

2.2 Project Management

The project management model describes the effort undertaken to realize a product over its useful life that will satisfy the changing needs of a designated customer/ simple market. This model is both a record of past and ongoing effort and a projection of potential future effort.

The essential responsibility of project management is to determine how best to use available resources so that a product suited to the customer's needs is provided in a predictable and timely fashion. Program management, in consultation with projects and considering enterprise-provided infrastructure, establishes uniform policies and conventions, a development process and shared assets, physical and computing facilities, and developmental quality criteria by which productivity (efficiency and effectiveness) of projects is evaluated and improved.

The project management model has three elements: project direction, product planning, and increment performance. Project direction concerns how the project operates to build and evolve a product in keeping with business goals, productivity criteria, and constraints. Product planning concerns how a product is developed over its useful life, in keeping with an incrementally realized master plan and consistent with customer needs. Increment performance concerns the project's efforts to iteratively build a product increment as defined in the product master plan.

Project Direction

The project direction element specifies the relationship of a project with the program and with any related projects. In initiating a project, program management specifies its product focus, its targeted customer, and resources for project performance. The responsibilities of project direction includes ensuring adherence to program-prescribed practices and services in operation of the project and the monitoring and periodic reporting on project plans, risks, and progress to program management and coordinating with related projects to leverage common interests and achieve best use of shared resources.

The project direction specification has four elements: project objectives, resources and acquisitions, process definition and developmental quality for an on-going profile of project productivity, and project oversight.

Project Objectives

The project objectives element derives from program objectives, focused on a product suited to the specific needs of a targeted customer. Project objectives define the scope and capabilities of an envisioned product in coordination with program marketing to align with program market objectives and technical competence.

Over time, program objectives, market, and capabilities will evolve in keeping with changing market circumstances and technology. Similarly, the experiences of each project may motivate changes in program objectives and competence as a reflection of changing customer needs or enabling technology. These changes, in turn, may result in changes in project objectives or practices.

Resources and Acquisitions

The resources and acquisitions element specifies the means taken to identify and obtain funding, staffing, and physical and computing facilities needed by the project over its life. The nature and level of resources obtained influence the goals and pace that product planning can expect development to achieve.

Funding may come from the program as a capital investment or from retained proceeds of prior product deliveries. Staffing may include personnel having expertise shared across projects, as transfers from other projects, as new hires, or as assignees from a customer organization. Physical and computing facilities may be shared program resources or may be obtained using project funds. The program may also allow a project to develop, use, and share assets (components or tools) of collaboratively maintained (program- or community- based) open source libraries when appropriate for project-determined needs.

Process Definition and Developmental Quality

The process definition and developmental quality element specifies the process to be performed by the project, in this case the activities and practices of product

development and criteria for the quality of its performance. A process, as a framework for defining the activities that comprise the work of a project, is conceived to achieve some specific result. For a product development process, that result is a product fit for a specified purpose and of acceptable quality. The process itself is judged from a perspective of productivity, that the effort to realize a product over its useful life is both effective and efficient. (This chapter assumes use of the concurrent development process, based on the specified project model, described in section 2.0.)

Program management defines a methodology to be followed by its projects, including how performance of the associated process, methods, and practices is to be evaluated and what enabling computational capabilities are to be used. Computational capabilities are provided by a computational platform appropriate for developing the program's products. Project management may be allowed to tailor this guidance as needed to suit the specific circumstances of the project, such as differing customer-prescribed standards or constraints related to future product sustainment.

Developmental quality specifies the criteria for evaluating the productivity (efficiency and effectiveness) of a project.¹ Productivity is expressed as a tailoring of the four categories defined and elaborated in the framework for developmental quality presented in section 2.0:

- (*feasibility*) The envisioned product can reasonably be actualized with expected observable behavior given the organization's competence, capabilities, and available resources
- (*sustainability*) The product can be built so as to accommodate potentially beneficial modifications over its useful life
- (*conformability*) The product can be built as a rational formulation of needed capabilities with appropriate similarity to other of the program's past, present, or future products

¹ Product quality (i.e., behavioral qualities) is specified separately, as an element of the product requirements model.

