

Product Life Cycle Management Guideline

EDM-P-210
New Product Exploration
A System Engineering Approach
V1.0
January 2023

Contact

Geert Willems

Phone: +32 16 288962
Mobile: +32 498 91 94 64
Geert.Willems@imec.be
IMEC
Kapeldreef 75
B3001 Heverlee

Verantwoordelijke uitgevers

Luc Van den Hove - IMEC

Copyright © imec 2023 All rights reserved.

Only an authorized person is hereby permitted to view and use this document subject to the following conditions:

1. This document may be used for informational purposes only.
2. Any copy of this document or portion thereof must include the copyright notice.
3. This information is provided "AS IS" and without warranty of any kind, express, implied, statutory, or otherwise.
4. Imec shall not be liable for any actual, direct, indirect, incidental or consequential damages arising out of the use, performance or application of this document.

Permission is not granted for resale or commercial distribution or use of the document, in whole or in part, or by itself or incorporated in another work.

The Product Life Cycle Management Guideline

The Product Life Cycle Management (PLCM) Guidelines intend to provide guidelines for the overall management of the life cycle of electronics and of the electronics' aspects of products containing electronics with focus on the design, manufacturing, operation, reliability and end-of-life.

- The recommendations given in the guidelines are intended to help the user in the Product Life Cycle Management of electronics and products with integrated electronics.
- The PLCM guidelines promote the use of scientific methods such as physical modeling, physics-of-failure based accelerated testing, simulation, virtual prototyping, etc. Physical models extend the capability of predicting the designed product's properties and behavior beyond experience. This provides a cutting-edge innovation advantage over an experience and test-based development approach.
- Physical models reduce the development cost and time by reducing product testing and, especially, the number of design iterations.

Product Life Cycle Stages and Phases

The following Product Life Cycle stages and phases are distinguished.

New Product Exploration

1. Problem Research

Evaluation of the product idea by experts and stakeholders on its technological feasibility, its viability of providing a solution to a user problem and its business potential. The output is a first assessment of business problem/opportunity, a preliminary solution concepts, and a in-depth **Product Research plan**.

2. Product Research

In-depth exploration and validation of most viable product options. The output of this phase is **Validated Concept**, demonstrating the desirability, feasibility and viability of the product solution.

New Product Planning

3. Product Specification

Based on the Validated Concept and in-depth understanding of the stakeholder needs and business opportunities, the requirements for the product are created. The output of the Specification phase is a high-level description of the product to be designed: the **Product Requirements Document (PRD)**.

4. Product Planning

The planning phase creates a business, operations and development plan for the product. It contains the main targets and their critical milestones and timing specified in a comprehensive **New Product Introduction (NPI) plan**.

New Product Introduction

5. Architecture

Based on the PRD the product's architecture is defined, the **Detailed Product Specification** and the **detailed NPI project plan** are created.

6. Design

Execution of the detailed design based on the output of the Architecture phase. Specification of the new product including manufacturing instructions for the product prototypes.

7. Prototyping

Design evaluation and product qualification on product prototypes.

8. Industrialization

Preparation of the regular production of the product and hand-over to operations.

Product-to-customer Stage

9. Production

Product manufacturing including quality management throughout the operational lifetime of the product.

10. Distribution

Distribution of products from the production warehouse(s) to the customer(s).

Product-at-customer Stage

11. Installation

Installation and start-up of the product at the customer's site.

12. Product Operation

Product operation including aspects like reliability and maintenance throughout the operational lifetime of the product.

Retirement Stage

13. Decommissioning

Actions taken to end the product's use.

14. The End

Re-use, recycling and/or waste handling of products that have been decommissioned.

Product Life Cycle related and supporting activities

The following related activities are identified:

1. Technology Development (product independent)
2. Component Development (product dependent)

The following supporting activities applicable to a class of products are identified (not limiting):

1. Technology qualification program
2. Design methods and guidelines
3. Product verification, validation and certification
4. Qualified supply chain
5. New Product Introduction Program
6. Product Change Program
7. Quality Control Program
8. Maintenance Program
9. Decommissioning Program
10. Re-use, recycling and waste handling

These activities belong to the Life Cycle Model Management process and Quality Management per ISO/IEC/IEEE 15288, 6.2.1. respectively 6.2.5.

Acknowledgement

Funding organizations

Agentschap Ondernemen is acknowledged for funding the project VIS-traject InProVoL and the ICON-project Compact (Flanders Make) and VLAIO for funding the COOCK-project "Oriënteren en Beslissen in Slimme Product Exploratie", that have provided the basis for this guideline.

imec contributors

Geert Willems, Ph.D., Thomas De Meester, Jorik Van den Bosch

Contributing EDM partners

Sirris – COOCK-project "Oriënteren en Beslissen in Slimme Product Exploratie" lead

