Eindhoven University of Technology

MASTER

Towards more professional innovation
improving the effectiveness and efficiency of the New Product Development process

Aerts, N.L.A.

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Towards more professional innovation

Improving the effectiveness and efficiency of the New Product Development process

by

N.L.A. (Nicky) Aerts

BSc Mechanical Engineering — Avans Hogeschool
Student identity number 0656015

in partial fulfilment of the requirements for the degree of

Master of Science
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First university supervisor: dr. J.A. Keizer
Department: Innovation Technology Entrepreneurship & Marketing

Second university supervisor: dr. F.M. van Eijnatten
Department: Human Performance Management

University: Eindhoven University of Technology
P.O. Box 513
Den Dolech 2
5600 MB Eindhoven
The Netherlands

Company supervisor: Project Manager Research & Development Holmatro Group
Zalmweg 30
4941 VX Raamsdonksveer
TUE. School of Industrial Engineering.
Series Master Theses Innovation Management

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Abstract

The major growth of Holmatro, combined with the technical possibilities and legal restrictions of today, is linked with an extension of the diversity and intensity of (new) product development, and with that also the complexity of projects. Structured project management is very important to manage these challenges in order to keep a clear overview of the project progress and get the product on the market in time. Within this Master Thesis, improvements for the current NPD process are searched for to further improve the manageability, objectivity and time-to-market of the projects.
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In order to graduate for my master program of Innovation Management, at the Eindhoven University of Technology, a Master Thesis has to be successfully completed. This Master Thesis describes my graduation period at Holmatro (Netherlands), in which recommendations are presented of how they can improve the effectiveness and efficiency of their New Product Development process.

This Master Thesis was a great opportunity to apply the gathered knowledge and skills from the master program of Innovation Management within a company like Holmatro. The result is this document, which is intended for all those involved within the NPD process of Holmatro. Besides, it is intended for the university supervisors and the assessment committee, who have the task to grade this Master Thesis.

I want to thank all the people who were involved within the Master Thesis, and who helped and advised me to find the right answers to all my questions.

Nicky Aerts
1 Introduction

This chapter provides an introduction into the Master Thesis’ topic of New Product Development, the company involved and the aim of this thesis, which describes the main research question.

1.1 New Product Development

Innovations are the creation of new products or services, or enhancements to existing products or services, or the creation of organizational processes which have a significant impact on a person, group, organization, industry or society (Higgins, 1996). Frequently, companies use innovations to increase or sustain their competitive advantage, therefore innovations can be called an important defence mechanism to secure substantial profits for the (near) future (McAdam & McClelland, 2002; Menzel, 2008).

To increase or sustain innovative performance, companies must stimulate a creative organizational and entrepreneurial culture, in which they must manage, communicate, but also stimulate employees to come up with new, creative and innovative ideas (Kenney et al., 2010; Fry, 1987). These ideas must be worked out in order to bring a new product or service to the market. This process from idea-to-launch is called a New Product Development process (NPD process). But having an effective and efficient NPD process is proved to be a big challenge, for instance:

- Many companies have difficulties finding an efficient and successful approach for highly innovative types of R&D projects, in which great levels of uncertainty are present and instead they go for the low risk, low value R&D projects (Brettel et al., 2011; Perry et al., 2011; Cooper, 2009).
- Some individuals cut corners to save time: they do a quickie market study instead of a thorough one, or come up with a poorly conceived launch plan. The end result is long times to market and underperforming launches (Cooper, 2009).

In sum, too many projects and teams miss the mark, they simply fail to perform. Research often reveals that these projects are plagued by missing steps and activities, poor organizational design and leadership, inadequate quality of execution, unreliable data, and missed timelines (Cooper, 1990).

One way to overcome these challenges is by making use of the Stage-Gate process from Cooper. A Stage-Gate process is a conceptual and operational map for moving new product projects from idea-to-launch and beyond. In the late 1980s, Cooper acknowledged the fact that the innovation of products and/or services can be managed with the use of simple process-management techniques (Cooper, 1990; Cooper, 2008).

Stage-Gate, in its simplest format (as can be seen in figure 1.1), consists of (1) a series of stages, where the project team undertakes the work, obtains the needed information, and does the subsequent data integration and analysis, followed by (2) gates, where Go/Kill decisions are made to continue or stop to invest in the project (Cooper, 2008).

![Diagram of Stage-Gate process](image-url)
A good Stage-Gate process leads to a higher percentage of successful (innovative) product development projects through (Cooper & Kleinsmid, 1993):

- **Less recycling and rework:** new product processes generally have a number of “quality checks” built into the process to ensure that activities are undertaken, and in a quality fashion: quality of execution is paramount;
- **Earlier detection of failures:** the use of gates with though Go/Kill criteria together with better market information in the pre-development stages helps sharpen project evaluations;
- **Shorter cycle time:** better market information, sharper product definition and less recycle all serve to shorten the idea-to-launch time.

But in reality it provides challenges to overcome as well, for instance (Keizer, 2008):

- **Structure can reduce creativity:** a lot of activities have to be executed within the process, which can be experienced as bureaucratic and a waste of time, causing less attention for creativity. Besides, the Stage-Gate process, does not include an organic idea generation phase, in which creative ideas can be generated;
- **Low guidance from the company strategy:** within a typical Stage-Gate process, the decision making process is more focused on the market potential and technical feasibility, than on the fit with the company strategy;
- **Projects are rarely killed:** individuals within an NPD process can get emotionally involved in a project and where they are very reluctant to terminate it, even if there are many clear signals that the project is not going to be successful, also called Escalation of Commitment (Biyalogorsky et al., 2006). These projects sometimes proceed to commercialization only to fail in the market at substantially higher costs than if they had been terminated earlier.

In the end, a great idea-to-launch process is not sufficient: it’s not a standalone driver of positive performance. Three other major factors that drive a business’s performance (Cooper & Mills, 2005):

- Having a product innovation and technology strategy in place for the business;
- Resource commitment, which focuses on the right projects and portfolio management;
- People: that is, having the right climate and culture, effective cross-functional teams, and senior management commitment to NPD.

### 1.2 Company description

#### 1.2.1 Company profile

Since 1967, Holmatro produces and delivers high pressure hydraulic tools for specialized industries worldwide. Nowadays the product range consists of three different product groups within 3 business units: Holmatro Industrial Equipment, Holmatro Rescue Equipment and Holmatro Marine Equipment.

**Holmatro Industrial Equipment (HIE)**
The industrial product line consists of high-pressure hydraulic tools such as jacks, cable cutters, pumps, pneumatic lifting bags, mechanical tools and many accessories. Important customers are shipyards, foundries, recycling industry, building & construction, machine factories, heavy-transport companies etc.

**Holmatro Rescue Equipment (HRE)**
The rescue product line includes high-pressure hydraulic cutters, spreaders, combitools, pumps, pneumatic lifting bags, a number of rescue assist tools and many accessories. These products are supplied to (corporate) fire brigades, the army, navy and airforce, civil defence and many other rescue teams.
Holmatro Marine Equipment (HME)

In 2002 Holmatro started a third standard product line under the name of Marine Hydraulics, especially for application on sailing yachts. This programme consists of various hydraulic rigging products to optimize sailing performance and includes integral adjusters, cylinders, mast jacks, control panels, pumps and many accessories, which are supplied to both yacht racers and leisure sailors.

Holmatro products comply with all current international norms. The industrial tools are in line with the CE machine directive, in addition to European norms. The rescue tools comply with quality and safety standards such as the American NFPA norm, European EN norm and German DIN norm. In 1992, Holmatro became the first manufacturer of rescue equipment with an ISO 9001 certificate.

1.2.2 Markets

From the beginning Holmatro has exported its products worldwide. Especially HRE achieves most of its turnover abroad and has grown to become the world’s largest supplier of hydraulic rescue equipment (with a market share of more than 50%). Distributors in more than 140 countries attend to sales and technical support. In addition, Holmatro has an extensive distributor network for its industrial tools. All distributors are supported from two manufacturing plants within the divisions Holmatro US in the United States, which is responsible for North and South America, and the head office in Raamsdonksveer, Holmatro Netherlands, for the rest of the world.

1.2.3 Strategy

The strategy of Holmatro is product leadership. Product leadership strives to produce a continuous stream of state-of-the-art products and services for the market, by continually challenging themselves to (Treacy & Wiersema, 1992):

- **Be creative**: ideas that usually originate outside the company must be recognized and embraced;
- **Commercialize their ideas quickly**: all the business and management processes have to be engineered for speed;
- **Pursue new solutions**: to the problems that their own latest product or service has just solved.