- (*verifiability*) The means exist to evaluate the degree to which the product satisfies specified behavioral qualities

As aspects of productivity, these four categories together accommodate all concerns that must be addressed to ensure the efficient building of an effective product. The program elaborates each of these quality factors with more specific factors, each having associated success criteria and metrics for evaluating the degree to which the project satisfies each of them. Project management must ensure that all relevant factors are given due consideration for project success.

Project Productivity

The project productivity element is an on-going analysis of the degree to which project performance is meeting program-specified process and developmental quality guidance. (The project direction element of project management defines productivity objectives in its developmental qualities specification.) Measurements of developmental quality factors are collected and analyzed for potential improvements in the process specification or the effectiveness of developers in performing that process. Performance measures come from reviews by competent developers of each task's performance (e.g., based on goal-question-metric practices appropriate to each process-specified activity). Reviews include ensuring that tasks provide analyses of alternatives considered, rationale for results, potential future changes, and evaluations of product model consistency.

Project Oversight

The oversight element specifies the control and coordination of project operations to ensure consistency and visibility of project performance. Oversight consists of periodic reviews that maintain evidence of conformance to project objectives, methodology guidance, developmental quality criteria, and progress against plan. Determinations of any deficiencies may result in additional performance guidance to the project or adjustments in product scope, project plan, or resources. Program management is provided with information on progress and concerns regarding project performance to ensure realism in program-level planning, direction, and coordination across projects.

Product Planning

The product planning element defines the relationship between the project and the customer as realized by the product. This entails coordination with the customer to keep expectations aligned with plans. Product planning has two elements: a customer relationship specification (the nature of the relationship between the project and its customer) and a product master plan specification (how the product is being developed over its useful life).

Customer Relationship

The customer relationship element specifies the relationship between the project and its targeted customer. If the relationship is based on a formal commitment (either contractual or by agreement) made between the project and customer, this specification is the medium by which conformance to that commitment is established and tracked. In any case, this specification will track any interactions between developers and customer representatives.

Project management evaluates the status of the product model as a whole in accordance with the current product model master plan and, in consultation with the customer, determines when the product is acceptable for deployment. This will typically entail, as the product model is being developed, a negotiation of changes in acceptance criteria, cost, and schedule according to project and customer priorities and tradeoffs.

If issues arise concerning the cost, schedule, or feasibility of product delivery, this specification is the vehicle by which changes in project planning and customer needs are negotiated with the customer (or program marketing as their proxy). This includes identification, negotiation between project and customer as needed, and resolution of any issues related to customer needs and responsibilities as specified in the project's product delivery element. Such issues can arise due to changes in the substance or understanding of customer's needs or circumstances or due to advances or impediments of product development.

By convention, projects deliver only the operationally-useful elements of a product to customers. These and associated developmentally-useful elements are retained for

developer use in the further development of this and other products. In the case of a product being developed for the sole use of a single customer, project management may agree to deliver the product as a whole (at increased cost) to allow the customer to independently maintain and improve the product. In such a case, the customer may specify use of specific development tools and practices, which may preclude use or require reformulation of previously developed assets.

Product Master Plan

The product master plan element specifies the project's development of a product over its expected useful life. This plan is a roadmap for a series of increments that evolve the product over time as needs and technology change. Each increment is characterized in terms of its contribution to improved behavior or capabilities that the product will provide to the customer.

A series of one or more related increments comprise a product release, each increment being a consistent (but possibly incomplete) version of the product. Each increment may be designated as being a candidate for release to the customer or as interim to a subsequent increment. Typically, an increment will span at most six to twelve months, enough time to do significant work but not too long to spend before circumstances can cause needs to change. A completed increment of the product that is judged releasable (i.e., acceptable vis-a-vis customer needs and consistent based on product quality evaluations over the course of development) may be deployed into use by the customer.

The product master plan will prescribe an objective, scope of expected improvements, staffing/resources, and timeline for each of a series of envisioned releases of the product. Improvements could include adding customer-directed capabilities, improving product behavior, or correcting discovered deficiencies. Significant improvements may be planned and developed over multiple increments. A release may be broken into multiple increments to permit interim points for evaluating progress. Each increment toward a release is evaluated against release criteria so as to revise the plan to account for actual versus projected progress and any changes in program, market, or customer needs and circumstances.