Table of Contents

The Product Life Cycle Management Guideline.....	2
Acknowledgement.....	3
1. Applicable Documents.....	5
ISO/IEC Systems and Software Engineering – Lifecycle profiles for Very Small.....	5
2. Applicability of the PLCM Guideline EDM-P-210.....	5
3. The Electronics Product Life Cycle: an overview.....	6
3.1. Definitions.....	6
3.2. Top-view on Product Innovation Stages.....	6
3.3. New Product Exploration Stage in a nutshell.....	7
4. Product Life Cycle Processes in the NPE stage.....	9
4.1. Alignment with ISO/IEC/IEEE System Engineering standards.....	9
4.2. Needs versus Requirements per ISO/IEC/IEEE 15288.....	10
4.3. Business/Mission Analysis per ISO/IEC/IEEE 15288.....	10
4.4. Stakeholder Needs and Requirements per ISO/IEC/IEEE 15288.....	12
4.5. System Requirements Definition per ISO/IEC/IEEE 15288.....	13
4.6. Validation per ISO/IEC/IEEE 15288.....	14
4.7. Life cycle Process preparation.....	14
5. New Product Exploration stage gating.....	17
5.1. Project Management of the New Product Exploration stage.....	17
5.2. Problem Research phase.....	18
5.3. Product Research phase.....	18
6. Exploration and validation techniques.....	20
6.1. Generic Low-Cost techniques.....	20
6.2. Modeling and simulation.....	21
6.3. Problem Space exploration.....	22
6.4. Solution Space characterization.....	24
6.5. Stakeholder Needs and Requirements: Desirability.....	24
6.6. Feasibility of the solution.....	26
6.7. Viability.....	27
7. Electronics in the NPE stage.....	29
7.1. Electronics as exploration and validation tool.....	29
7.2. Electronics as system element in the solution.....	29
8. Use of System Engineering standards by SME.....	31
Appendix A: System Stakeholders.....	32
A.1. List of typical stakeholders of system solutions.....	32
A.2. Business Requirements.....	32
A.3. Stakeholder Needs and Requirements.....	32
A.4. Life Cycle concept.....	33
A.5. System Life Cycle roles.....	33
Appendix B: Product Research Stage gating.....	35
B.1. Phase 1: Business Requirements.....	35
B.2. Phase 2: Stakeholder Needs.....	36
B.3. Phase 3: Life Cycle Concepts.....	37
B.4. Phase 4: Stakeholder Requirements.....	38
B.5. Phase 5: System Exploration.....	39
Revisions.....	41

1. Applicable Documents

This Product Life Cycle Management Guideline refers the most recent version of the following documents:

ISO/IEC/IEEE 15288	Systems and Software engineering – System life cycle processes
ISO/IEC/IEEE 24748-1	Systems and Software engineering – Life cycle management – Part 1: Guidelines for life cycle management.
ISO/IEC/IEEE 29148	Systems and software engineering – Life cycle processes - Requirements Engineering
ISO/IEC TR29110-1	Systems and Software Engineering – Lifecycle profiles for Very Small Entities (VSEs) – Part 1: Overview
INCOSE	System Engineering Handbook: A guide for system life cycle processes and activities, 4 th Edition, Wiley, 2015.
EDM-P-200	Predictive Product Life Cycle Management of Electronics
EDM-Q-200	Electronic Assembly Technology Qualification: “A White Box approach”

2. Applicability of the PLCM Guideline EDM-P-210

- 2.1. EDM-P-210 describes a high-level, comprehensive methodology to explore and to validate the concept of a new electronics containing product and its life cycle. The method is based on the system life cycle processes and life cycle management framework provided by ISO/IEC/IEEE 15288 respectively ISO/IEC/IEEE 24748-1. It can be considered as an introduction to the system engineering principles established in the these standards and the INCOSE System Engineering Handbook¹.
- 2.2. This guideline covers New Product Exploration starting from a set of ideas regarding business opportunities, stakeholder needs and/or potential product solutions, until the delivery of a validated concept upon which product development planning can be based, see Fig. 1 and EDM-P-200 for background.
- 2.3. EDM-P-210 can be used as source document for the establishment of the Life Cycle Model Management organizational project-enabling process per ISO/IEC/IEEE 15288, section 6.2.1., specifically for those system engineering activities related to the NPE stage or Concept stage of the system life cycle.
- 2.4. The level of formality in applying the New Product Exploration guidelines depend on:
 - 2.4.1. The need for communication between the NPE-project actors.
 - 2.4.2. The level of uncertainty
 - 2.4.3. The degree of complexity
 - 2.4.4. The risks and their consequences.

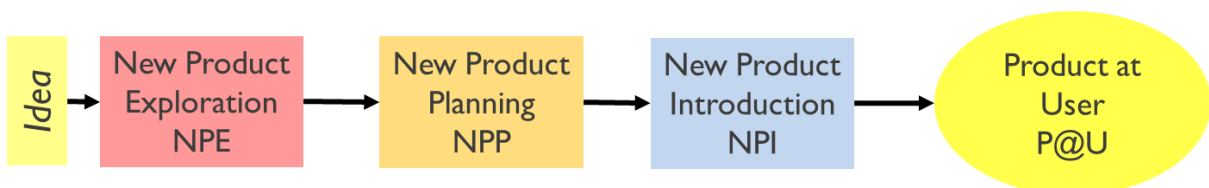


Figure 1: From idea to customer: three innovation stages.

¹ https://www.sebokwiki.org/wiki/INCOSE_Systems_Engineering_Handbook