Throughout its history, Holmatro has paid a lot of attention to product innovation. Over the years, both the industrial and rescue divisions have been market pioneers. Holmatro continuously apply their expertise to develop new products and enter new market segments. This is also the way in which the Marine Equipment product line came aboard. Another example of their pursuit of innovation is the fact that they stay in close contact with car manufacturers, thus ensuring that the rescue tools stay ahead of the challenges provided by new car materials and construction methods.

1.3 Problem Statement

The major growth of Holmatro, combined with the technical possibilities and legal restrictions of today, is linked with an extension of the diversity and intensity of (new) product development, and with that also the complexity of projects. Structured project management is very important to manage these challenges in order to keep a clear overview of the project progress and get the product on the market in time.

Within the current situation, the Project Manager R&D wants to further improve the manageability, objectivity and time-to-market of the projects under his supervision, by improving the current NPD process. Also Top Management want to further reduce the times-to-market and costs-to-market.
Within the current NPD process decision moments with a huge variety of stakeholders\textsuperscript{1} are not documented sufficient which makes it difficult to underpin these decisions in later stages of the project. The result, project specifications can easily be changed within the more expensive stages of a project. These changing variables might lead to the fact that costly and time-consuming corrections must be made in order to launch a high quality product into the market. Besides, scarce resources might be waste at the expense of other promising projects which might deliver even higher value for the company.

1.4 Aim of this Master Thesis

In the end, Holmatro wants to maintain their competitive advantage. Their current NPD process can be more effective and efficient, to create, fulfil and improve this competitive advantage in the future. Therefore the main research question can be stated as follow:

\textit{How to enhance the competitive advantage of Holmatro, by implementing (1) a more effective decision making process, and (2) a more efficient NDP process inspired by the Stage-Gate model from Cooper?}

The aim of this Master Thesis is to further professionalize the innovation process by building in more guidance and logic into the development process, while preserving an entrepreneurial culture. This can be achieved by recommending Holmatro a way of working inspired by the Stage-Gate model, with a number of stages, to build more routine into the process (Cooper, 1990). Within this design, the emphasis shall be on overcoming the limitations of a Stage-Gate process by making the decision moments more transparent and effective, in order to prevent escalation, and meanwhile improve the innovative performance by introducing the theory of Effectuation within the process. Basically, a more effective and efficient NPD process must be achieved within this Master Thesis towards more professional innovation, divided into two comprehensive phases (see figure 1.2):

- Phase 1: in the (fuzzy) front end: idea generation must be organized within an organic (flexible) organization, in which weak signals of new opportunities are absorbed from the market and where creativity is stimulated to generate new ideas. The theory of Effectuation might help to improve this (fuzzy) front end;
- Phase 2: execution of the idea-to-launch process: a more effective and more mechanistic project management process with a number of stages has to be implemented. Stage-Gate is a tool to structure the process and to design more routine into the process (Cooper, 1990). The right gates and the right preconditions have to be present within a Stage Gate process in order to proceed with the right projects only and to review the progress of the project in a justified way in order to prevent escalation, while preserving an innovative performance.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{a more professional NPD process}
\end{figure}

\textsuperscript{1} Stakeholder: a person, group or organization with an interest in a project (Wikipedia, 2011)
2 Theoretical background

Before any specific company analysis takes place, an answer to the main research question is searched for from a scientific literature perspective. Within the previous chapter a couple of theories are mentioned:

- Stage-Gating;
- Entrepreneurial culture;
- Escalation of Commitment;
- Effectuation.

These theories might provide some methods of how to improve the Holmatro NPD process, and with that the competitive advantage. First the theories will be discussed separately, after that the theories are linked to each other in the form of a model, which must provide an answer to the main research question as described in the previous chapter.

2.1 Stage-Gate process

The basics of a Stage-Gate process are already mentioned in chapter 1.1. This chapter collaborates on this idea-to-launch process by describing a rather typical Stage-Gate model, as can be seen in figure 2.1. Stage-Gate is a flexible process, instead of a mechanistic implementation of a standardized process (Cooper, 2008), and therefore, not every product does need all steps to bring it successfully to product launch. Less innovative, incremental, new products can have fewer gates since the risk of failure is lower and thus, less structure is needed to guide and assess the product (Cooper, 2008; Cooper, 2009). In the end, the activities stay the same, but differ in the degree of detail and depth of the analysis.

![Figure 2.1: a typical Stage-Gate Process (Cooper, 2009)](image)

The Stages

A couple of statements are described by Cooper (2008) of what each stage must consist of:

- Each stage is designed to gather information to reduce key project uncertainties and risks: the information requirements thus define the purpose of each of the stages in the process;
- Each stage cost more than the preceding one (US Department of Energy, 2007);
- The activities within stages are undertaken in parallel and by a team of people from different functional areas within the firm;
- Each stage is cross-functional: there is no research and development stage or marketing stage. No department owns any one stage.
The Gates

Gates serve as quality-control checkpoints and points where the path forward for the next play or stage of the project is agreed to (Cooper, 2000; Cooper, 2008). The general idea is to make the gate decision an objective process that drives opinion and conjecture out of the process. Anybody in the organization should come to the same decision (Langerak, 2009). Gates consists of the following:

- **Deliverables**: these are visible and are based on a standard menu for each gate, and are decided at the output of the previous stage;

- **Criteria against which each project is judged**: these include “chance-of-success”, “must-meet” and “should-meet” criteria (usually in aspects of time, market, technology and money (Langerak, 2009)) designed to weed out misfit or escalated projects. Criteria are different for each gate and become more rigorous as the project progresses (US Department of Energy, 2007). Another function of these gates is to evaluate the findings and insights from each phase to see if new means are provided, which can be used for possible new opportunities for the project or even for another project (further explained in chapter 2.4: Causation vs. Effectuation).

- **Outputs**: a decision, an approved action plan for the next stage, a list of deliverables and a date for the next gate are provided. There are 4 decisions possible (US Department of Energy, 2007):
  - **Go**: goals from the previous stage were met and funding is approved for the next stage;
  - **Kill**: project is not progressing as it should because the market has shifted permanently, the technology is obsolete, or desired technical objectives cannot be met;
  - **Hold**: project has been suspended for a specified period of time;
  - **Recycle**: goals or criteria have not been accomplished or met, but because the project is still a high priority, the team will return to the previous stage to complete the work.

In best-practice businesses, effective gates translates into a menu of specified deliverables for each gate, visible Go/Kill and prioritization criteria at the gates, defines gatekeepers per gate, clear gate outputs, and even “Rules of Engagement” for the gate keeping team of the business (Cooper & Edgett, 2001).

### 2.1.1 Common fail points of a Stage-Gate Process

Cooper (2008; 2009) mentioned a number of common fail points companies encounter with implementing and working with the Stage-Gate process.

1. **Making the gates work**

Too many bad projects and too many projects in trouble are sliding through, which is caused by:

- **Gates with no teeth**: once a project is approved, it never gets killed. As an example: once a project passes the idea screen, it is placed into the business’s product roadmap. This means that the estimated sales and profits from the new project are now integrated into the business unit’s financial forecast and plans. Once into the financial plan of the business, of course, the project is locked in: there is no way that the project can be removed from the roadmap or killed. In effect, all gates after the idea screen are merely rubber stamps.

- **Hollow decisions at gates**: gates are not project review meetings or milestone checks. Rather, they are a Go/Kill and resource allocation meeting. Frequently, the gate meeting is held and a Go decision is made, but resources are not committed. The project leader and team must leave the gate with the resources they need to continue their project. These hollow decisions at the gates usually lead to too many projects in the pipeline and projects take forever to get to market.

- **‘Who are the gatekeepers?’**: gatekeepers are the senior people in the business who own the resources required by the project leader and team to move forward. For major new product projects, gatekeepers should be a cross-functional senior group e.g. the heads of marketing, sales, technical, operations, and finance. When defining gatekeepers, keep the number small, only key resource owners, and try to keep “gatecrashers” out of the decision meetings. For
smaller, lower-risk projects, a lower-level gate keeping group and with fewer gates usually suffices. Finally, be sure to distinguish between gatekeepers and project leaders.

- **Gatekeepers behaving badly**: a decision-making team needs rules of engagement, or governance rules in order to keep them on track. Examples of what can go wrong:
  - Pet project, which receives special treatment and bypassing the gates;
  - Single-person decisions by executive edict, the assumption that one person knows all;
  - Go/Kill decisions based on opinion and speculation rather than on facts, and even worse, decision based on a political or personal agenda;
  - Using personal and hidden Go/Kill and prioritization criteria.

2. **Trying to do portfolio management without a stage-and-gate process**

An effective Stage-Gate system is essential to sound portfolio management. First, by having tough gates in place, poor projects are eliminated early in the process and thus the overall result is a better portfolio. Second, without a good Stage-Gate process in place, with key tasks and deliverables built in, project teams are left on their own about what data to gather and how to obtain them. The end result is that inconsistent data are gathered on projects. Thus, it becomes difficult to compare and rank projects against each other, so effective portfolio management is next to impossible.

