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Systems Engineering and Commercial and Public Interest Domains

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Abstract This case study examines systems engineering models applicable to different domains. The basics and principles of systems engineering are applicable within the different domains; however, each domain or industry requires variations of the basic principles relevant to the project or system being developed. Similarly, the baseline for systems engineering processes does not change, but is adapted for each domain. These domains examined include:

- defence, aerospace
- telecommunications
- transport, including commercial aircraft and high technology buses
- resource management, including facilities and radioactive disposal
- environment
- legal system

The system elements examined are project life cycle, system functions, system architecture, and requirements drivers. The case objective is to identify variations in system engineering elements and procedures price competition, regulations and standards, technological change and different user requirements [1].

Keywords Systems Engineering, Public Interest Domains, telecommunications

Introduction

Systems engineering was developed for defence applications, thus its principles and practices were derived from defence industries. The objectives underlying system engineering nevertheless are applicable to major projects and system developments, and its practices were adapted to serve many domains including commercial and public interest. INCOSE [2] compares defence to commercial applications, placing systems engineering into system development phases in both applications. Public interest is not compared to defence in the study, although it is compared to the commercial domain. Figure 1 illustrates these relationships.

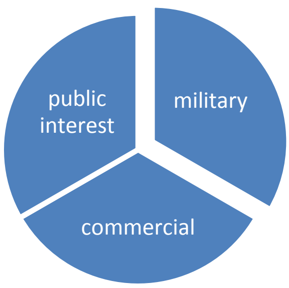

Figure 1: Systems engineering: relationships of domains [3]

Figure 1 shows the commercial domain, comprising for-profit businesses and public interest, consisting of government and not-for-profit organisations. Defence is slightly separate, as it has different objectives.

In systems engineering'sconceptual phase, mission analysis and needs analysis are undertaken in all domains. These elements are configured to accommodate the project or the system, based on a framework for each domain. An important step in system design is identifying and incorporating stakeholder requirements, and these relate to the type of domain and the priority of the requirement to determine the system's drivers. Moreover, the data relevant to a domain require analyses before being accepted into the systems design process, such as seat prices in commercial aircraft, or regulations and public reaction in waste management. Figure 2 shows the system design process.

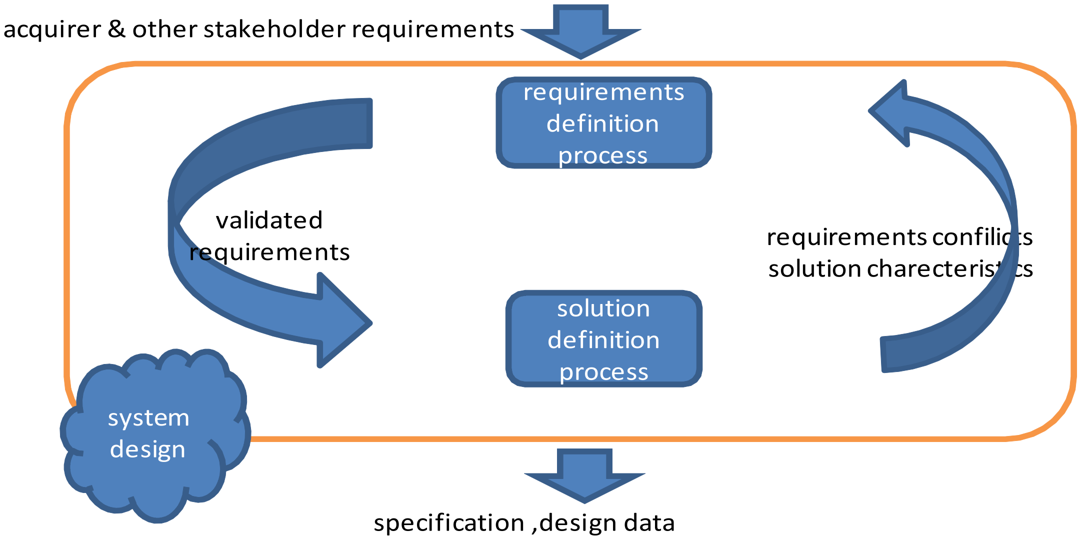

Figure 2: System design process [4]

As shown in figure 2, drivers, features, use and data for each system development vary substantially, each system is unique.

