International Standard

ISO 18676

Space systems — Requirements and guidelines for the management of systems engineering

Systèmes spatiaux — Exigences et lignes directrices pour le management de l'ingénierie système

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Foreword

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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 document 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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

This second edition cancels and replaces the first edition (ISO 18676:2017), which has been technically revised.

The main changes are as follows:

— updated the normative references in Clause 2;

— updated the terms and definitions references in Clause 3.

— changed some recommendations to requirements in Clauses 5 to 13.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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 requirements and recommendations for managing the systems engineering activities related to planning, assessment and control of space programmes/projects.

These requirements and recommendations are intended 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;

— technical activities 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 this document, 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.

This document emphasizes 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.

Space systems — Requirements and guidelines for the management of systems engineering

1 Scope

This document presents the requirements and recommendations 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).

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

This document does not describe in detail the standard systems engineering process or project management process for all types of space systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10795, *Space systems — Programme management and quality — Vocabulary*

ISO 14300-1, *Space systems — Programme management — Part 1: Structuring of a project*

ISO 27026, *Space systems — Programme management — Breakdown of project management structures*

ISO 21886, *Space systems — Configuration management*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10795 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
management
coordinated activities to direct and control an *organization* (3.2)

Note 1 to entry: Management can include establishing policies and objectives, and *processes* (3.3) to achieve these objectives.

Note 2 to entry: The word “management” sometimes refers to people, i.e. a person or group of people with authority and responsibility for the conduct and control of an organization. When “management” is used in this sense, it should always be used with some form of qualifier to avoid confusion with the concept of “management” as a set of activities defined above. For example, “management shall…” is deprecated whereas “top management shall…” is acceptable. Otherwise, different words should be adopted to convey the concept when related to people, e.g. managerial or managers.

[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

Note 1 to entry: The concept of organization includes, but is not limited to, sole-trader, company, corporation, firm, enterprise, authority, partnership, association, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

[SOURCE: ISO 9000:2015, 3.2.1, modified — Note 2 to entry has been removed.]

3.3
process
set of interrelated or interacting activities that use inputs to deliver an intended result

[SOURCE: ISO 9000:2015, 3.4.1, modified — Notes to entry have been removed.]

3.4
programme
group of *projects* (3.5) managed in a coordinated way to obtain benefits not available from managing them individually

[SOURCE: ISO 14300-1:2023, 3.2]

3.5
project
unique *process* (3.3), 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, modified — Notes to entry have been removed.]

3.6
system
set of interdependent elements constituted to achieve a given objective by performing a specified function

[SOURCE: ISO 16091:2018, 3.1.23, modified — Note 1 to entry has been removed.]

3.7
systems engineering
interdisciplinary approach governing the total technical and managerial effort required to transform a set of *stakeholder* (3.9) needs, expectations and constraints into a solution and to support that solution throughout its life

[SOURCE: ISO/IEC/IEEE 24748-1:2018, 3.57]

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* (3.1) tools like work breakdown structures, risk management, requirements traceability and reviews

3.9
stakeholder
customer, user, person who will receive the goods or services and is the direct beneficiary of the *system* (3.6). or other interested party who affects or is affected by the *project* (3.5)

Note 1 to entry: The stakeholders provide overarching constraints within which the customers' needs should be achieved

[SOURCE: ISO 16404:2020, 3.10, modified — "beneficiaries of the systems" has been replaced by " beneficiary of the system"; "providing overarching constraints within which the customers' needs should be achieved" at the end of the definition has been removed; note 1 to entry has been added.]

4 Positioning of systems engineering management

4.1 General

This clause justifies the space systems engineering management activity in relation to:

— the management of design and manufacturing engineering activities;

— project management;

— the mission/programme/project.

4.2 Need for systems engineering management

Systems engineering management is necessary due to the following reasons:

a) new requirements that keep coming up in 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 till 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 activities cannot be exhaustive.

4.3 Systems engineering

Systems engineering provides the identification and understanding of a need; it derives, develops and verifies a solution that will fit with the needs/requirements 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 into an effective product. These activities enable systems engineers to coordinate the interaction between engineers, other specialists, stakeholders, operators and manufacturers.

As defined in ISO 14300-1, the classical life cycle of space systems 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 the detailed design process; the production stage includes the synthesis process, the assembly, integration and verification process, and the system validation process; and the utilization stage includes the operations and maintenance processes.

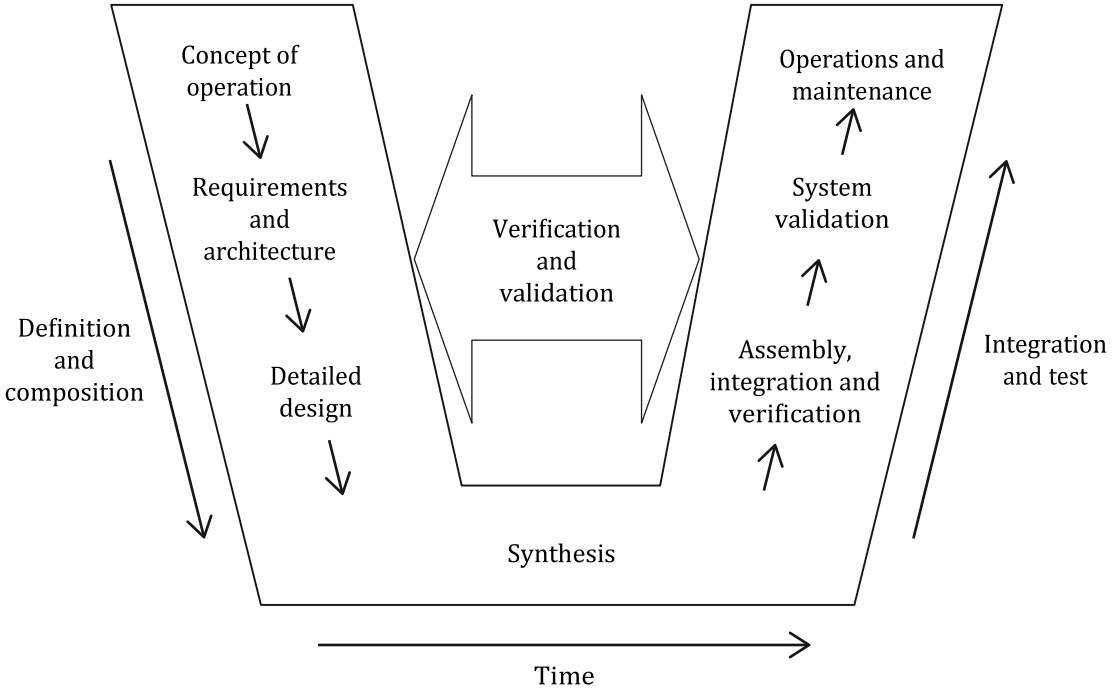

Figure 1 — Systems engineering V model

Systems engineering focuses on the delivery of a technical solution that meets stakeholder needs and provides a set of baseline requirements to be used as references for project management.

These references are used in project management to compare what is being implemented with what has been planned.

Project management covers 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 the delivery of a verified and validated solution. Also, systems engineering management includes configuration management, which shall be in accordance with ISO 21886, 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.