Brief History of Systems Engineering

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While many will attribute systems thinking to great accomplishments such as the Egyptian pyramids, Incan ziggurats, and the Roman aqueduct system, this article will pick up with the early mentions of systems engineering as a discipline. One only has to look to find a healthy body of works on the history of Systems engineering. Many of those fine articles are cited in the References section below. The purpose of this article is to highlight the evolution of the practice and definition of systems engineering as it emerged in the 20th century.

Contents

The Fifties (1950-1959)

Mervin J. Kelly worked for Bell Labs and became president of Bell Labs in 1951. In 1950 Kelly published

the article “The Bell Telephone Laboratories—An Example of an Institute of Creative Technology” in the Proceedings of the Royal Society B. In that article Kelly discussed the progress of Bell Labs over the first half of the century. He stated that the organization “grew in size and matured in the scope and character of its work during the period of rapid expansion in research in the physical sciences”. From there, he went on to describe the organization of their work. The first operational heading he described was described as research and fundamental research. The second general heading is of relevance to this article. That category of work was ‘systems engineering’. He went on to describe that group of individuals by stating “…the major responsibility is the determination of new specific systems and facilities development projects – their operational and economic objectives and the broad technical plan to be followed. ‘Systems engineering’ controls and guides the use of the new knowledge obtained from the research and fundamental development programmes in the creation of new telephone services and the improvement and lowering of cost of services already established…it attempts to ensure that the technical objectives of the development projects undertaken can be realized within the framework of the new knowledge available in the reservoir and present engineering practice.”

Another early writing directed toward the role of systems engineering appeared in1956. Schlager wrote “Increased complexity of systems recently developed in the fields of communications, instruments, computation, and control has led to an emphasis on the field of systems engineering. Though engineers with system functions can be found in almost all phases of the modern electronics and aircraft industries, there seems to be no commonly agreed upon definition of the term systems engineering. This situation is not at all unusual, since most new fields of engineering pass through an initial period of uncertainty and confusion. Because of the importance of this field to modern system development, this early period should be made as brief as possible. He went on to write that “the rise of systems engineering as a separate field has resulted in some organizational changes in the engineering departments of many companies… typical instance is that of a systems engineering group which has established itself on an equal level with other electrical and mechanical design groups in the engineering department.”

E.W. Engstrom grew up in the Radio Corporation of America (RCA) Laboratories. He became the president

and CEO of that organization in 1961 and 1966 respectively. However, in 1957 he published an article in Electrical Engineering. In the abstract, Engstrom promised to explain the concept of systems engineering in terms of its evolution and characteristics. The engineering of a color television system and of a specific weapons system are used to illustrate its application. In this article, he describes that the RCA had identified a group of individuals that “must supply a proper blending of competence and background in each of the three areas that it contacts: research and fundamental development, specific systems and facilities development, and operations.” He went on to state that “the task of adapting our increasingly complex devices and techniques to the requirements and limitations of the people who must use them has presented modern engineering with its greatest challenge. To meet this challenge, we have come to rely increasingly during recent years upon the comprehensive and logical concept known as systems engineering.”

The first textbook on the subject of systems engineering appears to be Systems Engineering: An Introduction to the Design of Large-Scale Systems. It sold for $10 when published in 1957.

The Sixties and Seventies (1960-1979)

Arthur Hall also worked for Bell Telephone Laboratories. He began teaching one of the earliest Systems Engineering course at MIT. In his book “A Methodology for Systems Engineering”, Hall identified 5 traits of the ideal systems engineer:

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[1]   an affinity for the systems
[2]   faculty of judgment
[3]   Creativity
[4]   facility in human relations, and
[5]   facility for expression
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He also wrote: “Systems engineering is most effectively conceived of as a process that starts with the detection of a problem and continues through problem definition, planning and designing of a system, manufacturing or other implementing section, its use, and finally on to its obsolescence. Further, Systems engineering is not a matter of tools alone; It is a careful coordination of process, tools and people.”

Another interesting historical description of systems engineering appeared in a report to the committee on science and astronautics for the U.S. House of Representatives. Bode (1967) wrote: "...the systems engineer resembles an architect, who must generally have adequate substantive knowledge of building materials, construction methods, and so on, to ply his [or her] trade. Like architecture, systems engineering is in some ways an art as well as a branch of engineering. Thus, aesthetic criteria are appropriate for it also. For example, such essentially aesthetic ideas as balance, proportion, proper relation of means to ends, and economy of means are all relevant in a systems-engineering discussion. Many of these ideas develop best through experience. They are among the reasons why an exact definition of systems engineering is so elusive."

The U.S Department of Defense released MIL-STD-499, MILITARY STANDARD: SYSTEM ENGINEERING MANAGEMENT in July 1969. The intent of this Mil-Std was to provide program managers guidance for managing the systems engineering process. Later, in 1974, the DoD updated their guidance with MIL-STD-499A. It too covered the process, but added the guidelines for the Systems Engineering Management Plan (SEMP) and task statements that could be selectively applied to a DoD acquisition program.

The Eighties and Nineties (1980-1999)

The National Council on Systems Engineering (NCOSE) grew out of the need for formally trained systems engineers. Meetings between industry and academia began in 1989 and continued through 1991. Notable names included Jeffrey Grady (GD), Dr. David Sworder (UCSD), Dr. Brian Mar (U of Washington), Dr. Terry Bahill and Dr. Ron Askin (U of Arizona), and Gerald Chasko (DSMC Regional Director). The group grew to include industry and DoD representatives from the USAF, TRW, Lockheed, Martin Marietta, MacDonnell Douglas, Aerospace Corp, Bechtel, TI, Boeing, Unisys, IBM and many others. In 1989, Dr. Brian Mar took the lead to begin the International Council on Systems Engineering and is recognized as the Father of INCOSE. (Grady, 2013).

Hughes hosted the January 1992 business meeting in Los Angeles with NCOSE now a formally incorporated organization (Honour, 1998). Later, this organization

would change their name and become known as the International Council on Systems Engineering. The first edition "Systems Engineering", the journal for the national council on systems engineering was published in July/September 1994.

In 1995, the NASA Systems Engineering Handbook (NASA/SP-6105) was published to bring the fundamental concepts and techniques of systems engineering to the National Aeronautics and Space Administration (NASA) personnel in a way that recognized the nature of NASA systems and the NASA environment.

Finally, version 1 of INCOSE's Systems Engineering Handbook first appeared in 1997.

2000 to Current

In 2005, the International Standards Organization published their first standard defining systems engineering application and management. The purpose of this ISO standard was to define the interdisciplinary tasks which are required throughout a system's life cycle to transform customer needs, requirements and constraints into a system solution. In addition, it defines the entire systems engineering lifecycle. A number of related standards followed, to include ISO/IEC TR 24748-1:2010, 15288 and 12207.

There are a many great articles documenting a more thorough history of systems engineering that are found in the References section of this brief article.

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