
Space systems — Guidelines for the management of systems engineering

*Systèmes spatiaux — Lignes directrices pour le management de
l'ingénierie système*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html. (standards.iteh.ai)

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Introduction

There is general consensus that to accomplish space programme/project requirements, it is mandatory to manage the systems engineering activities. The main role of systems engineering management is to ensure system performance conforms with expressed need, and to control the technical risks involved in development. Also, cost and schedule parameters are taken into account in space systems engineering in the search of optimal performance.

Thus, this document provides guidelines for managing the systems engineering activities related to planning, assessment and control of space programmes/projects.

These guidelines are intended to identify a set of recommendations to help customers and space system organizations to establish management requirements for systems engineering activities and help the organization to construct the elements of the systems engineering management plan (SEMP).

Given the need for systems engineering management, the overall systems engineering activities can be divided into two types:

- systems engineering management activities related to programme management which comprise planning, assessing, controlling, trade-off studies and decision making;
- the technical activities themselves, linked to the technical processes (stakeholder requirements analysis, system requirements analysis, system architectural design, system detailed design and assembly, integration, and verification and validation) applied to the system.

Therefore, systems engineering management reinforces the technical viewpoint within programme management.

In these guidelines, a set of leading indicators are suggested as measures for evaluating the effectiveness of each space systems engineering activity. Leading indicators are important tools for project management to make interventions and actions to avoid rework and wasted effort during the whole system engineering life cycle.

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Space systems — Guidelines for the management of systems engineering

1 Scope

This document presents the guidelines for the management of systems engineering for space systems.

This document addresses the systems engineering activities and provides guidelines for interfacing with specific major management subjects (e.g. configuration management, data management, interface management, risk management, requirements management, and integrated logistics support), which are themselves the subject of this document.

This document establishes a common reference for all customers and suppliers in the space sector to work with management systems engineering for all space products and projects.

These guidelines emphasize the following aspects of managing space systems engineering:

- the positioning of space systems engineering activities related to the management of space activities;
- the framework for the management of systems engineering;
- the systems engineering management plan (SEMP);
- the system, product and work breakdown structures;
- the phasing, scheduling and recursivity of the systems engineering management;
- reviews, audits and control gates;
- the main activities of systems engineering and the respective management approach.

It is not the scope of this document to describe in detail the standard systems engineering process or project management process for all types of space systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 management

coordinated activities to direct and control an *organization* (3.2)

[SOURCE: ISO 9000:2015, 3.3.3]

**3.2
organization**

person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

[SOURCE: ISO 9000:2015, 3.2.1]

**3.3
programme**

group of *projects* (3.5) managed in a coordinated way to obtain benefits not available from managing them individually

[SOURCE: ISO 10795:2011, 1.166]

**3.4
process**

set of interrelated or interacting activities that use inputs to deliver an intended result

[SOURCE: ISO 9000:2015, 3.4.1]

**3.5
project**

unique *process* (3.4), consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources

[SOURCE: ISO 9000:2015, 3.4.2]

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**3.6
system**

set of interrelated or interacting elements

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**3.7
systems engineering**

interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations and constraints into a solution and to support that solution throughout its life

[SOURCE: ISO 24748-1:2016, 2.56]

**3.8
systems engineering management**

discipline to ensure that *system engineering* (3.7) is properly applied and can be divided in planning, control, assessment and decision analysis, including management tools like work breakdown structures, risk management, requirements traceability and reviews

**3.9
stakeholder**

customers and/or users or those who will receive the goods or services and are the direct beneficiaries of the *systems* (3.6) or other interested parties who affect or are affected by the *project* (3.5), providing overarching constraints within which the customers' needs should be achieved

4 Positioning of systems engineering management

4.1 General

This clause aims to justify the space systems engineering management activity in relation to the management of design and manufacturing engineering activities, in relation to project management and in relation to the mission/programme/project.

4.2 Need for systems engineering management

This subclause highlights what is special in systems engineering that requires management.

The main aspects to be approached are:

- a) requirements not known beforehand but continuously engineered by the systems engineering process;
- b) complexity of the elements in the environment, material, information and energy, that exchange with the system;
- c) quantity and variety of stakeholders, requirements, concepts, functionalities, technologies, suppliers, contracts and life cycle process implementation organizations;
- d) iterative nature of the systems engineering process from requirements until the convergence to a system solution;
- e) recursive nature of the systems engineering process applicable to systems but also to subsystems in the various layers of the system breakdown structure;
- f) risk management when verification activity cannot be exhaustive.