3. **Too much bureaucracy in the Idea-to-Launch process**

Some companies have designed a cumbersome, bureaucratic process with a lot of make-work and non-value added activities. Some pitfalls:

- Deliverables overkill: far too much paperwork, which are not relevant for the decision. For instance, if a project team is not certain what information is required, they over deliver;
- Demanding much non-value-added work in the stages.

4. **Expecting the impossible from a process**

Stage-gate is not stand alone. By making the innovation process much more visible and transparent, the other weaknesses in the firm’s approach and methods become even more apparent. Although Stage-Gate may bring some relief – the gates will kill some weaker projects and thus will free resources – the full solution is likely to lie elsewhere, perhaps via a resource capacity analysis or the implementation of an effective resource tracking and portfolio management system.

5. **No pain, no gain**

Gates requires effort and represent new demands both for gatekeepers and project teams, especially in a company used to intuitive decision making or one-person, executive-edict gate meetings. Project leaders, team members and gatekeepers need to adapt to their new roles, which they may not like.

### 2.1.2 Link with Escalation of Commitment

Managers who are (too) long involved in specific development projects, can get too committed, which can result into Escalation of Commitment (described in detail in paragraph 2.3). A Stage-Gate process has the objective to exclude subjectivity and emotions during a decision making process, resulting in more projects to be killed and with that preventing escalation. Excluding subjectivity and emotions, with the use of a Stage-Gate process, can be achieved through (Biyalogorsky et al., 2006):

- Gate-Keepers: which are not too closely involved into the project;
- Objective data, used within the decision documents;
- Accept that managers have a complete own perspective regarding the projects. There must be some rules and procedures which minimize negative effects of it.

For the project team it can be difficult when their projects are killed, because killed projects can be perceived as (Langerak, 2009):

- Personal failure;
- Disruptive and unsatisfying: constantly starting new projects, never “finishing” anything;
- Threat to job security: constantly killing projects implying an insecure position.
Therefore, these perceptions must be altered into a shared view that killing projects is, in the end, better for the whole company, because only the good products reach the market. More transparency and structure on what a project will be judged on is a way to achieve this.

2.1.3 Link with creative organizational culture

When firms operate in dynamic markets which require innovation and change, resource availability can act as a shock absorber, allowing scope for experimentation, which is necessary to test ideas and with that a source for innovations (Zien, 1997; Bunduchi, 2009; Fry, 1987; Hornsby et al., 2002; McAdam & McClelland, 2002). This resource availability can be achieved through an effective Stage-Gate process, in which costly resources are used to continue promising projects only, and bad projects are excluded.

This experimentation time is necessary to stimulate a creative organizational culture where people will work at what they are best at doing and what they like doing best (Zien, 1997), in order to become more innovative. An example is available from 3M. They implemented a 15% rule, which allows people to work (15% of their time) on self-defined innovations, ideas and/or experiments, resulting in innovations like the Post-It (Zien, 1997; Fry, 1987). But most important, employees must perceive the availability of resources for innovative activities (Kuratko et al., 1990). If they know that resources are available for innovations, the barrier to come up with ideas is lowered.

2.1.4 Conclusion

Too many projects and teams miss the mark, they simply fail to perform. Research often reveals that these projects are plagued by missing steps and activities, poor organizational design and leadership, inadequate quality of execution, unreliable data, and missed timelines. Stage-Gate is simply that playbook (Cooper, 1990; Cooper, 2008). A good Stage-Gate process leads to a higher percentage of successful (innovative) projects through (Cooper & Kleinsmidt, 1993):

- **Less recycling and rework:** new product processes generally have a number of “quality checks” built into the process to ensure that activities are undertaken, and in a quality fashion: quality of execution is paramount;
- **Earlier detection of failures:** the use of gates with though Go/Kill criteria together with better market information in the pre-development stages helps sharpen project evaluations.
- **Shorter cycle time:** better market information, sharper product definition and less recycle all serve to shorten the idea-to-launch time.

In the end, the goal is to allocate the costly resources for promising projects only, which fit with the company strategy. Next to that, resource availability is necessary for experimentation, which is used to test ideas and with that a source for innovative and creative solutions within the fuzzy front end of a development process.

![Figure 2.2: a model of how to improve the efficiency of an NPD process](image)

Figure 2.2: a model of how to improve the efficiency of an NPD process
2.2 Entrepreneurial culture

As already described in chapter 1, companies must stimulate a creative organizational and entrepreneurial culture, in order to sustain their innovative performance (Kenney et al., 2010; Fry, 1987; McAdam & McClelland, 2002; Menzel, 2008). They must stimulate employees to come up with new, creative and innovative ideas (Kenney et al., 2010; Fry, 1987).

To come up with the best ideas, employees must behave more and more as an entrepreneur within a company, also called an intrapreneur (Moore et al., 2007). The theory behind it is that intrapreneurship refers to employee initiatives in organizations to undertake something new, without being asked to do so (Jong & Wennekers, 2008). An intrapreneur consistently looks for new business opportunities while sticking to the goals of the organization (Jong & Wennekers, 2008). They follow their own senses, abilities and experiences. Intrapreneurs want to change things, spend money, think long term, ask embarrassing questions, challenge authority, and perhaps to be disruptive (Fry, 1987). This is needed to find successful, novel ways of reaching their goals.

An entrepreneurial culture can be achieved by reducing the barriers to innovation, stimulating a creative organizational environment (e.g. by making use of a Stage-Gate process) and by spreading the skills of an intrapreneur (Menzel et al., 2006; Menzel et al., 2007; Menzel, 2008). A couple of positive effects for the company of stimulating an entrepreneurial culture:

- It contributes to superior firm performance, through higher rates of innovations, trust and learning (Kenney et al., 2009; Molina & Callahan, 2009; Menzel et al., 2006, 2007);
- Through strategic renewal, new insights and new approaches for reaching customers and markets can be achieved (Menzel et al., 2006; Menzel et al., 2007);
- Better qualified job applicants can be attracted (Kenney et al., 2009). There are lots of challenges for the intrapreneur within a company and people are stimulated to put a piece of their vision and talent in the company and with that becoming more enthusiastic about their work. In fact, an enthusiastic company culture will attract more talented innovative people, creating a competitive advantage in human resources (Monnavarian & Ashena, 2009);
- External strategic alliances are more common (Moore et al., 2007). If a company is known as an innovative firm, where most of the ideas come from the inside of the company, the chance of being approached by another company will be improved.

In the end, companies can gain competitive advantage, by making use of all the available creativity within the company (Menzel et al., 2006; Menzel et al., 2007).

2.2.1 Conclusion

An entrepreneurial culture, and with that an innovative performance, can be stimulated by having the right structures and procedures in place (Menzel et al., 2006; Menzel et al., 2007; Menzel, 2008). Stage-Gate is an example of it, as described in chapter 2.1 and visualized in figure 2.3.

![Stage-Gating](image)

Figure 2.3: A model of the link between an entrepreneurial culture and the NPD process
2.3 Escalation of Commitment

Escalation of Commitment (EoC) can be described as the phenomenon when individuals get emotionally involved in a project and where they are very reluctant to terminate it, or terminate it and resurrect it under a new name, even if there are many clear signals that the project is not (going to be) successful (Biyalogorsky et al., 2006; Schmidt & Calantone, 2002). They stick to their original course of action, driven by the hope and belief that things will improve and money is well spent (Ku, 2008; Staw, 1981).

They increase their commitment and invest more and with that following a course of action rather than an isolated choice (Staw, 1981). They invest too much to quit and become “entrapped” (Ku, 2008; Schmidt & Calantone, 2002; Biyalogorsky et al., 2006). These projects sometimes proceed to commercialization only to fail in the market at substantially higher costs than if they had been terminated earlier. Next to that, scarce resources are used at the expense of other promising projects. Other causes of EoC can be described by making use of the model as described by Keil (1995) and Schmidt & Calantone (2002):

![Figure 2.4: model of Project Escalation (Keil, 1995)](image)

The causes are grouped into 4 factors:

- **Project factors**: includes the objective features of the project itself and how it is perceived by management. Projects are more prone to escalation when they involve a large potential payoff, when they are viewed as requiring a long-term investment in order to receive any substantial gain, and when setbacks are perceived as temporary problems that can be overcome (Keil, 1995).

- **Psychological factors**: cause managers to convince themselves that things do not look so bad and that continuation will eventually lead to success. They turn around the failing situation and justify their previous behaviour, called self-justification (Ku, 2008; Staw, 1981; Keil et al., 2000; Schmidt & Calantone, 2002). Projects are more prone to EoC when there is a history of success, because they don’t want to appear wasteful to themselves and others, because it might damage their career and reputation (Keil, 1995; Karlsson, 2002; He & Mittal, 2007; Keil et al., 2000).

