# The Product Creation Process

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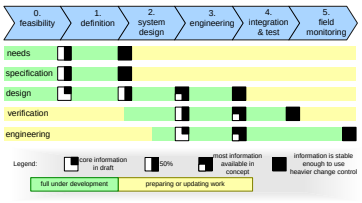


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## Abstract

The Product Creation Process is described in its context. A phased model for Product Creation is shown. Many organizations use a phased model as blueprint for the way of working. The operational organization of the product creation process is discussed, especially the role of the operational leader.



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# 1 Introduction

The Product Creation Process described how an organization gets from a product idea to a tested system and all product documentation that is required for the Customer Oriented Process. System Architects spend most of their time in the Product Creation Process. This chapter describes the Product Creation Process, including organizational aspects and the roles of people within the process.

# 2 The Context of the Product Creation Process

Figure **??** shows the context of the Product Creation Process in the decomposition of the business in 4 main processes. From Product Creation Process point of view the Policy and Planning Process determines the charter for the Product Creation Process. The Technology and People Management Process supplies people, process and technology enabling the Product Creation. The Customer Oriented Process is the customer: it receives and uses the results of Product Creation.

The Product Creation Process has a much wider context than the conventional "Research and Development" or "Development and Engineering" departments. The Product Creation Process includes everything that is needed to create a new product, for instance it includes:

- Development of the production process
- Design of the logistics flow and structure
- Development of required services
- Market announcement
- Market introduction

In other words the Product Creation Process is a synchronized effort of nearly all business disciplines within a company.

The term Product Creation is not only used for the development of entirely new products, but applies also to the development of variations of existing products or the development of upgrades or add-on products. The implementation of the Product Creation Process can vary, depending on the product being developed; a small add-on product will use a different organization than the development of a large new complex product.

# 3 Phases of the Product Creation Process

The Product Creation Process can be structures by using a phased approach. Figure 1 shows the phases as used in this book. The figure shows the participation of all

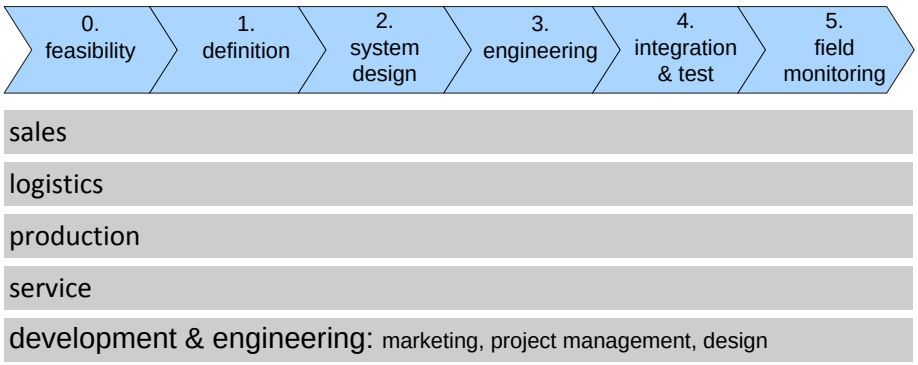


Figure 1: A phased approach of the Product Creation Process, showing the participation of all disciplines during the entire process

business disciplines during this process.

These phases are used across all business functions which have to participate in the Product Creation Process. It is a means to manage the relations between these functions and to synchronize them. Note that sales, production, logistics and service people are involved in the Product Creation Process. Their participation is required to understand the needs of the Customer Oriented Process. A good understanding of these needs is required to develop the new procedures and processes for the customer oriented process, such as ordering, manufacturing, and installation.

Figure 2 zooms in on the expected progress for the design deliverables. We use the term work flows for the horizontal classes of activities: *needs analysis*, *product specification*, *design*, *verification and validation*, and *engineering*. Note that needs analysis, product specification, and design progress concurrently. Also note that the first review typically takes place long before any of the work flows is complete. The main question for the first review is: does it make sense to invest in the later phases?

The advantages of a phased approach are shown in Figure 3. The project members get guidelines from the phase model,: *who* does *what* and *when*. At the same time the check lists per phase provide a means to check the progress for the management team. The main risk is the loss of common sense, where project members or management team apply the phase model too dogmatic.

