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# Concepts of Systems Engineering, Manufacturing Engineering, Production Engineering, Control Engineering and Software Engineering

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## DESCRIPTION

Systems engineering is an interdisciplinary subject of engineering and engineering management concerned with the design, integration, and administration of complex systems throughout their life cycles. Systems engineering, at its core, organizes this corpus of knowledge using systems thinking principles. An engineered system, which is the end result of such efforts, can be characterized as a collection of components that work together to perform a useful purpose. When dealing with large or complex projects, issues such as requirements engineering, reliability, logistics, coordination of different teams, testing and evaluation, maintainability, and many other disciplines that are required for successful system design, development, implementation, and ultimate decommission become more difficult.

## ORIGINS AND TRADITIONAL SCOPE OF INDUSTRIAL ENGINEERING

In such projects, systems engineering works with work processes, optimization strategies, and risk management tools. Industrial engineering, process systems engineering, mechanical engineering, manufacturing engineering, production engineering, control engineering, software engineering, electrical engineering, cybernetics, aerospace engineering, organizational studies, civil engineering, and project management are some of the technical and human-centered disciplines that overlap. All likely features of a project or system are analyzed and integrated into a whole through systems engineering. The systems engineering process is more like a discovery than a production process. A manufacturing process focuses on repeatable operations that produce high-quality outputs at a low cost and in a short amount of time. The first step in the systems engineering process is to identify the real issues that need to be addressed, as well as the most likely or high-impact failures that could occur. Systems engineering then entails developing solutions to these issues. Systems engineering is a term that refers to both an approach and, more recently, an engineering discipline. The goal of systems engineering education is to simply formalize multiple ways and, in doing so, find new methodologies and research opportunities, similar to what happens in other engineering domains. Systems engineering is a holistic and interdisciplinary approach to problem solving. Engineering's conventional scope includes physical system conception, design, development, production, and operation. This is where systems engineering, in its fundamental form, belongs. In this meaning, "systems engineering" refers to the development of engineering concepts. Over time, the phrase "systems engineer" has come to encompass a broader, more holistic understanding of "systems" and engineering processes. The phrase continues to apply to both the narrower and broader scopes, despite the change of the meaning being a source of continuous debate. Traditional systems engineering was thought of as a field of engineering in the traditional sense, that is, as a branch of engineering that solely related to physical systems like spaceships and aircraft. More lately, the term "systems engineering" has taken on a broader connotation, particularly when humans are seen to be an integral part of a system. For example, Peter Check land encapsulates the larger meaning of systems engineering when he says that "engineering" "may be read in its broadest sense; you can design a meeting or a political accord.

The Systems Engineering Body of Knowledge (SEBoK) has established three forms of systems engineering that are consistent with the broader scope of systems engineering:

1. Product Systems Engineering (PSE) is a type of classic systems engineering that focuses on the design of hardware and software-based physical systems.
2. Enterprise Systems Engineering (ESE) is concerned with the notion of enterprises, i.e., companies or groups of organizations, as systems.
3. Service Systems Engineering (SSE) is the study of how service systems are designed. A service system, according to Check land, is one that is designed to assist another system. The majority of civil infrastructure systems are service-oriented.

Early in the development cycle, systems engineering focuses on evaluating and eliciting customer needs and necessary functionality, documenting requirements, then moving on to design synthesis and system validation while considering the entire problem, or system lifecycle. This entails having a thorough understanding of all of the stakeholders. According to Oliver et al., the systems engineering process can be divided into two parts: a technical process for systems engineering and a management process for systems engineering.

The Management Process in Oliver's model aims to organize the technical effort throughout the lifecycle, while the Technical Process includes assessing available data, defining effectiveness measures, creating a behaviour model, creating a structure model, performing trade-off analysis, and creating a sequential build and test plan. Although there are different models in use in the business, all of them strive to determine the relationship between the various steps stated above and integrate feedback, depending on their application. The Waterfall model and the VEE model are two examples of such models (also called the V model).

## INTERDISCIPLINARY FIELD OF SYSTEM ENGINEERING

System development frequently necessitates input from a variety of technological areas. Systems engineering helps shape all technical contributors into a coherent team effort by offering a systems (holistic) view of the development effort, producing a structured development process that moves from concept through production to operation, and in some situations, termination and disposal. The holistic integrative discipline in an acquisition combines contributions and manages tradeoffs between cost, schedule, and performance while preserving an acceptable degree of risk throughout the item's life cycle. This viewpoint is frequently reproduced in educational programs, where systems engineering courses are taught by teachers from other engineering fields, fostering an interdisciplinary atmosphere. The necessity for systems engineering arose as the complexity of systems and projects increased, raising the likelihood of component friction and, as a result, the design's dependability. When used in this context, the term "complexity" refers to both engineering systems and the logical human structure of data. Simultaneously, a system can become more complex as its size grows, as can the amount of data, variables, or fields included in the design. An example of such a system is the International Space Station.

Systems engineering also includes the creation of smarter control algorithms, microprocessor design, and environmental system analysis. The use of tools and procedures to better understand and manage complexity in systems is encouraged by systems engineering. Taking an interdisciplinary approach to designing systems is inherently difficult since the behaviour of system components and their interactions are not always well defined or understood. One of the purposes of systems engineering is to define and characterize such systems and subsystems, as well as their relationships. The gap between informal requirements from users, operators, and marketing groups and technical specifications is successfully bridged as a result of this.