4.3 Systems engineering

Systems engineering provides the identification and understanding of a need and derives, develops and verifies a solution that will be balanced during the space system life cycle in order to meet that need. Systems engineering balances the satisfaction of all stakeholders involved in the solution life. [Figure 1](#) presents the V-Model and its set of systems engineering processes in the classical life cycle stages.

The term systems engineering process describes the activities used to transform requirements in an effective product. These activities enable systems engineers to coordinate the interaction between engineers, other specialists, stakeholders, operators, and manufacturing.

The classical space systems life cycle is divided into stages, and each stage contains systems engineering processes. The concept stage includes the concept of the operations process; the development stage includes the requirements and architecture analysis processes, and detailed design process; the production stage includes the synthesis process, assembly, integration and verification process, and system validation process; and the utilization stage includes the operations and maintenance processes.

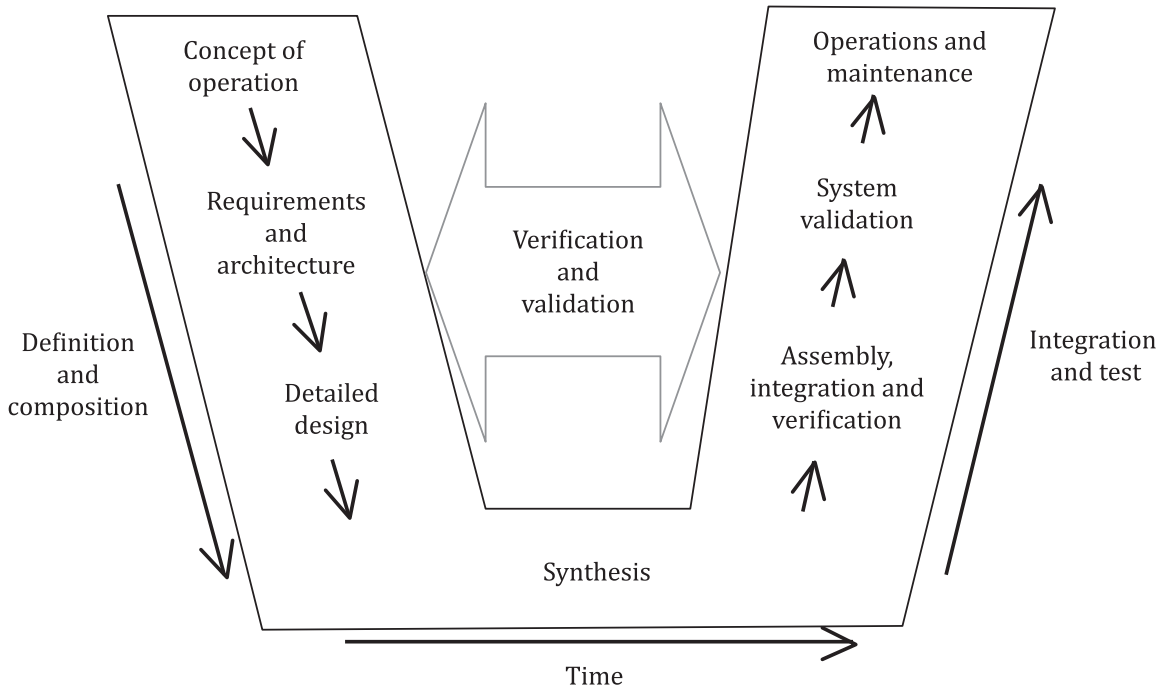


Figure 1 – Systems engineering V model
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Systems engineering is concerned with the delivery of a technical solution that meets stakeholder needs and provides a set of baseline requirements to be used as a reference for project management.

Project management uses these references provided by systems engineering to compare what is being implemented to what has been planned.

Project management is responsible for the project organization, and other aspects of the project, such as, cost, schedules, human resources, communication, programmatic risk, acquisition strategy, sustainment and external interfaces.

4.4 Systems engineering management

The systems engineering process is managed from the time of need identification to a verified and validated solution. Also, systems engineering management includes configuration management, data management, technical risk management, and interface management.

4.5 Systems engineering management relative to the mission/programme/project

Systems engineering management is part of the mission/programme/project, and interacts with other management disciplines within the mission/programme/project activities.

Figure 2 presents the position of programme management related to systems engineering activities. The programme management circle consists of the management tasks including planning, assessment of progress, control actions and trade-offs and decision making to correct the course of the project. The systems engineering circle is related to the main activities of systems engineering process, such as stakeholder requirements analysis, system requirements analysis, system architectural design, system detailed design, assembly and integration, and verification and validation. The intersection circle corresponds to the interaction between management tasks and the systems engineering activities required to accomplish the mission/programme/project.