*Customization of the phase model to the specific circumstances is always needed. Keep in mind that a phased process is only a means.*

The phase process is used as a means for the management team to judge the progress of the Product Creation Process. That can be done by comparing the actual progress with the checklists of the phase model, at the moment of a phase transition. The actual progress is measured at the moment of transition. Normally the development will continue after the phase review, even if some deliverables are

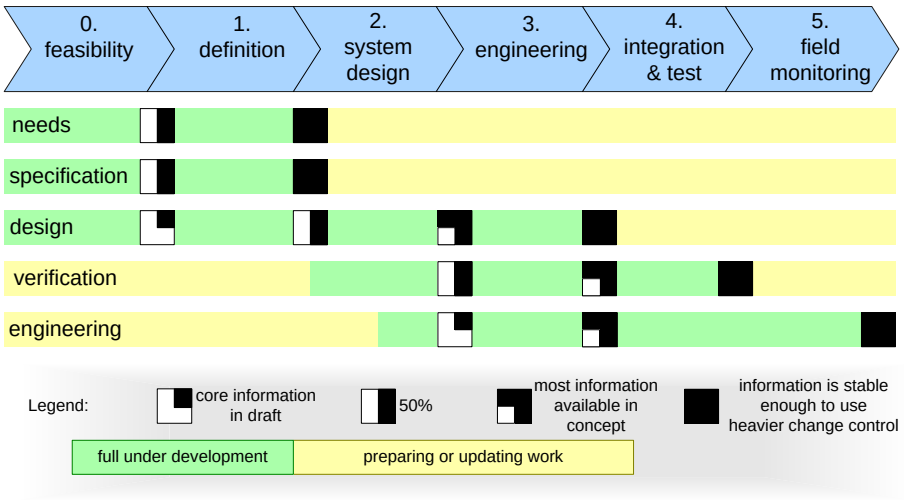


Figure 2: A phased approach of the Product Creation Process, showing the progress of the different design deliverables

| *benefits* | *disadvantages* |
|---|---|
| blueprint: how to work | following blueprint blindly |
| reuse of experience | too bureaucratic |
| employees know *what* and *when* | transitions treated black and white |
| reference for management | |

Figure 3: Advantages and Disadvantages of a phased approach

behind schedule. In that case the problem is identified, enabling the project team to take corrective action. Some management teams misinterpret the phase transition as a milestone with mandatory deliverables. Based on this misinterpretation the management team might demand full compliance with the checklist, disrupting the project. This kind of interference can be very counterproductive. See section 5 for a better management method with respect to milestones.

Important characteristics of a phase model are shown in Figure 4:

**Concurrency** of need analysis, specification, design, and engineering, and concurrency between activities within each of these work flows.

**Checkpoints** at phase transition. Often more checkpoints are defined, for instance halfway a phase.

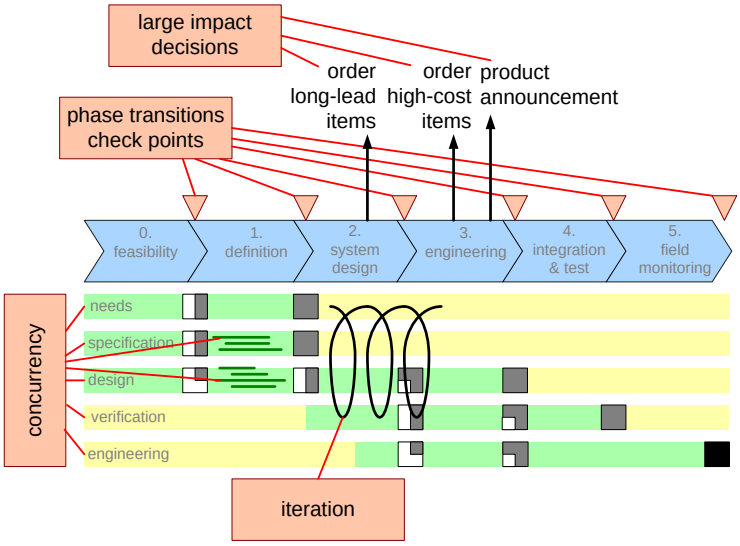


Figure 4: Characteristics of a phase model

**Iteration** over the work flows and over activities within the work flows.

**Large impact decisions** that have to be taken, often long before the full consequence of the decisions can be foreseen.

