

The Influence of Project Structure and Governance on Systems Engineering and Project Management Relationships

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Lead Author: *Alice Squires*

This article reviews various project structures that impact or provide governance to the project and that require key involvement from the program manager and the systems engineer. These structures include: the structure of the organization itself (functional, project, matrix, and specialized teams, such as Integrated Product Teams (IPTs), Change Control Boards (CCBs), and Engineering Review Boards (ERBs). This article also addresses the influence of schedule-driven versus requirements-driven projects on these structures.

Relationships between Systems Engineering and Project Management are covered in a related article.



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An Overview of Project Structures

Project management and systems engineering governance are dependent on the organization's structure. For some projects, systems engineering is subordinated to project management and in other cases, project management provides support to systems engineering. These alternatives are illustrated in Figures 1 and 2 of the Organizing the Team section in Team Capability.

A project exists within the structural model of an organization. Projects are one-time, transient events that are initiated to accomplish a specific purpose and are terminated when the project objectives are achieved. Sometimes, on small projects, the same person accomplishes the work activities of both project management and systems engineering. Because the natures of the work activities are significantly different, it is sometimes more effective to have two persons performing project management and systems engineering, each on a part-time basis. On larger projects there are typically too many tasks to be accomplished for one person to accomplish all of the necessary work. Very large projects may have project management and systems engineering offices with a designated project manager and a designated lead systems engineer.

Projects are typically organized in one of three ways: (1) by functional structure, (2) by project structure, and (3) by a matrix structure (see Systems Engineering Organizational Strategy for a fourth structure and related discussion). In a function-structured organization, workers are grouped by the functions they perform. The systems engineering functions can be: (1) distributed among some of the functional organizations, (2) centralized within one organization or (3) a hybrid, with some of the functions being distributed to the projects, some centralized and some distributed to functional organization. The following figure provides an organizational structure continuum and illustrates levels

of governance among the functional organizations and the project.

- In a functional-structured organization, the project manager is a coordinator and typically has only limited control over the systems engineering functions. In this type of organization, the functional manager typically controls the project budget and has authority over the project resources. However, the organization may or may not have a functional unit for systems engineering. In the case where there is a functional unit for systems engineering, systems engineers are assigned across existing projects. Trades can be made among their projects to move the priority of a specific systems engineering project ahead of other projects; thus reducing the nominal schedule for that selected project. However, in the case where there is not a functional unit for systems engineering, the project manager may have to find alternate sources of staffing for systems engineering – for example, hiring systems engineering talent or consultants, promoting or expanding the responsibilities of a current team member, etc.
- In a project-structured organization, the project manager has full authority and responsibility for managing the budget and resources to meet the schedule requirements. The systems engineer is subject to the direction of the project manager. The project manager may work with human resources or a personnel manager or may go outside the organization to staff the project.
- Matrix-structured organization can have the advantages of both the functional and project structures. For a schedule driven project, function specialists are assigned to projects as needed to work for the project manager to apply their expertise on the project. Once they are no longer needed, they are returned to their functional groups (e.g. home office). In a weak matrix, the functional managers have authority to assign workers to projects and project managers must accept the workers assigned to them. In a strong matrix, the project manager controls the project budget and can reject workers from functional groups and hire outside workers if functional groups do not have sufficient available and trained workers.

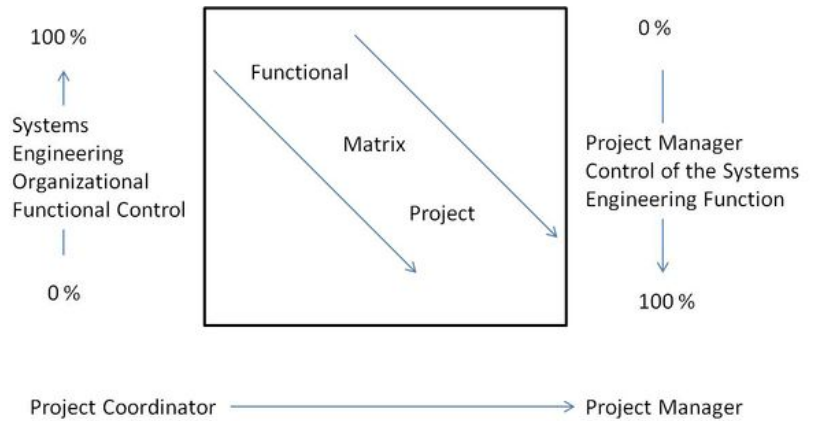


Figure 1. The Organizational Continuum (2). (SEBoK Original and Adapted from Fairley 2009). Reprinted with permission of the IEEE Computer Society. All other rights are reserved by the copyright owner.

In all cases, it is essential that the organizational and governance relationships be clarified and communicated to all project stakeholders and that the project manager and systems engineer work together in a collegial manner.

The Project Management Office (PMO) provides centralized control for a set of projects. The PMO is focused on meeting the business objectives leveraging a set of projects, while the project managers are focused on meeting the objectives of those projects that fall under their purview. PMOs typically manage shared resources and coordinate communication across the projects, provide oversight and manage interdependencies, and drive project-related policies, standards, and processes. The PMO may also provide training and monitor compliance (PMI 2013).

Schedule-Driven versus Requirements-Driven Influences on Structure and Governance

This article addresses the influences on governance relationships between the project manager and the systems engineer. One factor that establishes this relationship is whether a project is schedule-driven or requirements-driven.

