

Case Studies

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Systems engineering principles described in the Systems Engineering Body of Knowledge (SEBoK) Parts 1-6 are illustrated in Part 7, Systems Engineering Implementation Examples. These examples describe the application of systems engineering practices, principles, and concepts in real settings. These systems engineering examples can be used to improve the practice of systems engineering by illustrating to students and practitioners the benefits of effective practice and the risks of poor practice. There are two kinds of SE implementation examples: articles written for the SEBoK and those based on the SE literature.



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List of Examples from the SE Literature

The following examples 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
- Global Positioning System Case Study II
- Medical Radiation Case Study
- FBI Virtual Case File System Case Study
- MSTI Case Study
- Next Generation Medical Infusion Pump Case Study
- Design for Maintainability
- Complex Adaptive Operating System Case Study
- Complex Adaptive Project Management System Case Study
- Complex Adaptive Taxi Service Scheduler Case Study
- Submarine Warfare Federated Tactical Systems Case Study
- Northwest Hydro System

Systems engineering (SE) case studies can be characterized in terms of at least two relevant parameters, viz., their degrees of complexity and engineering difficulty, for example. Although a so-called quad chart is likely an oversimplification, a 2 x 2 array can be used to make a first-order characterization, as shown in Figure 1.

2 X 2 Case Study Profiler

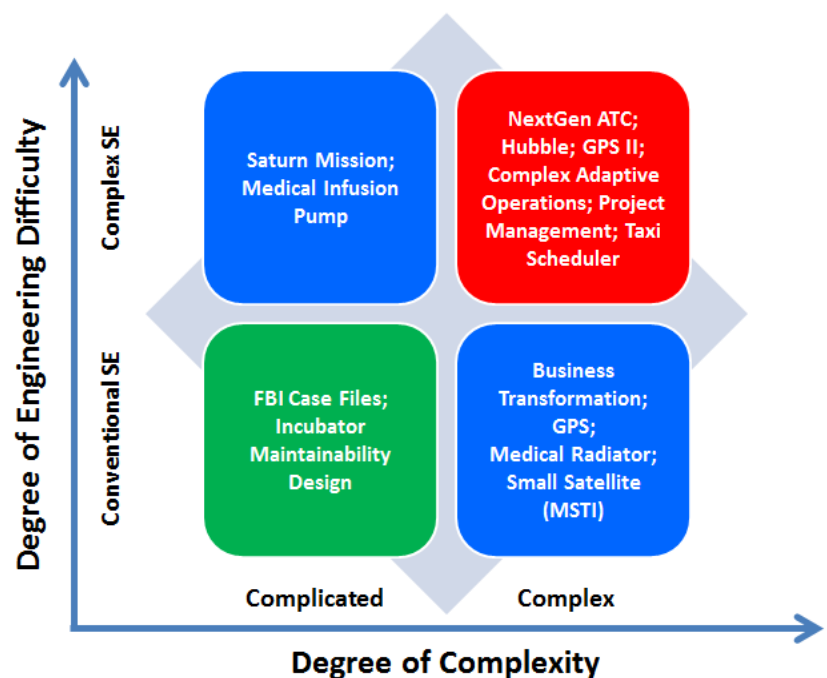


Figure 1 Case Study Profiler (SEBoK Original)

The x-axis depicts complicated, the simplest form of complexity, at the low-end on the left, and complex,

representing the range of all higher forms of complexity on the right. The y-axis suggests how difficult it might be to engineer (or re-engineer) the system to be improved, using Conventional (classical or traditional) SE, at the low-end on the bottom, and Complex SE, representing all more sophisticated forms SE, on the top. This upper range is intended to cover system of systems (SoS) engineering (SoSE), enterprise systems engineering (ESE), as well as Complex SE (CSE). The distinctions among these various forms of SE may be explored by visiting other sections of the SEBoK. In summary, the SEBoK case study editors have placed each case study in one of these four quadrants to provide readers with a suggested characterization of their case study's complexity and difficulty. For sake of compactness the following abbreviations have been used:

- Business Transformation (Successful Business Transformation within a Russian Information Technology Company)
- NextGen ATC (Federal Aviation Administration Next Generation Air Transportation System)
- Saturn Mission (How Lack of Information Sharing Jeopardized the NASA/ESA Cassini/Huygens Mission to Saturn)
- Hubble (Hubble Space Telescope Case Study)
- GPS and GPS II (Global Positioning System Case Study)
- Medical Radiator (Medical Radiation Case Study)
- FBI Case Files (FBI Virtual Case File System Case Study)
- Small Satellite MSTI (MSTI Case Study)
- Medical Infusion Pump (Next Generation Medical Infusion Pump Case Study)
- Incubator Maintainability Design (Design for Maintainability)
- Complex Adaptive Operations (Complex Adaptive Operating System)
- Taxi Scheduler (The Development of the First Real-Time Complex Adaptive Scheduler for a London Taxi Service)
- Project Management (The Development of a Real-Time Complex Adaptive Project Management Systems)
- SWFTS MBSE (Submarine Warfare Federated Tactical Systems Case Study)

Value of Case Studies

Case studies have been used for decades in medicine, law, and business to help students learn fundamentals and to help practitioners improve their practice. A Matrix of Implementation Examples is used to show the alignment of systems engineering case studies to specific areas of the SEBoK. This matrix is intended to provide linkages between each implementation example to the discussion of the systems engineering principles illustrated. The selection of case studies cover a variety of sources, domains, and geographic locations. Both effective and ineffective use of systems engineering principles are illustrated.

The number of publicly available systems engineering case studies is growing. Case studies that highlight the aerospace domain are more prevalent, but there is a growing number of examples beyond this domain.

The United States Air Force Center for Systems Engineering (AF CSE) has developed a set of case studies "to facilitate learning by emphasizing the long-term consequences of the systems engineering/programmatic decisions on cost, schedule, and operational effectiveness." (USAF Center for Systems Engineering 2011) The AF CSE is using these cases to enhance SE curriculum. The cases are structured using the Friedman-Sage framework (Friedman and Sage 2003; Friedman and Sage 2004, 84-96), which decomposes a case into contractor, government, and shared responsibilities in the following nine concept areas:

1. Requirements Definition and Management
2. Systems Architecture Development
3. System/Subsystem Design
4. Verification/Validation
5. Risk Management
6. Systems Integration and Interfaces
7. Life Cycle Support
8. Deployment and Post Deployment
9. System and Program Management

This framework forms the basis of the case study analysis carried out by the AF CSE. Two of these case studies are highlighted in this SEBoK section, the Hubble Space Telescope Case Study and the Global Positioning System Case Study.

The United States National Aeronautics and Space Administration (NASA) has a catalog of more than fifty NASA-related case studies (NASA 2011). These case studies include insights about both program management and systems engineering. Varying in the level of detail, topics addressed, and source organization, these case studies are used to enhance learning at workshops, training, retreats, and conferences. The use of case studies is viewed as important by NASA since "organizational learning takes place when knowledge is shared in usable ways among organizational members. Knowledge is most usable when it is contextual" (NASA 2011). Case study teaching is a method for sharing contextual knowledge to enable reapplication of lessons learned. The MSTI Case Study is from this catalog.

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Additional References

None.

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