- **Social factors**: these factors include competitive rivalry with other social groups, the need for external justification (blaming it on something outside of us), and norms for consistency. Projects are more prone to escalation when competitive rivalry exists between the decision-making group and another social group, when external stakeholders have been led to believe that the project is (or will be) successful, and when norms of behaviour favour “staying the course” (Keil, 1995).
Organizational factors: involves the structural and political environment surrounding a project. Projects are more prone to EoC when there is strong political support at the senior management level and when the project has become institutionalized (Keil, 1995; Biyalogorsky et al., 2006).

2.3.1 How to prevent Escalation of Commitment?
Preventing EoC (also called de-escalation of commitment) occurs as a result of an individual’s decision to cancel or redirect a course of action to which previous resource commitments has been made. A couple of structures and incentives to prevent EoC are provided in the following section (Keil, 1995).

Know the stage of the project and manage it accordingly
Companies should create a tracking system that gives senior management a full accounting of all projects and their current stages. Clear guidelines should be established to mark the point at which projects move from one stage to another (Keil, 1995). One way is to reduce project complexity by using a modular design and by breaking down large projects into smaller projects and make sure that the team members are knowledgeable and receive adequate training (Jani, 2010).

Assess risks early during the development process
Objective amount of project information during a project’s early stage might not have accumulated or be available (Biyalogorsky et al., 2006). As the project progresses, more information may become available providing decision makers the opportunity to better assess the future disposition of the project (He & Mittal, 2007). A possible approach is the use of mental budgeting. In this theory it is assumed that people set budgets so that they can track ongoing investments and limit risks (Karlsson, 2002).

Conduct serious project audits
Within a project audit, someone is appointed to serve as the organization’s devil’s advocate. This individual, together with a cross-functional project review team, should be charged with protecting the interests of the organization, checking the project goals (e.g. by making use of early warning systems with termination conditions at the outset of the project) and examine the project risks (Keil, 1995; Pan et al., 2009; Woolley, 2007; Keil et al., 2000; Biyalogorsky et al., 2006). Cross-functional project review teams appear to reduce the likelihood of escalation for two reasons: teams almost always have more collective experiences and knowledge than individuals acting alone and team decisions should dilute the level of responsibility each member feels (Schmidt & Calantone, 2002).

Reduce the need for self-justification
Whenever managers feel compelled to defend their actions against critics, they will be less flexible in their decision making. In order to reduce this psychological need for self-justification, organizations can make use of risk checklist, providing appropriate objective feedback to managers of the possible escalation position (Jani, 2010). By informing decision-makers that the phenomenon EoC exists, escalation tendencies can be reduced, because individuals learn to repeat actions that are pleasant and discontinue and avoid aversive behaviors (Little & Little, 2009; Keil, 1995; Ku, 2008).

2.3.2 Conclusion
It is important to prevent EoC (preferable as soon as possible), to save costly resources for promising projects only and with that linked to the performance of an NPD process. Besides of that, escalated projects are significantly more likely to have performance problems (Keil et al., 2000). EoC can be prevented through:

- Appropriate project management;
- Timely risk assessments;
- Project audits;
- Reduce the need for self-justification.
The findings of this literature search can be summarized through the following model.

Figure 2.5: cause and effects of Escalation of Commitment

### 2.4 Causation vs. Effectuation

Imagine a chef assigned the task of cooking dinner with two different ways of working. In the first, the chef begins with a given menu and focuses on selecting the most effective way to prepare the meal. In the second, the chef has to imagine possible menus, based on the available ingredients and tools, select the menu, and then prepare the meal Sarasvathy (2001). The first case, in which a meal is prepared based on a menu, is termed Causation. The second case is based on preparing a meal with the means available and in which no specific route to a specific end-goal is present, called Effectuation. But, the generalized end goal or aspiration remains the same in both cases, that is, to cook a meal (Sarasvathy, 2001).

Effectuation is a general theory of decision making in uncertain situations that focuses on the human action as the predominant factor shaping the future, in which uncertainty is defined as the difference between the information possessed and the information required to perform the particular task. On the opposite Causation processes take a particular effect as given and focus on selecting between means to create that effect. (Brettel et al., 2011). The main differences between Effectuation and Causation can be summarized with the use of table 2.1.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Causation</th>
<th>Effectuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting point</td>
<td>Ends are given</td>
<td>Means are given</td>
</tr>
<tr>
<td>Assumptions on future</td>
<td>Predictability means controllability</td>
<td>Controllability reduces need to predict</td>
</tr>
<tr>
<td>Predisposition towards risk</td>
<td>Expected return</td>
<td>Affordable loss</td>
</tr>
<tr>
<td>Appropriate for</td>
<td>Existing products and markets</td>
<td>New products and markets</td>
</tr>
<tr>
<td>Attitude toward outside firms</td>
<td>Competition</td>
<td>Cooperation</td>
</tr>
<tr>
<td>Type of model</td>
<td>Linear</td>
<td>Cyclical</td>
</tr>
</tbody>
</table>

Table 2.1: comparison of the Causation and Effectuation model (Kraaijenbrink, 2008)

**Starting point**

Effectuation involves seeing means and resources, rather than a particular end goal (see figure 2.6). Based on these relatively unalterable characteristics, an imagined end can be decided, which brings the chef closer to the general aspiration, to cook a meal. The chef knows from his/her experience how to transform the available ingredients into a tasteful meal and uses the ingredients he or she is familiar with, and if not, he/she can consult others, to gather new means. On the opposite, with Causation a given goal has to be achieved or a decision has to be made which is usually well structured and very specific, like the menu in the cooking example is (Sarasvathy, 2001; Perry et al., 2011).
**Assumptions on future**

*Causation:* If I can predict the future, I can control it.

*Effectuation:* If I can control the future, I do not need to predict it (Sarasvathy, 2001).

Translated into the cooking example, within the Causation example the chef knows what is expected and how to fulfill this expectation, because he/she has done this before. And the customer knows what to expect when ordering the meal. The future can be predicted, and the chef can control it. On the opposite, within the Effectuation situation, the chef knows which ingredients he/she can choose from and combine the ones from which he/she knows will be tasteful. By repeating this cycle, several times, a couple of components for a complete meal can be put together in the end.

**Predisposition towards risk**

*Within Causation,* maximization of expected returns (the product) is the end goal by selecting the most efficient means to achieve it. On the opposite, *within Effectuation,* a predetermined level of affordable loss or acceptable risk is accepted and from this perception people are free to find a way which strives for the general aspiration (Sarasvathy, 2001). This freedom might result in more creative thoughts.

The chef who works according to the Causation logic will make the meal as efficient as possible. Waste is minimized to provide the meal fast and cheap. If something goes wrong in the process to the meal, then the whole meal is failed. But in the end, every meal will look and taste the same. An Effectuation perspective assumes the used ingredients as affordable loss. This loss is much smaller than is the case of Causation. If the used ingredients are not tasteful enough, then other options are searched for.

**Appropriate for**

*Causation* models would dominate exploitation, focusing on the existing products and markets. Contradictory, *Effectuation* would improve processes of exploration, to develop new products and markets (Sarasvathy, 2001). E.g. when you cook a meal based on a menu, the only thing you can do is to improve the efficiency of the process, but never coming to radical new meals. But when you cook a meal based on ingredients as given means there is a bigger probability that a completely new meal is provided.

**Attitude toward outside firms**

The cooperation dimension of Effectuation refers to the involvement of partners into the decision-making process in order to expand means. Stakeholders (e.g. suppliers or customers) may provide the necessary information and resources to reduce uncertainty and ambiguity, by providing new means (Brettel et al., 2011). Causation consists of competitive analysis to find improvements for the current products. In the thought of Effectuation, the chef can involve the supplier of the ingredients and ask for tips for a great meal. This was never happened when the menu was already known.
Type of model
Within Effectuation, continually listening to the stakeholders and building an ever-increasing network of customers and strategic partners, available means increases and with that an increased possibility to create a product that wasn’t expected upfront (Sarasvathy, 2001). The chef can make use of his/her stakeholders to gather cooking tips, taste opinions, and new combinations, resulting in a completely new to the world meal. Causation is more linear, the given goal is static from the beginning.

2.4.1 Link with Stage-Gate and Creative organizational culture
Many companies have difficulties finding an efficient and successful approach for highly innovative types of R&D projects, in which great levels of uncertainty are present. Effectuation seems to do a good job overcoming these difficulties. Findings indicate that Effectuation is positively related to R&D performance (output and efficiency) when innovativeness is high (Brettel et al., 2011; Perry et al., 2011). Effectuation is particularly suitable for forming a conceptual basis within high innovative R&D projects, because they face high levels of uncertainty (Sarasvathy, 2001; Brettel et al., 2011). Figure 2.7 explains this finding and also what the effects can be on R&D project performance (Brettel et al., 2011). The four dimensions described in the figure will be explained in the following section.