# 4 Evolutionary models for Product Creation

The phase model stresses and supports concurrent activities, see also [3]. A common pitfall is a waterfall interpretation of a phased approach. Following a strict top-down approach can be a very costly mistake, because feedback from implementation and customers is in that case too late in the process. Early and continuous feedback both from implementation as from customer point of view is essential, see Intermezzo **??**.

High market dynamics exposes one weakness of the phased approach: market and user feedback becomes available at the end of the creation process. This is a significant problem, because most product creations suffer from large uncertainties in the specifications. Discovering at the end that the specifications are based on wrong assumptions is very costly.

Figure 5 show the V-model and evolutionary model side by side. Evolutionary methods focus on early feedback creation. EVO [2] by Gilb recommends to use evolutionary development steps of 2% of the total development budget. In every step some product feedback must be generated. Extreme Programming (XP) [1] by Beck is based on fixed duration cycles of two weeks. XP requires additional

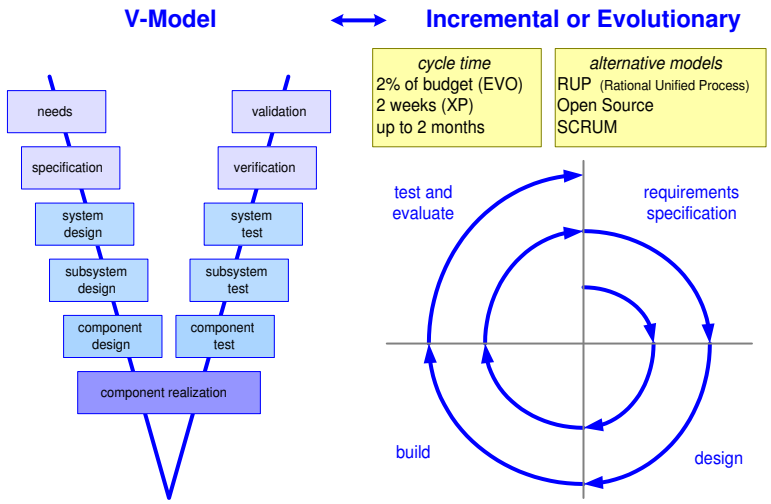


Figure 5: V-model versus Incremental or Evolutionary development models

customer value in every increment.

The class of agile product creation approaches is struggling with the architecting process. The leaders of these communities dislike the “big design up-front”. However, running in a treadmill of small increments may cause the loss of the “big picture”. Architecting and short cycles, however, are not in conflict. The architecture also has to grow in incremental steps.

# 5 Milestones and Decisions

The project team is faced with a limited number of large impact decisions during the creation process. The decision in general engage the organization with a commitment somewhere in the future. For example:

**Ordering of long lead items** where changes in specification or design might obsolete ordered items. Re-ordering will cause project delay. Using the initially ordered items might decrease system performance.

**Ordering of expensive materials** where changes in plan, specification or design might obsolete the ordered materials.

**Product announcement** can not be reversed once the outside world has seen the announcement. Note that announcing a new product often impacts the order intake of existing products. Announcing a new product late might cause competitive risks.

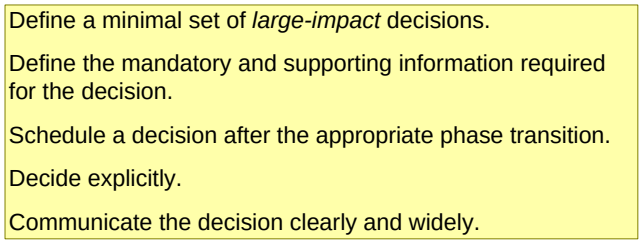


Figure 6: How to deal with large impact decisions

An explicit decision can be planned as a milestone in the project master plan. Information should be available to facilitate the decision: some of the information is mandatory to safeguard the company, some of the information is only supportive. In general the mandatory information should be minimized to prevent a rigid and bureaucratic process, causing the company to be unresponsive to the outside world. These decisions can be planned after the phase transition when most of the required supportive information will be available in an accessible way. Figure 6 shows the recommendations how to deal with large impact decisions.

