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

162. Answer A - Total float calculation

Total float is late start minus early start, or equivalently late finish minus early finish. Both calculations give three working days. The five-day difference between early start and early finish is duration. Float depends on the network, calendar and chosen backward-pass anchor.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 3. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.4.2.

163. Answer C - Crew size and productivity

Additional people shorten work only where tasks, space, skills and access permit useful parallel effort. The single accessible cabinet may remain the limiting workfront. Estimate the proposed method's feasible output rather than assume that labour headcount and duration always have a linear relationship.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 3; original teaching scenario.

164. Answer D - AI-assisted schedule development

Generated content is a proposal requiring the same substantive checks as any other draft. Unreferenced durations and unlimited-resource assumptions may produce misleading dates despite a plausible diagram. Validation and documented corrections allow accountable people to assess the model before baseline authorisation.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching scenario.

165. Answer D - Working hours and finish time

Monday and Tuesday each provide eight hours, using sixteen of the twenty required hours. Four hours remain on Wednesday, from 09:00 until 13:00. Working duration must be accumulated through the defined calendar rather than added continuously across nights.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 4; original teaching example.

166. Answer D - Programme interface integration

Matching milestone names does not establish matching delivery conditions. The producer and receiver must agree what constitutes a usable release and identify any verification work. Consistent owners and references then allow the integrated model to represent the dependency and reveal changed handover assumptions.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 8; original teaching scenario.

167. Answer D - Fast-tracking readiness

Fast-tracking can be viable where separable scope is sufficiently stable, but unresolved interfaces may create rework or unsafe assumptions. Identify what can genuinely be released, the necessary conditions and residual risks, then model and compare the revised sequence before seeking the relevant decision.

Domain 3: Schedule Monitoring and Controlling. Source focus: PMI-SP Examination Content Outline (2012), Domain 3, Task 4. PMI (2019), Practice Standard for Scheduling, Third Edition, section 3.3.3.

168. Answer B - Different information cut-offs

Valid datasets can describe different periods. Stating their boundaries lets recipients understand what can be compared and which measures are provisional. Relabelling dates or assuming no change creates false consistency; suppressing useful current schedule information is not necessary when its limitations are made clear.

Domain 5: Stakeholder Communications Management. Source focus: PMI-SP ECO Domain 5 Task 3

169. Answer A - Shared scheduling terminology

Common definitions and submission rules establish what contributors must provide and what reviewers must check. Briefing them supports consistent participation. Supplier size does not determine meaning, and targets can be useful when distinguished clearly; relying on one planner's inference creates avoidable ambiguity.

Domain 1: Schedule Strategy. Source focus: PMI-SP ECO Domain 1 Task 5; PMI (2019), Section 3.1

170. Answer A - Milestone obligations and deliverable scope

The milestone must represent the agreed obligation, not a narrower interpretation that happens to fit the desired date. Linking installation and accepted testing exposes the true gap and supports feasible alternatives. Responsibility being external does not remove a dependency from the integrated delivery model.

Domain 2: Schedule Planning and Development. Source focus: PMI-SP Examination Content Outline (2012), Domain 2, Task 9; original teaching scenario.

Domain performance index

Divide each domain subtotal by its question count for a diagnostic practice percentage. This is not a PMI scaled score or a pass prediction.

Table C.3 | Question mapping for diagnosis by domain

Domain	Questions	Question numbers
1. Schedule Strategy	24	5, 13, 55, 56, 57, 61, 63, 68, 69, 78, 84, 87, 93, 100, 101, 108, 111, 112, 133, 147, 149, 156, 160, 169
2. Schedule Planning and Development	53	1, 2, 3, 4, 8, 12, 14, 15, 18, 23, 31, 33, 34, 36, 38, 44, 45, 46, 47, 58, 59, 64, 70, 74, 82, 86, 89, 92, 98, 103, 104, 109, 113, 116, 121, 125, 126, 127, 129, 137, 140, 143, 144, 148, 151, 152, 154, 155, 163, 164, 165, 166, 170
3. Schedule Monitoring and Controlling	59	7, 9, 16, 21, 24, 25, 26, 29, 30, 32, 35, 37, 39, 41, 42, 48, 49, 50, 51, 54, 60, 62, 65, 66, 67, 72, 73, 75, 77, 80, 81, 83, 88, 91, 96, 99, 105, 106, 110, 115, 117, 118, 120, 128, 130, 131, 132, 134, 135, 136, 138, 139, 142, 145, 146, 150, 159, 162, 167
4. Schedule Closeout	10	27, 94, 114, 119, 122, 123, 124, 141, 157, 158
5. Stakeholder Communications Management	24	6, 10, 11, 17, 19, 20, 22, 28, 40, 43, 52, 53, 71, 76, 79, 85, 90, 95, 97, 102, 107, 153, 161, 168

Review calculation errors, terminology, omitted constraints and decision reasoning separately. Reconstruct the correct reasoning and revisit the cited source area before trying a changed example.

Reference basis

Project Management Institute (2012). *PMI Scheduling Professional (PMI-SP) Examination Content Outline*. Printed pp. 3-10. Official outline.

Project Management Institute (2019). *Practice Standard for Scheduling*. Third edition. Newtown Square, PA: Project Management Institute.

The contextual application reflects this book; it does not promise the wording, difficulty or distribution of any particular official examination.

Make every delivery date defensible.

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