In general, a project manager is responsible for delivering an acceptable product/service on the specified delivery date and within the constraints of the specified schedule, budget, resources, and technology.

The systems engineer is responsible for collecting and

defining the operational requirements, specifying the systems requirements, developing the system design, coordinating component development teams, integrating the system components as they become available, verifying that the system to be delivered is correct, complete and consistent to its technical specification, and validating the operation of the system in its intended environment.

From a governance perspective, the project manager is often thought of as being a movie producer who is responsible for balancing the schedule, budget, and resource constraints to meet customer satisfaction. The systems engineer is responsible for product content; ergo, the systems engineer is analogous to a movie director.

Organizational structures, discussed previously, provide the project manager and systems engineer with different levels of governance authority. In addition, schedule and requirements constraints can influence governance relationships. A schedule-driven project is one for which meeting the project schedule is more important than satisfying all of the project requirements; in these cases lower priority requirements may not be implemented in order to meet the schedule.

Classic examples of these types of projects are:

- a project that has an external customer with a contractual delivery date and an escalating late delivery penalty, and
- a project for which delivery of the system must meet a major milestone (e.g. a project for an announced product release of a cell phone that is driven by market considerations).

For schedule-driven projects, the project manager is responsible for planning and coordinating the work activities and resources for the project so that the team can accomplish the work in a coordinated manner to meet the schedule. The systems engineer works with the project manager to determine the technical approach that will meet the schedule. An Integrated Master Schedule (IMS) is often used to coordinate the project.

A requirements-driven project is one for which satisfaction of the requirements is more important than the schedule constraint. Classic examples of these types of projects are:

1. exploratory development of a new system that is needed to mitigate a potential threat (e.g. military research project) and
2. projects that must conform to government regulations in order for the delivered system to be safely operated (e.g., aviation and medical device regulations).

An Integrated Master Plan is often used to coordinate event-driven projects.

To satisfy the product requirements, the systems engineer is responsible for making technical decisions and making the appropriate technical trades. When the trade space includes cost, schedule, or resources, the systems engineer interacts with the project manager who is responsible for providing the resources and facilities needed to implement a system that satisfies the technical requirements.

Schedule-driven projects are more likely to have a management structure in which the project manager plays the central role, as depicted in Figure 1 of the Organizing the Team section in Team Capability. Requirement-driven projects are more likely to have a management structure in which the systems engineer plays the central role, as depicted in Figure 2 of the Organizing the Team section in Team Capability.

Along with the Project Management Plan and the Systems Engineering Management Plan, IMP/IMS are critical to this process.

Related Structures

Integrated Product Teams (IPTs), Change Control Boards (CCBs), and Engineering Review Boards (ERBs) are primary examples of project structures that play a significant role in project governance and require coordination between the project manager, systems engineer and other members of the team.

Integrated Product Team

The Integrated Product Team (IPT) ensures open communication flow between the government and industry representatives as well as between the various product groups (see Good Practices in Planning). There is typically a top level IPT, sometimes referred to as the Systems Engineering and Integration Team (SEIT) (see Systems Engineering Organizational Strategy), that

oversees the lower level IPTs. The SEIT can be led by either the project manager for a specific project or by the systems engineering functional manager or functional lead across many projects. Each IPT consists of representatives from the appropriate management and technical teams that need to collaborate on systems engineering, project management, and other activities to create a high-quality product. These representatives meet regularly to ensure that the technical requirements are understood and properly implemented in the design. Also see Team Capability for more information.

Change Control Board

An effective systems engineering approach includes a disciplined process for change control as part of the larger goal of configuration management. The primary objective of configuration management is to track changes to project artifacts that include software, hardware, plans, requirements, designs, tests, and documentation. Alternatively, a Change Control Board (CCB) with representatives from appropriate areas of the project is set up to effectively analyze, control and manage changes being proposed to the project. The CCB typically receives an Engineering Change Proposal (ECP) from design/development, production, or operations/support and initially reviews the change for feasibility. The ECP may also be an output of the Engineering Review Board (ERB) (see next section). If determined feasible, the CCB ensures there is an acceptable change implementation plan and proper modification and installation procedures to support production and operations.

There may be multiple CCBs in a large project. CCBs may be comprised of members from both the customer and the supplier. As with the IPTs, there can be multiple levels of CCB starting with a top level CCB with CCBs also existing at the subsystem levels. A technical lead typically chairs the CCB; however, the board includes representation from project management since the CCB decisions will have an impact on schedule, budget, and resources.

See Figure 2 under Configuration Management for a flow of the change control process adapted from Blanchard and Fabrycky (2011). See also Capability Updates, Upgrades, and Modernization, and topics included under Enabling Teams. See also the UK West Coast Modernization Project which provides an example where change control was an important success factor.

Engineering Review Board

Another example of a board that requires collaboration between technical and management is the Engineering Review Board (ERB). Examples of ERBs include the Management Safety Review Board (MSRB) (see Safety Engineering). Responsibilities of the ERB may include technical impact analysis of pending change requests (like the CCB), adjudication of results of engineering trade studies, and review of changes to the project baseline. In some cases, the ERB may be the management review board and the CCB may be the technical review board. Alternatively, in a requirement driven organization the ERB may have more influence while in a schedule driven organization the CCB may have more impact.

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This page was last edited on 2 May 2024, at 23:24.