![Figure 2.7: when to use Effectuation (Brettel et al., 2011)](image)

**Dimension 1: means-driven vs. goals-driven**
Means-driven R&D projects have a positive impact on the R&D output with high innovativeness, because project targets are initially fuzzy and may even remain highly abstract. On the other hand, a Causation approach defines detailed project goals, which dictate the required resources. The core of a means-driven approach is the focus on existing resources, rather than on the formulation of concrete goals (Sarasvathy, 2001). Since goals are kept fuzzy at the beginning, a means-driven approach can be expected to affect project efficiency negatively: accumulating knowledge can lead to superior R&D output, but it is time-consuming, especially when no concrete goals guide the process.

The benefits of goal-setting are particularly evident when low levels of innovativeness limit the uncertainty in projects and few or no changes are necessary in the planning process. Being goals-driven is therefore not so promising for highly innovative projects, because in dynamic and uncertain situations planning slows adaptations and can blind the organization to important changes in the environment.
Dimension 2: affordable loss vs. expected returns

When upside information is fuzzy, as is the case in highly innovative and therefore uncertain environments, expected returns may not lead to the right choice. Affordable loss describes situations in which decisions are made with the objective of minimizing risk. Commitments to the project budget help avoid overspending, so an effectual approach should positively impact the efficiency of highly innovative projects. However, a low level of innovativeness implies less uncertainty and, accordingly, better access to reliable data, such as forecasts on market acceptances and sales volumes.

Dimension 3: partnership vs. competitive market analysis

The partnership dimension of Effectuation refers to the involvement of partners in the decision-making and innovation process in order to expand means. Stakeholders (e.g. suppliers or customers) may be able to provide the necessary information and resources to reduce uncertainty and ambiguity, thereby positively impacting R&D output. A less innovative project is less dependent on external stakeholders because they are not needed to reduce ambiguity and uncertainty (Griffin, 2002).

When high levels of innovativeness drive significant uncertainty, competitive market analysis becomes outdated very quickly, so close adherence to such competitive analyses can lead to flawed decisions and retard a company’s ability to adapt to new situations – with negative consequences for R&D outputs. On the other hand, projects that involve low levels of innovativeness are expected to profit from detailed market and competitor analyses since analyzing market scenarios is worthwhile when uncertainty is low.

Dimension 4: acknowledge the unexpected vs. overcome the unexpected

Projects with elements of design flexibility are better suited to accommodating new information and circumstances. In case of strong flexibility (acknowledge the unexpected), it is more likely to modify plans as more information becomes available, whereas, when flexibility is low, it might engage in costly and time-consuming information gathering. With the causal types of projects, sticking to initial project targets is beneficial since unexpected scenarios (e.g. in terms of market acceptance or technical problems), which would require changing the plan, are unlikely (overcome the unexpected).

2.4.2 Conclusion

Effectuation is particularly suitable for forming a conceptual basis within high innovative R&D projects, because they face high levels of uncertainty (Sarasvathy, 2001; Brettel et al., 2011). The core of an effectual means-driven approach is the focus on existing means, rather than on the formulation of concrete goals (Sarasvathy, 2001). Since goals are kept fuzzy at the beginning, accumulating knowledge can lead to creative organizational cultures with superior R&D output, because new situations and means (e.g. through partners) are continually considered within this flexible, adaptable process (see figure 2.8).

Figure 2.8: a model of how to improve the efficiency of an NPD process
2.5 Conclusion

Within this literature study, an answer is searched for the main research question:

*How to enhance the competitive advantage of Holmatro, by implementing (1) a more effective decision making process, and (2) a more efficient NDP process inspired by the Stage-Gate model from Cooper?*

Four different theories are explored for the right answers to this question:
- Stage-Gating;
- Entrepreneurial culture;
- Escalation of Commitment;
- Effectuation.

A Stage-Gate process as described within this literature study is seen as a means to improve the effectiveness and efficiency of the NPD process, because this process places more structure within the process and has the objective to exclude subjectivity and emotions during a decision making process, resulting in more projects to be killed and with that preventing Escalation of Commitment.

In the end, the goal is to allocate the costly resources for promising projects only, which fit with the company strategy as described in paragraph 1.2. Next to that, this resource availability is necessary for experimentation, which is necessary to test ideas and with that a source for innovative and creative solutions. Effectuation is a theory which can be used to guide this creative way of working, especially within high uncertain and innovative projects.

In sum, the effectiveness and efficiency of the NPD process, in order to stimulate the competitive advantage of Holmatro, can be improved by making use of the literature as described within this chapter. The following figure (2.9) describes how the theories are linked to each other, and can be used as the foundation for concrete process improvements within Holmatro.

![Proposed Model](image)

*Figure 2.9: proposed model*
3 Methodology

This chapter describes the structure of this Master Thesis and which steps are undertaken within the period of 21 weeks, which started at January 31, 2011. First the research design is described, followed by the research questions and finally how the answers to these questions are gathered.

3.1 Research design

The regulative cycle from van Strien (1997) is used for this Master Thesis (see figure 3.1). This regulative cycle is suitable for this situation because it fulfils the condition that \textit{an individual problem in a particular circumstance is dealt with} and \textit{does not aim at developing theories} because the developed plan is often only suitable for a specific situation (Van Strien, 1997).

![Regulative Cycle](image)

Figure 3.1: The regulative cycle (Van Strien, 1997)

The regulative cycle starts with a definition of the unsatisfactory performance within the company, the problem statement (as already described in chapter 1). In chapter 4, a diagnosis of the current situation will be described which must confirm the problem statement. The following part describes the design phase, in which an object design will be formed to provide a solution to the stated problems. This is the most important phase for Holmatro, because improvements for the current NPD process are gathered within this phase. Next to the solutions, a realization design is set up, which describes how the solutions can be realized within the current situation of Holmatro.

Due to the limited time of 21 weeks for this Master Thesis, this research will end after this third phase. A change plan will be the end results, which describes the object and realization design, so the company can take over the project and implement the changes (the intervention). Finally, the new solution must be evaluated to see whether it has the expected impact, if this is not the case a follow-up cycle should be arranged (Van Aken et al. 2007).
3.2 Research questions

Because of the fact that the main research question can provide a number of different answers, and therefore cannot be answered right away, a number of sub research questions are formulated to guide the Master Thesis in a more specific direction. The sub research questions are:

1. How can the current NPD process within Holmatro be improved?
2. How can a more effective decision making process be achieved?
3. How to improve the current NPD process into a structured Stage-Gate process?
4. In what way can the NPD process enhance the competitive advantage of Holmatro?
5. What (success) criteria must be present to implement the improvements?

The first sub question will be answered within the diagnosis phase of the regulative cycle. Through qualitative and quantitative analysis, a good view of the current situation must be provided and an overview of the bottle-necks must form the basis of the process improvements. Within this diagnosis phase it is very important that a realistic overview is formed without interventions of the researcher. This can be achieved with observations in the form of orientating interviews with the most important persons within Holmatro, as well as analysis of the company data and documentation related to the NPD process.

Sub questions 2 and 3 shall be answered within the design phase. By making use of the literature, as described in the previous chapter, a solid foundation can be formed of what an ideal NPD process looks like. This approach can be described as an expert approach, in which the best proven solutions and theories will be used to find the best solutions and recommendations for Holmatro.

The literature provides the criteria for an ideal decision making process, an ideal Stage-Gate process, and for a successful implementation of the new design. But the most important activity within this Master Thesis is the translation from the scientific viewpoint into a practical useable solution for the company. This must be achieved through interactions with the potential users of the improved NPD process. The change-plan in chapter 6 must function as this translation. Within this chapter an answer to the last 2 sub questions are described.
4 Diagnosis

This chapter describes the analysis of the current situation with the end goal of validating the problem statement, as described in chapter 1, and provides the actual diagnosis. It must provide the answer to the question of how the current NPD process within Holmatro can be improved. First the orientating interviews are described, which provided a number of bottlenecks within the current NPD process within Holmatro. A couple of them could be validated with the use of company data, as described in the second part.

4.1 The orientating interviews

Orientating interviews provided insight into the current situation of Holmatro, and especially identified the bottle-necks within the current NPD process. Nine key persons were selected for the interviews, which were expected to be aware of what is experienced on their department and within the rest of the company. An interview template was set up, to provide guidance and to find the answers to the following topics:

- Their functions and linkages with the NPD process;
- Points of improvement within the NPD process and within the company;
- Procedures which are related to their work;
- The content of Project Management.

The Stream analysis method from Porras (1987) was used to structure the data processing of the collected information. Through a couple of steps, the gathered information could be processed into cause and effect relationships, which provided a good insight into the organizational problems.