[slide 7 of SSIMP Concept Design showing transition (as-is/increment/to-be -> new as-is) view for a master plan]

Planning for the lifecycle of a product requires giving thought based on knowledge of the purpose of the product in a customer enterprise to envision how needs and enabling technology for it are likely to change over time. The ability to evolve a product as needs and technology change can be less costly if the product is built with an awareness as to what sorts of changes are most likely in the future. Attempting to foresee likely changes does not eliminate the need to accommodate unforeseen changes but is meant to limit those based on well-founded foresight; unexpected changes can undermine the conceptual and structural integrity of a product, imposing untenable costs and risks on a project. If change becomes unduly difficult or disruptive to a product, a new effort will then have to be undertaken to revamp or replace the product. An objective of product planning is to provide the project with a well-founded concept of how the product will be likely to change over its useful life.

Increment Performance

The increment performance element defines the development, in accordance with the project process and the product master plan, of a baselined version of the product model. An increment is focused on goals as specified in the product master plan, reflecting customer and enabling technical needs to be addressed and available resources. Each increment entails a set of tasks, each defined to revise appropriate elements of the product model. Each task is organized into a series of iterations, each planned for a fixed-time duration, ideally no more than two to four weeks, to allow for timely review to evaluate progress and any changes in increment tasking. An increment is complete when the result is a consistent product model that satisfies the specified goals for the increment, adjusted as needed to account for time allotted to it by the master plan.

As assigned tasks are performed, the role of project management is to continuously monitor progress and recognize when adjustments to the increment plan are needed. This includes ensuring that the product is being built in conformance with perceived

customer needs and that tasks are being performed in accordance with specified process activity definitions and developmental quality criteria.

The increment plan can and should be revised in-progress if an unforeseen opportunity or impediment arises. An opportunity might involve unexpected technical progress that will result in improved product capabilities or early completion of the increment. For impediments, there are three dimensions in which the plan could be adjusted, considering the effect of each on the master plan. The preferred change is to reduce the capability to be completed as part of the increment, deferring work to a later increment. An alternative option is to extend the increment, possibly delaying product release, in order to complete envisioned capabilities or improve quality. The most detrimental option, in that it can impact the long term viability of the product, is to accept reduced product quality but with a clear near-term plan for addressing deficiencies.

{feedback to product planning based on increment performance experience}

Increment performance has three elements: an increment plan, version management, and task performance.

Increment Plan (Tasking and Coordination)

(constrained addressable scope of a product release, consistent with negotiated (partial) customer needs)

The increment plan element specifies the assignment and iterative performance of tasks in accordance with the master plan specified objective and resources to develop a revised baseline of the product model. Each task is an allocation of time, staff, and scope to perform activities associated with designated elements of the product model. An increment begins with any needed revision to the product master plan based on the results of previous product increments and the resulting baseline product model.

An increment may be conditionally designated in the lifecycle plan as being targeted for release to the customer. If completeness criteria for the increment is met, tasking

includes work required to transfer the completed product to the customer for validation and certification and, upon acceptance, for deployment into operational use.

A task is the assignment of one or more developers to perform specified work over a given span of time. Developers are assigned based on having available time and competence to perform the needed work. The work to be done is specified in terms of the aspects of the product model to be developed and the corresponding subject matter scope to be addressed. A task may focus on selected elements of one or more product model facets. In this, a task may be limited to some portion of a single product model facet or it may encompass related work over multiple product model facets, depending on the scope of the work and the developer competence needed to perform that work. For example, a task to modify the customer needs specification of the product delivery model might also include revising related aspects of the product requirements model. Or, a task to create scenarios to verify satisfaction of customer needs might include developing test materials for use in evaluating those scenarios. Conversely, this work might be split into different tasks if that would result in more effective use of developer efforts.

Ordering of tasks is influenced by information dependencies among model elements. Work can be proceeding concurrently on various elements of the product model. Work on a given model element is typically initiated when the content of a model element on which it depends has been modified or when work on a dependent element identifies issues with its existing content. When the content of a model element has been evaluated as satisfying task criteria, including consistency with specified versions of related model elements, the content is baselined as a version accredited for reference by other tasks.

Each product development increment is defined by an objective for advancing the product toward an envisioned release. Increment planning considers the capability and technical objectives envisioned for the increment and the availability of staff with corresponding competence, to define tasking that will best achieve those objectives. An increment is successfully completed when iteration of specified tasking has been

determined to have created a consistent product instance that satisfies the increment objective.

