The SEBoK provides a widely accepted, community-based, and regularly updated baseline of systems engineering (SE) knowledge. Therefore, it is a curated body of knowledge which is updated on a semi-annual basis. This baseline strengthens the mutual understanding across the many disciplines involved in developing and operating systems.

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Topics

Each part of the SEBoK is divided into KAs (knowledge areas), which are groupings of information with a related theme. The KAs, in turn, are divided into topics. This KA contains the following topics:

- Scope of the SEBoK
- Structure of the SEBoK
The primary focus of the SEBoK is on the current baseline of knowledge describing the practice of domain independent systems engineering (SE). This Knowledge Area (KA) contains topic articles which provide an overview of SE practice and discuss its economic value, historic evolution and key relationships.

Topics

Each part of the SEBoK is divided into KAs, which are groupings of information with a related theme. The KAs, in turn, are divided into topics. This KA contains the following topics:

- Systems Engineering Overview
- Economic Value of Systems Engineering
- Systems Engineering: Historic and Future Challenges
- Systems Engineering and Other Disciplines

Systems Engineering

SE is a transdisciplinary approach and means to enable the realization of successful systems. Successful systems must satisfy the needs of their customers, users and other stakeholders. Some key elements of systems engineering are highlighted in Figure 1 and include:

- The principles and concepts that characterize a system, where a system is an interacting combination of system elements that accomplish a defined objective(s). The system interacts with its environment, which may include other systems, users, and the natural environment. The system elements that compose the system may include hardware, software, firmware, people, information,
techniques, facilities, services, and other support elements.

- A systems engineer is a person or role who supports this transdisciplinary approach. In particular, the systems engineer often serves to elicit and translate customer needs into specifications that can be realized by the system development team.
- In order to help realize successful systems, the systems engineer supports a set of life cycle processes beginning early in conceptual design and continuing throughout the life cycle of the system through its manufacture, deployment, use and disposal. The systems engineer must analyze, specify, design, and verify the system to ensure that its functional, interface, performance, physical, and other quality characteristics, and cost are balanced to meet the needs of the system stakeholders.
- A systems engineer helps ensure the elements of the system fit together to accomplish the objectives of the whole, and ultimately satisfy the needs of the customers and other stakeholders who will acquire and use the system.

![Figure 1. Key Elements of Systems Engineering. (SEBoK Original)](image)

**References**

None.

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**SEBoK v. 2.2, released 15 May 2020**

While the primary focus of the SEBoK is on the current practice of domain independent systems engineering, it is also concerned with the future evolution of the discipline.

The topics in this Knowledge Area (KA) summarize SE knowledge which is emerging and transitioning to become part of the practice of systems engineering, such as Model-Based Systems Engineering (MBSE). In general, topics will be introduced here and then expanded into other SEBoK KA’s over time.

The knowledge covered in this KA reflects the transformation and continued evolution of SE. For a summary of the current and future challenges that contribute to this evolution, see Systems Engineering: Historic and Future Challenges. This notion of SE transformation and the other areas of knowledge which it includes are discussed briefly below.
Topics

Each part of the SEBoK is divided into Knowledge Areas (KAs), which are groupings of information with a related theme. The KAs, in turn, are divided into topics. This KA contains the following topics:

- Transitioning Systems Engineering to a Model-based Discipline
- Digital Engineering
- Set-Based Design
- Model-Based Systems Engineering Adoption Trends 2009-2018
- Systems Engineering Core Concepts

Systems Engineering Transformation

The INCOSE Systems Engineering Vision 2025 (INCOSE 2014) describes the global context for SE, the current state of SE practice and the possible future state of SE. It describes a number of ways in which SE continues to evolve to meet modern system challenges. These are summarized briefly below.

Systems engineering has evolved from a combination of practices used in a number of related industries (particularly aerospace and defense). These have been used as the basis for a standardized approach to the life cycle of any complex system (see Systems Engineering and Management). Hence, SE practices are still largely based on heuristics. Efforts are under-way to evolve a theoretical foundation for systems engineering (see Foundations of Systems Engineering) considering foundational knowledge from a variety of sources.

Systems engineering continues to evolve in response to a long history of increasing system complexity. Much of this evolution is in the models and tools focused on specific aspects of SE, such as understanding stakeholder needs, representing system architectures or modeling specific system properties. The integration across disciplines, phases of development, and projects continues to represent a key systems engineering challenge.

Systems engineering is gaining recognition across industries, academia and governments. However, SE practice varies across industries, organizations, and system types. Cross fertilization of systems engineering practices across industries has begun slowly but surely; however, the global need for systems capabilities has outpaced the progress in systems engineering.

INCOSE Vision 2025 concludes that SE is poised to play a major role in some of the global challenges of the 21st century, that it has already begun to change to meet these challenges and that it needs to undergo a more significant transformation to fully meet these challenges. The following bullet points are taken from the summary section of Vision 2025 and define the attributes of a transformed SE discipline in the future:

- Relevant to a broad range of application domains, well beyond its traditional roots in aerospace and defense, to meeting society’s growing quest for sustainable system solutions to providing fundamental needs, in the globally competitive environment.
- Applied more widely to assessments of socio-physical systems in support of policy decisions and other forms of remediation.
- Comprehensively integrating multiple market, social and environmental stakeholder demands against “end-to-end” life-cycle considerations and long-term risks.
- A key integrating role to support collaboration that spans diverse organizational and regional boundaries, and a broad range of disciplines.
- Supported by a more encompassing foundation of theory and sophisticated model-based methods and tools allowing a better understanding of increasingly complex systems and decisions in the face of uncertainty.
- Enhanced by an educational infrastructure that stresses systems thinking and systems analysis at all learning phases.
- Practiced by a growing cadre of professionals who possess not only technical acumen in their domain of application, but who also have mastery of the next generation of tools and methods necessary for the systems and integration challenges of the times.