# 6 Organization of the Product Creation Process

The Product Creation Process requires an organizational framework. The organizational framework of the Product Creation Process is independent of the Organizational frameworks of the other processes[1]

## 6.1 Hierarchical decomposition

The operational organization is a dominant organizational view on the Product Creation Process. In most organizations the operations of the Product Creation are decomposed in multiple hierarchical levels, at the highest level the entire product portfolio at the lowest level the smallest operational entity for instance a subsystem. Note that in figure 7 the hierarchy stops at subsystem level, although for large developments it can continue into even smaller entities like components or modules. The hierarchy is simply the recursive application of the decomposition principle.

Figure 7 is simplified by assuming that a straight forward decomposition can be applied. This assumption is not valid when lower level entities, e.g. subsystems, are used by multiple higher level entities, e.g. systems. For instance, if one

[1] Quite often a strong link is present between People and Technology Management Process and the Product Creation Process; Using similar frameworks can be quite counterproductive, because these processes have quite different aims and characteristics. Of course, nearly all people are part of both organizational frameworks.

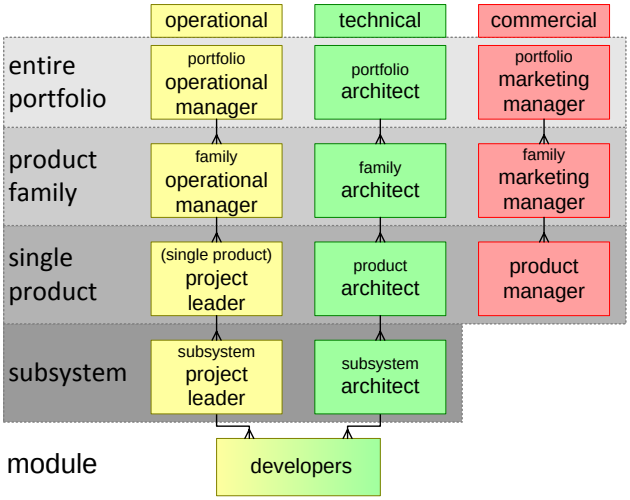


Figure 7: The simplified hierarchy of operational entities in the Product Creation Process form the core of this process.

subsystem is used in different products. In Chapter **??** we elaborate this aspect further.

## 6.2 Further decomposition of the Product Creation Process

The Product Creation Process can be decomposed in 3 processes as shown in 8:

**Marketing:** Defining how to obtain a sellable profitable product, starting with listening to customers, followed by managing the customer expectations, introducing the product at the customer and obtaining customer feedback.

**Project Management:** Realizing the product in the agreed triangle of

- specification
- resources
- amount of time

**Design Control:** Specifying and designing the system. The Design Control Process is that part of the Product Creation Process that is close to the conventional R&D activities. It is the content part of the Product Creation Process.

The functions mentioned in figure 7 map directly on the processes in figure 8:

- The *operational* or *project leader* is responsible for the *operational management*
- The *architect* is responsible for the *design control*

