Capability Engineering

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Capability is increasingly being used to describe the Systems Engineering of Operational Capabilities. The INCOSE UK Capability System Engineering Guide (Kemp and Daw) built on this analysis and describes:

- That Capabilities are realised through a combination of people, processes, information as well as equipment;
- They are concerned with delivering outcomes, rather than outputs;
- They are enduring, with capabilities being upgraded rather than replaced;The term emerged in defence in the early 2000, however the concepts go back far earlier (Checkland, 1997).
- The concepts of Capability Systems Engineering have been used in Rail (Dogan, 2012) and Healthcare (Royal Academy of Engineering, 2017).

is widely used across many industrial sectors and has begun to take on various specific meanings across, and even within, those sectors. Terms such as capability-based acquisition, capability engineering and management, life capability management, capability sponsor, etc. are now ubiquitous in defense and elsewhere. Henshaw et al. (2011) have identified at least eight worldviews of capability and capability engineering and concluded that the task of capability engineering is not consistently defined across the different communities.

The aim of capability systems engineering is to ensure that the upgraded capability meets stakeholders needs. Good Capability Systems Engineering provides a clear

line of sight from the purpose of the capability, through the operational concept and whole system design down to specific requirements and interfaces (Figure 1)

[Add Figure]

Capability engineering is concerned with the whole lifecycle (Figure 2); the "Fuzzy front end" of capability trade-offs, the conventional 'V' product lifecycle, and the "Messy in-service" support phase.

[Add figure]

Capability Systems Engineering uses standard SE tools, applied from the perspective of the asset owner-operators (i.e. the military user or rail transportation provider).

Kemp and Daw (2014) note several differences between Capability Systems Engineering and the more traditional product Systems Engineering:

- Using persuasion and influence as much as command and control to implement decisions
- Building in flexibility where possible, as the capability will change.
- Implementing the transition to the improved capability as both an engineering and cultural change.
- Recognising that capabilities are often Complex Adaptive Systems. As the capability improves, users or competitors change their behaviour, reducing the effectiveness of the capability
- Capability trade-offs are not about simple comparisons, between similar things – often they are choices between new equipment, better training or new processes.

There is a strong relationship between Capability Engineering and system of systems (SoS).. To some a Capability is a type of system/SoS, to others it is what the system/SoS does. This is explored in Henshaw et al. (2011), who describe at least eight worldviews of capability and capability engineering

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Services View of SoSE

As it has been discussed throughout the Systems of Systems (SoS) knowledge area, a 'system of systems' is typically approached from the viewpoint of bringing together multiple systems to provide broader capability. As is discussed in Architecting Approaches for Systems of Systems, the networking of the constituent systems in a SoS is often a key part of an SoS. In some circumstances, the entire content of a SoS is information and the SoS brings together multiple information systems to support the information needs of a broader community. These 'information technology

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information technology (IT)-based' SoSs have the same set of characteristics of other SoSs and face many of the same challenges. Currently, IT has adopted a 'services' view of this type of SoS and increasingly applies a International Organization for Standaradization (ISO) 20000 series (Information technology -- Service management) or Information Technology Infrastructure Library (ITIL) v. 3 (OGC 2009) based approach to the design and management of information-based SoS. A service perspective simplifies SoSE as it:

- is a more natural way for users to interact with and understand a SoS,
- allows designers to design specific services to meet defined performance and effectiveness targets, and
- enables specific service levels to be tested and monitored through life.

Although it has not been proven to be universally applicable, the services view works well in both IT and transportation SoS.

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This page was last edited on 18 November 2023, at 22:02.