First a list of bottlenecks was set up, and subsequently, a number of bottlenecks were grouped. By making use of consensus diagnosis, which presumes that a statement is valid when a majority (in this case 60%) agrees, a number of bottle-necks were perceived (van Eijnatten, undated). The next step was to analyse the relationships between the bottlenecks with the use of a matrix table.

Finally, all the bottle-necks were summarized within a Current Reality Tree (CRT). A CRT treats multiple problems as symptoms arising from a few ultimate root causes. It describes, in a simple visual drawing, the main perceived symptoms (along with secondary ones that lead up to the perceived symptom(s)) of a problem scenario and ultimately the apparent root cause(s). The benefit of doing this is that it is much easier to identify the connections or dependencies between these. Focus can be placed on the bits which would cause the biggest positive change, if tackled (Wikipedia, 2011).

Based on this analysis a number of root causes can be identified, which influences the whole process. The CRT and the root causes are not described in this publication version because of company interests. But in the end, the symptoms of these root causes can influence the competitive advantage.

4.2 Conclusion

The goal of this chapter was to validate the problem statement from chapter 1 and to provide an answer to the first research sub question. Orientating interviews and company data resulted in an overview of improvement points of the current NPD process. The theory as described in chapter 2 can contribute to a solution to improve the effectiveness and efficiency of the NDP process within Holmatro. How to achieve this will be described in the following chapter.
5 Object design

This chapter describes the object design phase, in which a solution will be described of how to overcome the root causes as described in the previous chapter. ‘A design can be defined as a model of an entity to be realized, as an instruction for the next step in the creation process’ (van Aken et al., 2007). The first part describes the requirements and criteria the design must meet but also the limitations of the design. The actual object is described in the second part and a new NPD process will be introduced, which fit the current activities of Holmatro.

5.1 Design requirements, criteria and limitations

The design must meet a couple of requirements and criteria in order to be accepted by the company and to meet the academic level of this Master Thesis. For Holmatro the design should provide improvements to the current situation, as stated in the previous chapter.

On the academic side, a number of requirements and criteria can be enumerated of what the new process design should meet in order to stimulate the competitive advantage based on scientific literature. As described in chapter 2, the new process should:

- modify the current NPD process into a structured Stage-Gate process;
- stimulate the internal conditions of a company and with that improve the innovative performance;
- reduce the possibility of Escalation of Commitment;
- stimulate Effectuation in high innovative projects.

5.2 Design of the NPD process

The new idea-to-launch process will be introduced within this part. Chapter 2 already described the basics of a Stage-Gate process and also how a typical Stage-Gate process looks like. This information is used within the design of the new process. The designed NPD process for Holmatro is showed in figure 5.1, in which every project pass a number of stages during the development of a product. The power of the Stage-Gate process is that every stage ends with a gate, where the project is assessed, with in the end a decision if the project gets the investments needed to continue or that it will be killed.

Figure 5.1: the new NPD process for Holmatro
The most important part of the process design is to describe the underlying activities within the stages and gates, which fit the development process of Holmatro. Therefore, the whole process will be described in detail within the following section. Process examples from the literature (from chapter 2), company data and input from employees within Holmatro contribute to the completion of the process.

5.2.1 Discovery

Fuzzy front end

Two shortcomings of the typical Stage-Gate process, is that the fuzzy front end is not included in the process and that the process is mainly focused on the internal process. It only threatens the process from the moment that an idea is present and therefore, within this design, the inclusion of the idea generation is described.

Creative ideas are needed to achieve the innovative performance as required within Holmatro. To stimulate the idea generation within Holmatro, the idea generation phase must be very organic (flexible) and should stimulate to be creative, in order to embrace ideas, weak signals and new opportunities outside the company and to pursue new solutions. These are all requirements which fit with the strategy of Product Leadership.

The inclusion of Effectuation can help to achieve the generation of these creative ideas. This theory fits well when uncertainties are high, as is the case within the fuzzy front end of a process. No specific end goal and expected returns are described yet, which is ideal to stimulate an explorative perspective. As described within chapter 2, the Stage-Gate process should result in more projects to be killed, in order to allocate the costly resources for promising projects only and also to get some resources available for experimentation. This is needed to test innovative and creative thoughts within the employees minds, but also to test new means that are discovered during a development project, which might evolve into new innovative ideas for development.

This experimentation time must be separated from the planned activities and projects within the company. Employees must get the possibility to spend some working time to work on self-defined innovations, ideas and/or experiments, with the possibility that new ideas can be identified. Within the new NPD process, it is recommended to implement a 10% rule. This 10% rule, must be seen as an affordable loss for the company with no specific end goal specified. But it allows people to work 10% of their time to work out their thoughts. They can make use of the equipment which is available within the company and can ask colleagues (or potential partners) to help when needed (in other words, they can make use of all the available means). When the initiator thinks that the experimentations provide some interesting results for the company, he or she can propose it to be a project to develop.

Another potential advantage of this way of working is that an entrepreneurial culture is stimulated. Initiatives of people are taken seriously and people can undertake something new, with the chance of gathering new insights and approaches for their company. Because people can work on their own ideas, enthusiasm within the company can be stimulated, which makes it attractive for talented innovative people to work for Holmatro.

Describe the idea

At the end of this fuzzy front end an idea is born, but not every idea can be a project, due to the scarce resources Holmatro has for product development. On average 6.6 ideas are needed to generate one success (Griffin, 1997) and in order to choose the right ideas to elaborate on, a couple of (costless) activities should be executed within the Discovery stage so that every idea can be evaluated on the same components.

The activities can be guided by an Idea registration form (appendix 4; template Idea registration), which describes the idea within (at maximum) 1 page. The activities to come up with the necessary information can be divided into 3 main categories:
- **Market evaluation**: identify the market segment, size of the segment, product value (in- & externally) and check if the idea fits with the core business of Holmatro. The product value describes what value the idea provides to the customer, other stakeholders and to Holmatro;
- **Technology evaluation**: describe innovativeness, development risks and gaps with the current technology. This information forms the input for the research topics for the next stage;
- **Economic evaluation**: provide an indication of the investment needed for stage 1.

### 5.2.2 Gate 1: Idea screen

This is the first meeting where resources are committed: the project is born at this point (Cooper, 1990). Gate 1 is the first screen, and assesses the idea, based on the Idea registration form only, to a handful of key “must meet” and “should meet” criteria (with the help of a criteria list (Cooper & Edgett, 2001)). These criteria deal with:

- **Strategic fit**: assess alignment with Holmatro’s strategy and its impact on the (core) business;
- **Product & competitive advantage**: check if the product offers unique benefits for the customer and if it provides excellent value for money to the customer;
- **Market attractiveness**: assess if a market exists for the product;
- **Core competencies leverage**: check if the product leverages all core competencies;
- **Technical feasibility**: assess the size of the technical gap and complexity of the product, which are indicators of the chance of success;
- **Financial reward vs. Risk**: assess the expected profitability and investment risks;
- **Work plan and deliverables**: verify the presence of work plans and that deliverables are set for the next stage.

All criteria, except the last one, are scored (on a scale of 0 to 10) by the gatekeepers (in this gate, the CEO, R&D Manager and the Product Manager), within a gate meeting. This score is multiplied with a weight factor, which differs per gate, and finally a score comes out for each criterion. By adding the scores from each criterion, a total project score is the result, which is used to make a Go/Kill decision. A minimal score of 6 out of 10 is desired for a Go decision, and if this score is not achieved then it might indicate that the project is not performing as it should be.

When the project score is not satisfying a discussion takes place of what the next step shall be. Should the project be killed, put on hold, or should the stage be recycled. In the case of ‘Go’, ‘Hold’ and ‘Recycle’ a date for the next Gate meeting must be agreed on, as well as, the goals for that meeting. Also, resources must be committed to the project in order to reach the goals. The project can only continue when resources are committed within the meeting.

Finally, any recommendations on the project so far are discussed and documented within the document. Within this discussion the gatekeepers decide if the project should be guided by the complete NPD process with all the Gates (in case of radical innovations), or that the project does not need that much guidance and quality checks (incremental innovations). Incremental innovation projects with low risk of failure can be guided with the use of only gate 1, 3 and 5 in order to prevent the experience that the NPD process is a bureaucratic and slow process. Besides, if any new insights/means are identified within the project, which can be used for this or any other project, they must be documented as well.

At the end of the meeting, the document must be signed by the gatekeepers and also by the submitter of the document (so he/she agrees what is decided), who also is responsible that the document is documented in the right way by the project team. How the meeting must be organized will be discussed in detail in chapter 5.5.