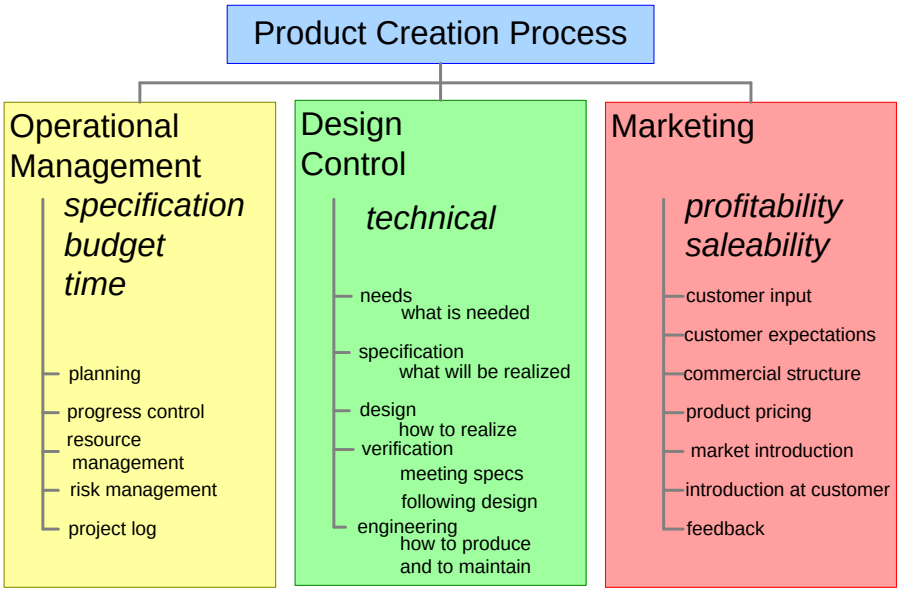


Figure 8: Decomposition of the Product Creation Process

- The *marketing* or *product manager* is responsible for the *commercial* aspects

## 6.3 Design Control

The ISO 9000 standard has a number of requirements with respect to the *design control* process. The design control process is a core content oriented process, it is the home base of the system architect. The system architect will support the project management and the commercial process.

The design control process itself is further decomposed, also shown in figure 8:

- Needs
- Specification
- Design
- Engineering
- Verification

The needs express what the stakeholders of the system need, not yet constrained by business or technical considerations. Most development engineers tend to forget the original needs after several iterations of commercial and technical trade-offs.

The specification describes what will be realized, in terms of functionality and performance. This specification is the agreement with all stakeholders. The

difference between the needs and the specification is that in the specification all trade-offs have been made. See also Chapter **??** where we elaborate the process of needs analysis and requirements management.

The design is the description how the specification will be realized. For instance, the physical and functional decomposition and the budgets for critical technical resources belong to the design.

Needs, specification and design are documented in development documents. The main function of these documents is to streamline the Product Creation Process. During this process these are living documents fulfilling an important communication function, while at the same time they play an important role in the control aspect of the design process.

The verification process verifies that the implementation meets the specification in the way it is specified in the design.

The engineering process provides the foundation upon which the Customer Oriented Process works for the entire life-cycle of the product. The documentation generated in the engineering process is the output of the Product Creation Process.

## 6.4 Operational Management

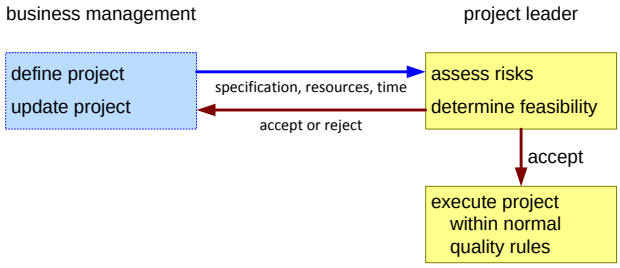


Figure 9: Commitment of the operational leader to the project charter

The operational management is governed by a simple set of rules, see Figure 9. These rules combine a number of very tightly coupled responsibilities in one function, to enable a dynamic balancing act by the operational leader. These responsibilities form the operational triangle as shown in figure 10.

The rules ensure that the operational leader takes ownership of the timely delivery of the specification within the agreed budget, with the "standard" quality level. Transfer of one of these responsibilities to another person change the system in an open loop system[2].

[2] Many conventional development organizations have severe problems with this aspect. The most common mistake is that either the quality responsibility or the resource(budget) responsibility is transferred to the People and Technology Management Process. The effect is that excuses are

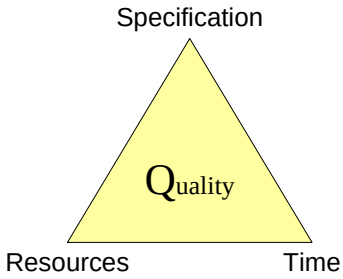


Figure 10: The Operational Triangle of responsibilities; The operational leader commits to the timely delivery of the specification within the agreed budget, with the "standard" quality level

## 6.5 Marketing

The marketing manager knows the market: who are potential customers, what are their needs, what is of value in the market, what are commercial partners, what is the competition. This knowledge is “future” oriented and is used to make choices for future products. What are feasible products, what are the features and performance figures for these products, based on choices where value and cost are in a healthy balance. Hence the marketing manager is involved in packaging and pricing of products and options. A good marketing manager looks broader than the current products. Most innovations are not “more of the same”, but are derived from new opportunities, technical or in the application.