There is domain commonality in systems engineering regarding a system's life cycle, where projects generally follow the traditional model from recognition of needs to disposition. On the other hand, "the most apparent differences between US DoD and commercial programs show up in program phases and the typical time span to accomplish any (and all) phases" [5]. Consequently, the study author did not consider time span and program phases although stating that system engineering in different domains follow the traditional model of life cycle.

Functions refer to performance of system elements such as hardware and software, and functional architecture is the model for these elements. Elements display performance characteristics, interactions, constraints and perhaps time limitations and these form part of the functional architecture. Each element has a number of sub functions to meet the objectives of the whole system. Therefore, the configuration of the system, the numbers of sub functions and their types, and the number of levels (depth) depend on the objective of the system [5]. Function, as a model of sub-routines and elements, is again common to all domains across systems engineering and with both product and service developments.

Building blocks

For comparison of domain architectures, the author refers to building block models. Although the structure of the diagram is similar in each case, the elements vary. In figure 3, the building block diagram is based on a product domain where every element necessary to support the top-level system can be included into the system and can be deconstructed into further levels.

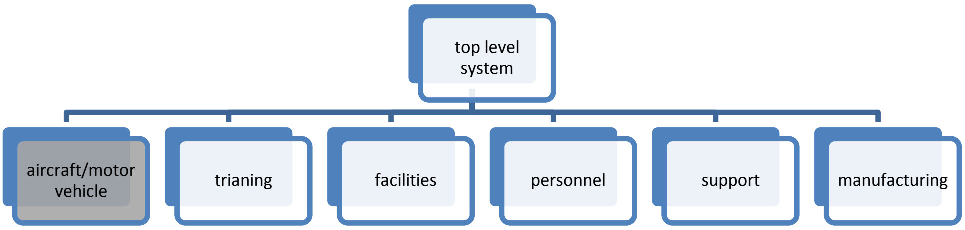

Figure 3: Model building blocks [6]

In the case study, the aircraft and motor vehicle element forms a summary level to a series of sub-functions, and contributes to the system in parallel with other elements which together support the system mission. Figure 3 illustrates the physical building blocks. Note that aircraft or motor vehicle is part of the system and elements of the system. The difference in level two is that there is an extra element called systems engineering and integration in motor vehicle system.

Characteristics of Design

The elements of system engineering reported in the case are system or project life cycle, functional and physical architecture, and priority requirements or drivers. Commercial and public interest domains are explained and separated from the original defence concepts for system engineering. The system uses a hard system approach in which functions, architecture and requirements are determined and specified, and the physical elements relevant to project or system, by domain, are described.

Identify and Resolve Complexity

The case study describes complex interactions between the elements of the system in the commercial and public interest domains. The size of each systems adds another dimension as more elements are introduced, thus contributing exponentially to complexity. There is a wide range stakeholders involved in each domain which makes the system more complex. This is illustrated in public interest projects, where public input on perhaps unlimited topics regarding the project adds further complexity to the process. In traditional concepts (military) the process has greater definition as the project often has a single customer, whereas in public interest and commercial areas customers are within a market for the product or service. Hence, a competitive market requires very different planning than a defence client with a focus on performance. Regulatory constraints form complexity with a range of public interest and defence usages, and are a factor for commercial domains. System complexity is difficult to resolve and must be managed to avoid risk.

Evaluate the Systems Engineering Application

The methodology for the case study is effective and described in accordance with INCOSE [5]. System engineering applications in the domains is realistic, the examples are explained clearly and well matched with system engineering principles.

Conclusion

Although there is a commonality in approach, each systems domain has characteristics that require design adaptation. The type of project or service is also relevant in design, so that each project is unique. Complexity in the larger models is not controllable, as each additional element contributes another degree of interaction, thus management of the system itself is required, rather than reducing the number of components. There is a hierarchy of sub-systems in each model, and the levels of each sub-system contribute to the overall project or service goal from conception through to termination. Finally, systems engineering processes should be compatible with the environment of specific domains.

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