### 5.2.3 Stage 1: Scoping

The first, short-time and inexpensive stage has the objective of determining the project’s technical and marketplace merits in order to define a better and sharper product definition (Cooper & Edgett, 2001).
Projects that were characterized by such sharp agreements prior to the development phase were considerably more successful, because they provide buy-in across functional areas and it provides a clear set of objectives, instead of vague (or even moving) goal posts, for the development team to strive towards (Cooper & Kleinsmidt, 1993).

The activities within the Scoping stage can also be guided by a template: Project definition, which describes the idea within (at maximum) 3 pages. The activities to come up with the necessary information can be divided into 4 main categories:

- **Initial market assessment**: identify the market share potential and market obstacles. Also, carry out a competitive analysis and contact key users, so rough customer needs can be set up;
- **Initial technical assessment**: define the product and check the development feasibility, for instance through identifying knowledge gaps and legal issues;
- **Manufacturing evaluation**: assess fit with current manufacturing capabilities;
- **Initial financial assessment**: make a rough estimate of revenues and required investments. This information guides the project plan for stage 2.

The project definition document forms the input for gate 2.

### 5.2.4 Gate 2: Second screen

Within this second screen the project definition document is assessed in the same way, and with the same gatekeepers, as within gate 1, but now with the new information included. Additional evaluation criteria are included, next to the ones as already described in the previous gate:

- Positive customer feedback from key users (Product & Competitive advantage);
- Margins earned by others in this market (Market attractiveness);
- Payback period and certainty of return (Financial Reward vs. Risk).

A Go decision provides the permission to enter stage 2: Build Business Case.

### 5.2.5 Stage 2: Build Business Case

This is the final stage prior to development, which must verify the attractiveness of the project prior to heavy spending and in which the project must be clearly defined. Many projects are poorly defined when they enter the development phase. This is often the result of weak predevelopment activities: the target user is not well understood, user needs and wants are vaguely defined and required product features are fuzzy. With a poorly defined project, R&D waste time seeking definition, often recycling back several times to get the product right, so more detailed research within this phase pays back in reduced development time and improved success rates (Cooper & Edgett, 2001).

The activities within this stage include:

- **Detailed market assessment**: set-up a customer panel and identify strategic development partners which can be informed when concepts are developed. Also, a detailed user needs-and-wants study and a potential growth analysis must be executed in order to re-evaluate the target market;
- **Detailed technical assessment**: identify the technology limitations, legal issues and the needs-and-wants from the internal stakeholders. This information is needed for the program of demands (POD), which provides the design specifications of the product. Within this POD, customer needs-and-wants are translated into technical specifications. After that, a concept must be created which provides the looks of the product, which can be used for the market assessment;
- **Initial manufacturing assessment**: identify if the product can be manufactured, what the costs are, the required investments and the needed raw materials. Based on this information the process specifications can be set for the product;
- **Detailed financial assessment**: more information is available on the potential market, so detailed estimates of the revenues can be described, and with that, detailed cost targets can be set. The pricing strategy must be chosen together with the sales and marketing department. Finally, the project plan for stage 3 to 5 can be made, based on these financial data.
All the gathered information must be captured within a Business plan and an initial manufacturing plan. These documents are updated during the rest of the NPD process and must consist all the information needed to guide the development of the product. The business plan is a 15+-page document with a predetermined format and content, providing full assessment of the product.

5.2.6 Gate 3: Go to development
The project is once again subjected to the set of "must meet" and "should meet" criteria used at Gate 2, with additional criteria, like market size, market growth & future potential (all within the Market attractiveness category). Finally, because a heavy spending commitment is the result of a Go decision at Gate 3, the results of the financial analysis are an important part of this screen. The gatekeepers within this gate are the same, except that the Planning & Control Manager is added to the list of reviewers. Within this gate it is also recommended to include a market representative or a potential strategic partner.

5.2.7 Stage 3: Development
Within this stage, the product is developed, and a lot of product data is gathered. The activities can again be divided into a couple of categories, which forms again the input for the business plan and the manufacturing plan, which are updated within this stage. The activities within this stage include:

- **Update market assessment:** within this stage, initial customer feedback is desired. With the use of the concept test (looks) from stage 2 this can be achieved. For the development of the prototype, the strategic partners can be involved;
- **Technical development:** to develop a prototype, at least the following activities must be executed: layout product, do calculations/simulations, overcome knowledge gaps, make product technical drawings, produce rapid prototypes (functional models), a design FMEA, a refined POD, solve legal issues, final prototype development and in-house testing;
- **Detailed manufacturing assessment:** acquiring raw materials and production equipment. A production process must be developed, and after that, a production planning can be made. Finally, a scale-up feasibility analysis must be executed to see if the product is ready for production;
- **Updated financial assessment:** calculate the global cost price of the product, based on the information provided within the previous activities.

A final prototype is the result of this stage, which must be tested and validated within stage 4. After this stage, major changes in the design are not allowed anymore.

5.2.8 Gate 4: Go to testing
This gate is a check on the progress and the continued attractiveness of the product and project. Development work is assessed and checked, ensuring that the work has been completed in a quality fashion and that the prototype satisfies all the required specifications. This gate revisits the economic question via a revised financial analysis based on new and more accurate data (Cooper, 1990). The gatekeepers for the gate are the CEO, R&D Manager, Product Manager, Planning & Control Manager and the Production Manager of the firm.

5.2.9 Stage 4: Testing and validation
This stage tests the entire viability of the project: the product itself, the production process, customer acceptance, and the economics of the project. Again, the findings are documented within the business and marketing plan. A number of activities are undertaken at Stage 4:

- **Update market assessment:** the target market must be re-evaluated, a trial sell takes place to test the selling process, and an end of life plan is included within the business plan;
- **Further technical development:** design (and specs) freeze is the first step after the prototype. This is important, because the final drawings/exploded views, bills of material and manuals & instructions must be made and implemented within the (information) system. A design
FMEA, extended in-house tests, test market/field trials, and training are needed before product certification can be achieved.

- **Update manufacturing assessment:** process routings are assessed, and a process FMEA must prove that the process is safe, if not, improvements have to be made before the O-series production (test production) can start;
- **Updated financial assessment:** calculate the detailed cost price of the product and the estimated cost-to-completion. After that the price list can be made.

### 5.2.10 Gate 5: Go to launch

After stage 4 the product must be ready for full commercialization. The project can still be killed, because after this point, large investments are required for commercialization. This gate is assessed in the same way as all the other gates, but especially the quality of the activities must be assessed. Financial projections must be solid and positive, before a Go decision can be made. The gatekeepers are almost the same as within the previous gate, except that the Planning & Control Manager is replaced by the Quality Manager. At this gate meeting, this team must assess the business plan and approve the launch of the manufacturing plan.

### 5.2.11 Stage 5: Launch

This final stage involves the launch of the manufacturing plan and the completion of the business plan: including a spare parts plan, training plan for the dealers, making of sales & marketing materials, and a test for the infrastructure readiness (the information system) within the organization. Within stage 5, a plan has to be set up of how the project results will be monitored for the post-launch review, 16 months after the initial introduction, within a launch report.

### 5.2.12 Post-launch review

At some point following commercialization, the new product project must be terminated. The team is disbanded, and the product becomes a "regular product" in the firm's line. This is also the point where the project and product's performance is reviewed, on average, 16 months after initial introduction (Griffin, 1997) and also to discuss the learning points with each other. The latest data on revenues, costs, expenditures, profits, and timing are compared to projections to gauge performance (Cooper, 1990).

### 5.2.13 Roles within the NPD process

Implementation of the process requires a NPD team with clearly delineated roles and responsibilities. NPD teams vary in composition depending on the nature, size and stage of the project, but their roles and responsibilities stay the same (US Department of Energy, 2007):

- **Technology managers:** responsible for all funding decisions and ensuring those managers apply Stage-Gate guidelines appropriately. A number of responsibilities include:
  - Providing input to Gate decision criteria development;
  - Participating in Gate meetings, especially, for large, high profile projects;
  - Providing clear decisions and recommendations during/after Gate meetings;
  - Allocating funding for approved projects;
  - Verifying that gatekeepers comments have been documented and addressed;
  - Interacting with project managers and team members to resolve project issues.

- **Project Managers:** responsible for applying the Stage-Gate guidelines to projects under their supervision. A number of specific responsibilities include:
  - Providing input to criteria development;
  - Identifying external gatekeepers if necessary;
  - Assessing and approving detailed R&D stage plans;
  - Verifying that gatekeeper comments have been documented and addressed;
  - Interacting with team members to resolve project issues as appropriate;
  - Contracting/arranging resources;
- Tracking progress versus budgets and schedules;
- Facilitating task execution;
- Communication status, results and accomplishments.

**Team members:** generally responsible for planning and running the Gate meeting and other tasks. Specific responsibilities:
- Executing and controlling the project stages: gathering and analyzing information, researching and developing technology, documenting results and progress, communicating with managers and end-users;
- Distributing outputs and stage plans to the project team in advance of Gate meetings;
- Developing materials for the Gate meeting: presenting stage accomplishments, addressing Gate criteria, presenting the plan for next stage;
- Revising and distributing Stage plans;
- Documenting gatekeeper comments.