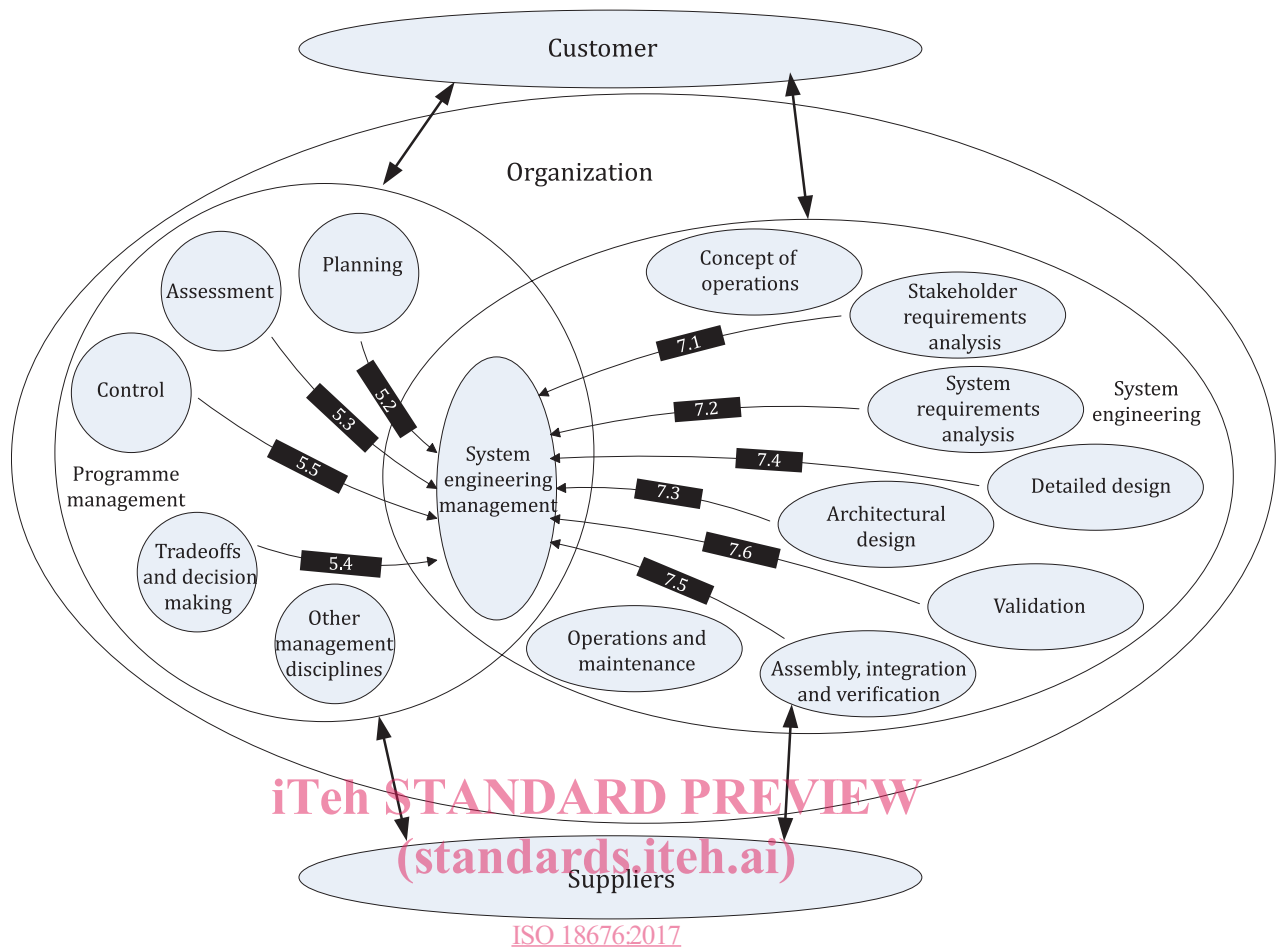


Figure 2 — Position of programme management related to system engineering activities

5 Management of the systems engineering activities

5.1 General

The objective of the management of systems engineering activities is to achieve the required outputs of the space system project. This management covers the task planning, assessment, control, trade-offs, and decision making applied to assure the correct management of the project in all phases of the systems engineering process.

5.2 Planning

Planning refers to the identification of the activities to be performed, their appropriate sequence and resources needed for their accomplishment. This task consists of preparing the necessary technical plans and complementary project planning information used to support the mission and the systems engineering activities, and should include the following.

- Implementation strategy: Define a strategy for implementing the mission/programme/ project and the systems engineering activities as a basis for project technical planning;
- Technical effort: Describe what will be accomplished, how systems engineering will be done, what resources are needed and how the systems engineering effort will be monitored and controlled in accordance with the implementation strategy;
- Schedule and organization: Define how the technical effort will be scheduled and organized;