A task may entail creating multiple versions of product model elements in order to comparatively explore any uncertainties, alternatives, and tradeoffs as needed to determine which version will best meet customer needs.

When a task discovers an issue or error in a related element of the product model, the current task effort can be modified in one of three ways:

- The task can proceed to conclusion taking the problematic information as valid but recognizing that the information is likely to change and require further work later.
- Some or all of the task can be deferred awaiting resolution of the error or issue, with the possible need to defer other dependent tasks and to collaborate with other tasks to determine a best resolution overall.
- The task can proceed to conclusion assuming that the error or issue will be resolved in a predictable way. The identified inconsistency remains until all relevant aspects of the model have been revised.

Version Management

The version management element specifies the dependencies among versioned elements of the product model. Each version of the product model is a network of versions of interrelated product model facets and their elements. A releasable product is one for which all elements of the product model are mutually consistent. This specification is the medium for verifying consistency of the product model as a whole.

Consistency is expressed in the specification-realization dependency among elements of the product model. Elements of a product under development may be inconsistent. The normal flow of iteration is the development of a specification followed by the development of a compliant realization; improvements are then made to the specification, in part due to issues raised in developing the realization, and the iteration repeats. As iteration proceeds, each specification-realization pair will progress toward

consistency. Every element of the product model is either a specification or a realization and may be both.

The soundness of a product release requires a version management specification that tracks the identity of the versions of all product model elements that comprise that release. This includes ensuring that the versions of related elements have been confirmed as being mutually consistent.

A product model *baseline* is a product model version which satisfies the objectives of a project increment, providing a basis for subsequent development increments. A product *release* is an extract of the operationally-useful elements of a product model baseline that is to be deployed into customer operational use. (Every version of a product model has an associated specification of its *configuration*. A configuration identifies the associated versions of each included element of each included product model facet.)

a given version of an element may span multiple product versions if appropriate.

Each instance of a product model is distinguished as a uniquely identified *version*, defined by a corresponding set of uniquely versioned, operationally- and developmentally-useful elements. Each version of a product model and its elements has associated metadata that substantiates its derivation and dependencies. A baselined product model is the source for a releasable product; a deliverable product is the extract of the operationally-useful elements of the product model.

Each versioned element of a product model may exist in a series of *revisions*. A product model version is considered “partial” until all expected elements have been confirmed as complete according to project objectives for a corresponding development increment.

Task Performance

The task performance element documents the experience of performing a designated task. This documentation consists of the product-specific results of task performance, product quality reviews of results, rationale for results based on analyses of alternatives and tradeoffs, and process quality reviews of task performance.

(Task Results)

Each task is defined in terms of the project model elements and subject matter scope that it is meant to address.

(Product Quality Reviews)

Every task requires a documented review that verifies the quality of its results (in terms of consistency with related elements' content and completeness relative to other elements' content and subject matter expertise) as a prerequisite to its being baselined. A task review is documentation of a directed evaluation of the approach taken, its results, and how all complex or unsettled issues regarding the content and quality of a subject work product have been resolved. Each task may include interim reviews at the discretion of the developer. A review is informed by the results of any related empirical or theory-based evaluations.

Product quality reviewers include peer developers of related product model elements and program-designated experts who are cognizant in subject matter relevant to the content of work being evaluated.

The developer of material to be reviewed identifies the appropriate reviewers and specifies relevant questions that each reviewer is asked to consider according to their particular competence. The developer is expected to direct each reviewer with questions appropriate to their specific competence related to particular content so as to focus them on issues of most significance or uncertainty that will increase confidence in that content. Questions to be considered should address adherence to developmental quality criteria, proper satisfaction of technical objectives including implications for achieving behavioral quality criteria, and consistency with any relevant specification as well as with any other related product model elements.

(Results Rationale with Analyses of Alternatives and Tradeoffs)

Developmental tradeoffs documents the decisions encountered in performing a task and associated risks, tradeoffs, and rationale for its subsequent resolution. Tradeoffs support reviews of task results. This informs consistency and completeness relative to related elements of the product model.

contribution to product quality

*{systematically analyze tradeoffs, resolve, and document rationale for identified risks/
uncertainties: eg spend more time for better quality or deploy an acceptable but inferior product
(expose tradeoffs between developmental and behavioral qualities)}*