Technical Planning

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Planning is an important aspect of systems engineering management (SEM). Systems engineering (SE) planning is performed concurrently and collaboratively with project planning. It involves developing and integrating technical plans to achieve the technical project objectives within the resource constraints and risk thresholds. The planning involves the success-critical stakeholders to ensure that necessary tasks are defined with the right timing in the life cycle in order to manage acceptable risks levels, meet schedules, and avoid costly omissions.

Contents

SE Planning Process Overview

SE planning provides the following elements:

- Definition of the project from a technical perspective.
- Definition or tailoring of engineering processes, practices, methods, and supporting enabling environments to be used to develop products or services, as well as plans for transition and implementation of the products or services, as required by agreements.
- Definition of the technical organizational, personnel, and team functions and responsibilities, as well as all disciplines required during the project life cycle.
- Definition of the appropriate life cycle model or approach for the products or services.
- Definition and timing of technical reviews, product or service assessments, and control mechanisms across the life cycle, including the success criteria such as cost, schedule, and technical performance at identified project milestones.
- Estimation of technical cost and schedule based on the effort needed to meet the requirements; this estimation becomes input to project cost and schedule planning.
- Determination of critical technologies, as well as the associated risks and actions needed to manage and transition these technologies.
- Identification of linkages to other project management efforts.
- Documentation of and commitment to the technical planning.

Scope

SE planning begins with analyzing the scope of technical work to be performed and gaining an understanding the constraints, risks, and objectives that define and bound the solution space for the product or service. The planning includes estimating the size of the work products, establishing a schedule (or integrating the technical tasks into the project schedule), identification of risks, and negotiating commitments. Iteration of these planning tasks may be necessary to establish a balanced plan with respect to cost, schedule, technical performance, and quality. The planning continues to

evolve with each successive life cycle phase of the project (NASA 2007, 1-360; SEI 1995, 12).

SE planning addresses all programmatic and technical elements of the project to ensure a comprehensive and integrated plan for all of the project's technical aspects and should account for the full scope of technical activities, including system development and definition, risk management, quality management, configuration management, measurement, information management, production, verification and testing, integration, validation, and deployment. SE planning integrates all SE functions to ensure that plans, requirements, operational concepts, and architectures are consistent and feasible.

The scope of planning can vary from planning a specific task to developing a major technical plan. The integrated planning effort will determine what level of planning and accompanying documentation is appropriate for the project.

Integration

The integration of each plan with other higher-level, peer, or subordinate plans is an essential part of SE planning. For the technical effort, the systems engineering management plan (SEMP), also frequently reffered to as the systems engineering plan (SEP), is the highest level technical plan. It is subordinate to the project plan and often has a number of subordinate technical plans providing detail on specific technical focus areas (INCOSE 2011, sec. 5.1.2.2; NASA 2007, appendix J).

In U.S. defense work, the terms SEP and SEMP are not interchangeable. The SEP is a high-level plan that is made before the system acquisition and development begins. It is written by the government customer. The SEMP is the specific development plan written by the developer (or contractor). In this context, intent, and content of these documents are quite different. For example, a SEP will have an acquisition plan that would not be included in a SEMP. Figure 1 below shows the SEMP and integrated plans.

Figure 1. SEMP and Integrated Plans. (SEBoK Original)

Task planning identifies the specific work products, deliverables, and success criteria for systems engineering efforts in support of integrated planning and project objectives. The success criteria are defined in terms of cost, schedule, and technical performance at identified project milestones. Detailed task planning identifies specific resource requirements (e.g., skills, equipment, facilities, and funding) as a function of time and project milestones.

SE planning is accomplished by both the acquirer and supplier and the activities for SE planning are performed in the context of the respective enterprise. The activities establish and identify relevant policies and procedures for managing and executing the project management and technical effort, identifying the management and technical tasks, their interdependencies, risks, and opportunities, and providing estimates of needed resources/budgets. Plans are updated and refined throughout the development process based on status updates and evolving project requirements (SEI 2007).

Linkages to Other Systems Engineering Management Topics

The project planning process is closely coupled with the measurement, assessment and control, decision management, and risk management processes.

The measurement process provides inputs for estimation models. Estimates and other products from planning are used in decision management. SE assessment and control processes use planning results for setting milestones and assessing progress. Risk management uses the planning cost models, schedule estimates, and uncertainty distributions to support quantitative risk analysis (as desired).

Additionally, planning needs to use the outputs from assessment and control as well as risk management to ensure corrective actions have been accounted for in planning future activities. The planning may need to be updated based on results from technical reviews (from assessment and control) addressing issues pertaining to: measurement, problems that were identified during the performance of risk management activities, or decisions made as a result of the decision management activities (INCOSE 2010, sec. 6.1).

Practical Considerations

Pitfalls

Some of the key pitfalls encountered in planning and performing SE planning are listed in Table 1.

Table 1. Major Pitfalls with Planning. (SEBoK Original)

Name	Description
Incomplete and Rushed Planning	Inadequate SE planning causes significant adverse impacts on all other engineering activities. Although one may be tempted to save time by rushing the planning, inadequate planning can create additional costs and interfere with the schedule due to planning omissions, lack of detail, lack of integration of efforts, infeasible cost and schedules, etc.

Inexperienced Staff	Lack of highly experienced engineering staff members, especially in similar projects, will likely result in inadequate planning. Less experienced engineers are often assigned significant roles in the SE planning; however, they may not have the appropriate judgment to lay out realistic and achievable plans. It is essential to assign the SE planning tasks to those with a good amount of relevant experience.

Good Practices

Some good practices gathered from the references are in Table 2.

Table 2. Proven Practices with Planning. (SEBoK Original)

Name	Description
Use Multiple Disciplines	Get technical resources from all disciplines involved in the planning process.
Early Conflict Resolution	Resolve schedule and resource conflicts early.
Task Independence	Tasks should be as independent as possible.
Define Interdependencies	Define task interdependencies, using dependency networks or other approaches.
Risk Management	Integrate risk management with the SE planning to identify areas that require special attention and/or trades.
Management Reserve	The amount of management reserve should be based on the risk associated with the plan.
Use Historical Data	Use historical data for estimates and adjust for differences in the project.
Consider Lead Times	Identify lead times and ensure that you account for them in the planning (e.g., the development of analytical tools).
Update Plans	Prepare to update plans as additional information becomes available or changes are needed.

Use IPDTs	An integrated product development team (IPDT) (or integrated product team (IPT)) is often useful to ensure adequate communication across the necessary disciplines, timely integration of all design considerations, as well as integration, testing, and consideration of the full range of risks that need to be addressed. Although there are some issues that need to be managed with them, IPDTs tend to break down the communication and knowledge stovepipes that often exist.

Additional good practices can be found in the *Systems Engineering Guidebook for Intelligent Transportation Systems (ITS)*, *NASA Systems Engineering Handbook*, the *INCOSE Systems Engineering Handbook*, and *Systems and Software Engineering - Life Cycle Processes - Project Management* (Caltrans and USDOT 2005, 278; NASA December 2007, 1-360, sec. 6.1; INCOSE 2011, sec. 5.1; ISO/IEC/IEEE 2009, Clause 6.1).

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