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# History of System Engineering

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**Анотація**

Системна інженерія стала окремою фахової дисципліни в останні півстоліття у відповідь на все зростаючої складності нових продуктів і систем. Початок розвитку поняття Системної інженерії бере ще з років Другої Світової війни

**Ключові слова**

Системна інженерія, фахова дисципліна, продукти, системи, розвиток, Друга Світова війна

**Abstract**

Systems Engineering has emerged as a distinct professional discipline in the past half century in response to the ever-increasing complexity of new products and systems. The beginning of the concept of system engineering is still in World War II

**Keywords**

Systems Engineering, distinct professional discipline, products, systems, concept, World War II

## Systems Engineering

The term Systems Engineering (SE) is a generic term that describes the application of structured engineering methodologies to the design and creation of complex systems. While there has been great discussion about the term "system", it can be argued that from the point of view of the System Engineer, a system is a collection or set of "parts" that work together to perform a particular function. These parts can be in the form of hardware, software, or liveware, and in themselves may be considered systems. The system definition is essentially relative to the perspective of the individual who views the system. The discipline of Systems Engineering focuses on the coordination of all of the disciplines, tasks, and activities necessary to develop the total system.

Unlike traditional engineering disciplines, such as hydraulics engineering, structural engineering, or electrical engineering, Systems Engineering is not governed by a set of fundamental mathematical relations based on physical properties. In essence, it has not traditionally been a strict laboratory-based form of engineering. It has emerged from a need to deal with the ever-increasing complexity of system development projects, and emerged as a collection of best-practices for managing the development of complex engineering systems

The field of System Engineering as we know it emerged from the post World War II (WWII) military-industrial-academic complex that was embroiled in an accelerating weapons race with the former Soviet Union. While many pre-WWII systems were designed, built and implemented in a succession of steps with relatively few decision makers affecting the technical design and development of the system. The foundation of System Engineering, as it is known today, emerged from this era via the Atlas Intercontinental Ballistic Missile (ICBM) Program.

## The System Engineer

In many respects, the System Engineer is similar to the general practitioner in medicine, an individual who is able to grasp the issues of importance by looking at the whole system, and delegating responsibility for handling each issue to the appropriate specialist or team of specialists. While not necessarily called the "System Engineer", anyone who is responsible for the design and implementation of a total system based on a set of customer requirements is acting as a System Engineer. The role of the System Engineer , therefore ,is one of a manager that possesses and uses a set of formal tools that structure the system development process. In fact, the adoption of international standards for System Engineering has resulted from the appearance of requirements for certain process adherence guidelines in military and government system development contracts in the past few decades.

The primary concern in all literature on Systems Engineering is the customer, or more specifically, customer requirements and constraints. All System Engineering processes begin with the collection and documentation of customer requirements. These requirements are formally established as the basis for the system development, and more importantly, are methodologically tracked from the time they are created until the system is operated. There is essentially a paper trail of documentation and decision tools that describe or demonstrate the source of any system design choice to specific customer requirements. Unlike typical "push" design methodologies that are based on the premise of "build it and they will come", System Engineering processes are more of a "pull" system that has the customer driving the design requirements and parameters that most directly affect the performance of the system.

## The System Engineering Methodology

At the highest level, the System Engineering methodology focuses on several major steps including (1) problem statement, (2) identification of objectives and requirements documentation, (3) concept generation, (4) analysis of alternatives and trade studies, (5) selection of primary concept, (6) system creation, including decomposition, design, development, integration, verification and validation, and (7) system operation and life cycle disposal. The system is then physically reconstructed from its individual components into subsystems and eventually integrated into a complete system. Plans are created by the System Engineer to ensure that the subsystems and overall system perform as designed (verification) and ultimately meet the desired intent of the customer (validation) by performing the desired function.

Standards for System Engineering have emerged from many sources, and first appear in military standards in the late 1960's. A standard is a document that establishes engineering and technical requirements for products, processes, procedures, practices, and methods, and has either been decreed by authority, or

adopted by consensus. Typically, government and military Systems Engineering standards have been decreed by authority, while commercial standards (i.e. ISO, EIA, SAE, and IEEE) have been adopted by consensus. However, the development of both decreed and adopted standards for System Engineering have been interdependent and mutually influential in their evolution.

## The Future of the Field

The field of Systems Engineering has emerged from a collection of best practices in system development project management to formal degrees that are now provided in educational institutions. The International Committee on Systems Engineering (INCOSE) acts as a focal point for communicating the development of this work via publications and conferences.

While it is arguable that Systems Engineering is not a simple input/output function into which a set of requirements are entered and a system design emerges, it does provide the framework for managing and creating systems that meet customer needs in a manner that attempts to maximize the customer's value as measured via cost, time, and performance metrics. Systems Engineering will thus continue to survive and evolve as a professional discipline given the ever-increasing complexity of the distributed systems being created in an information age.

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