Some of these future directions of SE are covered in the SEBoK. Others need to be introduced and fully integrated into the SE knowledge areas as they evolve. This KA will be used to provide an overview of these transforming aspects of SE as they emerge. This transformational knowledge will be integrated into all aspects of the SEBoK as it matures.

References

Works Cited


Relevant Videos

- Leading the Transformation of Model-Based Engineering

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**SEBoK v. 2.2, released 15 May 2020**

The users and uses described in this article were identified based on the six SEBoK purposes described in the SEBoK Introduction.

Users can either be primary (those who use the SEBoK directly) or secondary (those who use the SEBoK with assistance from a systems engineer). Indicative, but not exhaustive, sets of example uses are shown in Tables 1 and 2 below.

**New to SEBoK or Systems Engineering?**

The list of users and use cases below allow someone who has come to the SEBoK with a particular focus to identify quickly where to focus their reading. If you are completely new to systems engineering or have no clear view of how it is covered in the SEBoK, you should use Use Case 0 below to orient yourself and learn the basics before looking at the other use cases:

- Use Case 0: Systems Engineering Novices

**Primary Users**

Primary users are those who use the SEBoK directly, as shown in Table 1. Hyperlinks in the second column link to the associated use case, where one has been written. The use cases are listed at the end of the topic, and may also be seen here.

<table>
<thead>
<tr>
<th>#</th>
<th>Users</th>
<th>Uses</th>
</tr>
</thead>
</table>

Table 1. Primary SEBoK Users and Common Uses. (SEBoK Original)
1 Practicing Systems Engineers ranging from novice through expert

• Taking on a new SE role in a project; preparing by finding references for study
• Expanding SE expertise and specialization; preparing by finding references for study
• Seeking to understand the principles of SE; seeking the best references to elaborate on those principles
• Reviewing a project or mentoring a new SE performer; seeking to understand what best practices to look for
• Pursuing professional development through study of SE topics, including new developments in SE

• Maintaining a library of SE process assets; seeking to understand which SE process models and standards are most relevant
• Tailoring a process for a specific project; seeking to learn how others have tailored processes, or how a specific application domain affects tailoring
• Measuring the effectiveness of an organization’s SE processes; seeking to learn how others have implemented processes
• Defining standards for a professional society or standards organization

2 Process engineers responsible for defining or implementing SE processes

• Developing a new graduate program in SE and deciding what core knowledge all its students must master; the user should consult the Graduate Reference Curriculum for Systems Engineering (GRCSE™) in conjunction with the SEBoK

3 Faculty Members

• Developing a new SE course; seeking to identify course objectives, topics, and reading assignments
• Incorporate SE concepts in courses or curricula focused on engineering disciplines other than SE

4 GRCSE authors

• As members of the GRCSE author team, deciding what knowledge to expect from all SE graduate students; see Graduate Reference Curriculum for Systems Engineering (GRCSE™) (Pyster et al. 2015)

5 Certifiers

• Defining a company’s in-house SE certification program; seeking to understand what others have done, how such programs are typically structured, and how to select the knowledge that each person seeking certification should master
• Defining certification criteria for a professional society or licensure program

6 General Managers, Other Engineers, Developers, Testers, Researchers

• Learning of what the role of the systems engineer consists, relative to others on a project or in an organization
• Learning to effectively perform a general manager role on an SE integrated product team

• Mastering basic vocabulary, boundaries, and structure of SE; seeking a few primary references
• Learning what the scope of SE is, relative to the General Manager role

7 Customers of Systems Engineering

• Providing resources to and receiving artifacts from systems engineers
• Seeking to better understand what to ask for, how to request it, how much to pay for it, and how to judge the quality of what is received
• Evaluating possible changes in team processes and tools proposed by systems engineers on various teams; seeking independent information with which to evaluate the proposals

8 SE Managers
Secondary Users

Secondary users are those who use the SEBoK with assistance from a systems engineer, as shown in Table 2.

<table>
<thead>
<tr>
<th>#</th>
<th>Users</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Human Resource Development Professionals</td>
<td>• Supporting the hiring and professional development of systems engineers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Augmenting understanding of central concerns with information about relevant SE topics, e.g., a contracting manager might want to better understand SE deliverables being called out in a contract</td>
</tr>
<tr>
<td>2</td>
<td>Non-Technical Managers</td>
<td>• Defining the impact of SE performance on central concerns, e.g., understanding the liability of a systems engineer for errors in judgment on a project, or the limitations of SE in guaranteeing the success of a project against actions of sponsors, managers, or developers</td>
</tr>
<tr>
<td>3</td>
<td>Attorneys, Policy Makers</td>
<td></td>
</tr>
</tbody>
</table>

List of Use Cases

At this time, not every class of user has a use case developed. To illustrate the major uses, the following use cases are included:

- Use Case 1: Practicing Systems Engineers. This covers the first set of users from Table 1.
- Use Case 2: Other Engineers. This covers the second and sixth sets of users from Table 1.
- Use Case 3: Customers of Systems Engineering. This covers the seventh set of users from Table 1.
- Use Case 4: Educators and Researchers. This covers the third, fourth, and ninth sets of users from Table 1.
- Use Case 5: General Managers. This covers the sixth and eighth sets of users from Table 1.

While not exhaustive, the use cases show the utility of the SEBoK in various applications and contexts.

References

Works Cited

None.

Primary References

None.

Additional References

None.