Note that most sales managers are much more backward oriented: we sell what we have to customers who know existing systems. Good sales persons are often not good marketing persons!

## 6.6 Product Creation Teams

So far we have discussed *Operational management*, *Design Control* and *Marketing*. However, in the Product Creation Process more specialized functions can be present. Figure 11 shows a number of more specialized functions as part of a number of concentric operational teams. The amount of specialization depends on the size of the operation. In very small developments none of the specializations exist and is even the role of project leader and architect combined in a single person.

present for every deviation of the commitment, for instance *I missed the timing because the people were working on non project activities.*

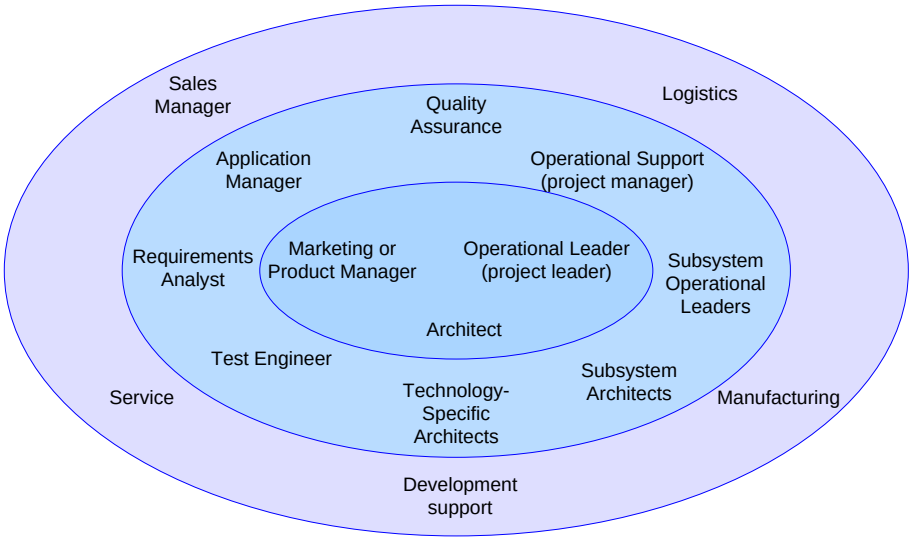


Figure 11: The operational teams managing the Product Creation Process

# 7 Acknowledgements

Rahim Munna suggested to add a short description of Marketing.

# References

[1] Kent Beck. *Extreme Programming Explained: Embrace Change*. Addison-Wesley, Reading, MA, 2000.

[2] Thomas Gilb. *Competitive Engineering: A Handbook For Systems Engineering, Requirements Engineering, and Software Engineering Using Planguage*. Elsevier Butterworth-Heinemann, London, 2005.

[3] Ivar Jacobson, Grady Booch, and James Rumbaugh. *The Unified Software Development Process*. Addison-Wesley, Reading, MA, 1999.

[4] Gerrit Muller. The system architecture homepage. `http://www.gaudisite.nl/index.html`, 1999.

**History**

## Version: 2.2, date: July 8, 2010 changed by: Gerrit Muller

- removed duplicate text evolutionary models

**Version: 2.1, date: June 17, 2010 changed by: Gerrit Muller**

- added text about evolutionary development models
- added V-model to spiral figure

**Version: 2.0, date: June 16, 2010 changed by: Gerrit Muller**

- text updates
- replaced lists by figures
- changed status to concept

**Version: 1.4, date: 10 April 2007 changed by: Gerrit Muller**

- added Marketing subsection
- added acknowledgements

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- added incremental PCP model
- changed status to draft

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- abstract added

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- layout change and small repairs

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- Small changes to fit in overall article and intermezzo structure
- Section on organization split in subsections; Text from "Positioning the System Architecture Process" copied to this section to make this article more self sustained.

**Version: 0.1, date: october 25 1999 changed by: Gerrit Muller**

- Added development support to figure 6: operational teams managing the Product Creation Process

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- Created, no changelog yet