

# Guidance for Systems Engineering Novices

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Some users of the Systems Engineering Body of Knowledge (SEBoK) may be new to the field. This article provides recommended readings for such a user.



## Contents

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Learn the Basic Terms

Get an Overview

Learn About Systems

Learn How the Systems Approach Is Applied to Engineered Systems

Explore the Methods of Systems Engineering

Explore the Applications of Systems Engineering

Read Case Studies

For Later Reading

References

Works Cited

Primary References

Additional References

## Learn the Basic Terms

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As discussed in the Introduction to the SEBoK, there are four key terms that you should first understand when learning about systems engineering (SE):

- A system is “a collection of elements and a collection of inter-relationships amongst the elements such that they can be viewed as a bounded whole relative to the elements around them.” Open systems exist in an environment described by related systems with which

they may interact and conditions to which they may respond. While there are many definitions of the word “system,” the SEBoK authors believe that this definition encompasses most of those which are relevant to SE.

- An engineered system is an open system of technical or sociotechnical elements that exhibits emergent properties not exhibited by its individual elements. It is created by and for people; has a purpose with multiple views; satisfies key stakeholders’ value propositions; has a life cycle and evolution dynamics; has a boundary and an external environment; and is part of a system-of-interest hierarchy.
- Systems engineering is “an interdisciplinary approach and means to enable the realization of successful (engineered) systems.” It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions while considering the complete problem, from system concept exploration through system disposal.
- A systems engineer is “a person who practices systems engineering” as defined above, and whose systems engineering capabilities and experience include sustained practice, specialization, leadership, or authority over SE activities. These activities may be conducted by any competent person regardless of job title or professional affiliation.

## **Get an Overview**

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The next step for someone new to SE is get an overview of the discipline. Part 1: SEBoK Introduction contains four articles particularly helpful to one new to SE.

- The article Systems Engineering Overview frames systems engineering inside the larger topic of ‘Systems Science.’
- The article Economic Value of Systems Engineering makes the business case for investing in systems engineering as a way to reduce total ownership cost.
- The article Systems Engineering and Other Disciplines discusses briefly how systems engineers and other engineers interact as they develop complex systems together.

- Finally, the article Systems Engineering: Historic and Future Challenges gives a quick history of the discipline and discusses what lies ahead.

## **Learn About Systems**

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Engineering is often described as the application of science to develop new products or systems. Part 2: Foundations of Systems Engineering describes some of the underlying systems principles that form the foundation for systems engineering.

- The Knowledge Area on Systems Fundamentals contains five articles. What is a System? is recommended for a new user.
- The Knowledge Area on Systems Science presents two articles on its history and approaches. Both are recommended.
- The Knowledge Area on Systems Thinking has four articles. The first, What is Systems Thinking?, is recommended on a first reading.
- One of the most important current research and practice areas of SE is Model Based Systems Engineering (MBSE). The Knowledge Area Representing Systems with Models provides the foundation for MBSE. The first three of the five articles in the KA are recommended.

## **Learn How the Systems Approach Is Applied to Engineered Systems**

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The Knowledge Area Systems Approach Applied to Engineered Systems describes how systems science and systems thinking lead to the practice of systems engineering. All eight articles are recommended.

- Overview of the Systems Approach
- Engineered System Context
- Identifying and Understanding Problems and Opportunities
- Synthesizing Possible Solutions
- Analysis and Selection between Alternative Solutions
- Implementing and Proving a Solution
- Deploying, Using, and Sustaining Systems to Solve Problems

- Stakeholder Needs and Requirements
- Applying the Systems Approach

## **Explore the Methods of Systems Engineering**

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The SEBoK uses a life-cycle framework to describe the processes that comprise systems engineering. Part 3: SE and Management contains the plurality of the content of the SEBoK in eight knowledge areas. A new user should be familiar with the introductions to each of these Knowledge Areas, and should read further in those KAs of interest.

- Life Cycle Models
- Concept Definition
- System Definition
- System Realization
- System Deployment and Use
- Systems Engineering Management
- Product and Service Life Management
- Systems Engineering Standards

## **Explore the Applications of Systems Engineering**

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The SEBoK partitions the body of knowledge between methods and areas of application. Areas of application are classified as:

- Product Systems Engineering
- Service Systems Engineering
- Enterprise Systems Engineering
- Systems of Systems (SoS)

A new user should read the introduction to Part 4: Applications of Systems Engineering and to the four knowledge areas listed above. The reader's interests can then suggest which further reading should be done.

## **Read Case Studies**

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Finally, the new user should scan the case studies and vignettes in Part 7: SE Implementation Examples and read a few of those in areas that appeal to the reader.

This will help reinforce the fundamentals as well as illustrate the practice of SE.

The following case studies are included:

- Successful Business Transformation within a Russian Information Technology Company
- Federal Aviation Administration Next Generation Air Transportation System
- How Lack of Information Sharing Jeopardized the NASA/ESA Cassini/Huygens Mission to Saturn
- Hubble Space Telescope Case Study
- Global Positioning System Case Study
- Medical Radiation Case Study
- FBI Virtual Case File System Case Study
- MSTI Case Study
- Next Generation Medical Infusion Pump Case Study

## For Later Reading

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Part 6: Related Disciplines contains a broad selection of Knowledge Areas and Topics that describe how systems engineers work with other disciplines. The Knowledge Area on SE and Software Engineering is particularly important, as modern systems get much of their functionality from software.

Part 5: Enabling Systems Engineering has KAs describing how individuals, teams, and organizations can develop to practice effective systems engineering.

A person new to SE should become familiar with several references that are beyond the SEBoK. They include the INCOSE Handbook, several standards (listed in Relevant Standards), and the main journals of systems engineering (including but not limited to *Systems Engineering*, the *Journal of Enterprise Transformation*, and *Systems, Man, and Cybernetics*).

## References

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### Works Cited

None.

## Primary References

None.

## Additional References

None.

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[Previous Article](#) | [Parent Article](#) | [Next Article](#) >  
**SEBoK v. 2.9, released 20 November 2023**

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**This page was last edited on 19 November 2023, at 19:19.**