**Gatekeepers:** responsible for deciding whether a project should continue and receive funding for the next stage. Specific responsibilities:
- Assess results against preset gate criteria;
- Gate decisions and funding allocations;
- Recommendations for revisions to the R&D plan going forward.

### 5.2.14 Conclusion

Within this paragraph a NPD process based on the Stage-Gate principle from Cooper is designed for the company, which is showed in figure 5.2. This process can help improve the current NPD process and treats the most important, if not all, activities that are required in order to streamline an idea-to-launch process successfully.

![Figure 5.2: the complete design of the NPD process](image-url)
5.3 Preventing Escalation of Commitment

An important criterion for the new NPD process is that it must reduce the possibility of escalating projects. In chapter 2, four structures were described to prevent Escalation of Commitment. These are implemented within the new NPD process.

Know the stage of the project and manage it accordingly
The new NPD process provides a clear guideline of how to execute a project from idea-to-launch. It clearly delineates the stages of a project, and what is needed to pass the gate, in order to move to the next stage. This transparency in expectancies makes the new NPD process suitable as a tracking system for senior management, in order to get a total overview of all projects and their current stages.

Assess risks early during the development process
The main goal of the first 3 pre-development stages within the new NPD process is collecting objective project information, in order to reduce key project uncertainties and risks. Compared to the current NPD process, this is far more extensive, but makes it a lot easier to assess the future disposition of the project. The strength of a Stage-Gate process is that the use of mental budgeting can easily be applied, which reduces the chance of escalation. At each gate a budget is assigned to complete the activities necessary to complete the stage, which makes it ideal to limit risks within a development project.

Conduct serious project audits
The gates within the new NPD can be seen as project audits. Within this meeting the gatekeepers act as devil’s advocates. They protect the interests of the organization, check the project goals, and examine the project risks. Because the decision is not based on one individual, but a cross-functional gatekeepers team, the likelihood of escalation reduces. The logic behind it is that a team has more collective experience and knowledge to estimate the chance of project success.

Reduce the need for self-justification
The new NPD process provides gate meetings after each stage. Within these meetings a project is scored on a number of criteria, by the gatekeepers team. This score provides appropriate objective feedback of the possible escalation position, which makes it difficult for the project leader, project team or the gatekeepers to defend their actions against critics. Hopefully, they realize that they are too committed to the project and that continuation does not bring success.

5.4 Stimulating Effectuation within the new NPD process

It is described that Effectuation is very useful within the fuzzy front end of the development process. But Effectuation, is also very useful for the decision making process in highly uncertain and innovative situations (Brettel et al., 2011; Perry et al., 2011). Because of the fact that the strategy of Holmatro focuses on Product Leadership, most of the projects should be innovative (and with that brings in a level of uncertainty) to produce a continuous stream of state-of-the-art products (Treacy & Wiersema, 1992).

Means driven
In the beginning of an R&D project, targets may be deliberately kept abstract in order to prevent blinding the organization to important changes in the environment and to stimulate exploration. But most of the times, extensive market information may not be available, because Product Leadership focuses on new products and new (to the firm) market segments. And with that it is not always clear, in the beginning, where to get the right information for the project. When the project proceeds, it is desired that new information or insights (means) can be processed within the work so far.
The new NPD process fulfills this desire by introducing the Gates, in which new insights can be assessed that should be taken into account for this (or any other) project. This can be fulfilled in 2 ways: recycle the stage with the use of the new insights, or continue the project with the new insight (only in the case the new insight doesn’t impact the project too heavily). Especially, the first 2 stages of the new NPD process are rather short and inexpensive, stimulating the flexibility of implementing new means and/or insights.

**Controllability reduces the need to predict**
Design flexibility is important to accommodate new information and changing market or technical circumstances within the project. Within the new NPD process this is achieved through the implementation of Gates as a quality check. Within this meeting, new insights, changes in project specifications, involved partners etcetera are discussed and finally recommendations for the next phase are described. If changes in the plan or activities are required, they can be discussed, decided and approved immediately within the Gate meeting (improving controllability).

**Affordable loss**
Commitment to a project budget per stage is necessary to make this rather fuzzy process more efficient, to avoid overspending and to minimize project risks. This focus on affordable loss instead of expected outcomes is especially valuable within the first stages of the NPD process, when extensive market information and financial data are not available in order to set specific goals for the project. Within every Gate meeting, the gatekeepers must decide on how many resources are made available for the next stage of the project and arrange the date for next meeting, all in order to reduce and control project risks.

**New products and markets**
Effectuation stimulates exploration, in which new products and markets can be developed (Sarasvathy, 2001). Translated into the Gate meetings, an assessment takes place which checks if the project fits the company strategy (Product Leadership). Other criteria within the Gate, which support this assessment, are ‘Product & Competitive advantage’ and ‘Core competencies leverage’. The core competencies should allow Holmatro to expand into new end markets as well as provide significant benefit to the customers.

**Cooperation**
The involvement of partners (and/or customers) within the project can provide the information and resources necessary to lift the project to the next level and to reduce uncertainty and ambiguity (Griffin, 2002). Within the new NPD process, partners are advised to be present within the Gate meetings and are involved within the activities of the NPD process, in order to expand the means for a successful project. Besides, within high innovative projects, competitive analysis might provide too little guidance to define the project, through the fast changing variables of the project.

**Cyclical**
At every Gate meeting a decision is made if the project continues to the next stage or that it will be put on hold, is killed, or is recycled. This build in cycle makes it possible to digest any new means for the project, in order to create a product that wasn’t expected upfront (Sarasvathy, 2001). New means can be collected from the involved stakeholders (the Gatekeepers), customer and/or strategic partners.

### 5.5 The organization of the Gate meetings

Within the NPD process a number of Gate meetings must be executed to assess the quality of the project. It is important to structure these meetings in order to reach the goal: an objective Go/Kill/Hold/Recycle decision at the end of each Gate. This part provides an answer to the sub research question: *how can a more effective decision making process be achieved?*
An important part of an effective decision making process, is already described within the previous sections. The gates, scoring criteria, templates and the gatekeepers teams are described, which forms the basis of an effective decision making process. But it probably won’t function when the actual structure of a Gate meeting is not described and agreed on. This part elaborates on this actual structure.

5.5.1 Rules of Engagement
As described in chapter 2, a common fail point of a Stage-Gate process was the fact that gatekeepers behave badly with the effect that gates are not working and with that are not effective. It was mentioned that a decision-making team needs Rules of Engagement in order to keep them on track. Cooper (2008) mentioned a number of rules of engagement which can be used for the new NPD process:

- All projects must pass through the gates. There is no special treatment or bypassing of gates for pet projects;
- Once a gate meeting date is agreed, gatekeepers must make every effort to be there. If the team cannot provide deliverables in time for the scheduled gate, the gate may be postponed and rescheduled, but timely advance notice must be given;
- If a gatekeeper cannot attend, s/he can send a designate that is empowered to vote and act on behalf of that gatekeeper (including committing resources);
- Pre-gate decision meetings should be avoided by gatekeepers – don’t prejudge the project;
- Gatekeepers should base their decisions on scoring criteria. Decisions must be based on facts, not emotion and gut feel!
- A decision must be made the day of the gate meeting (Go/Kill/Hold/Recycle). The project team must be informed of the decision, face to face, and reasons why;
- When resource commitments are made by gatekeepers (people, time or money), every effort must be made to ensure that these commitments are kept;
- Gatekeepers must accept and agree to abide by these Rules of Engagement.

Next to these rules of engagement, Langerak (2009) mentioned a number of additional rules:

- Gatekeepers must review team presentation before the meeting;
- Serious concerns must be communicated before the meeting: no “surprise attacks” allowed;
- No “cross-examination” allowed during team presentations;
- Gatekeepers cannot require and/or base decisions on information outside of the scope of the stage being assessed;
- Final vote must be unanimous. Gatekeepers must be willing to negotiate with other gatekeepers.

To ensure that the gatekeepers act according to these rules of engagement and behave properly, a document is added to the gate documents which list these rules. When they sign the Gate document, they also agree with these rules of engagement.

5.5.2 Gate meeting agenda
Within the template, a Gate meeting agenda is also described. This agenda must ensure that the meeting is structured, and that every stakeholder gets a chance to explain his or her thoughts. This agenda must be made available, by the project leader, 5 working days before the gate meeting takes place. A clear time distribution must be present within the agenda, which indicates the maximum time per part.

Every meeting should start with a short presentation (maximal 20 minutes) by the project team (and the project leader), describing the current status of the project, outstanding issues and/or changes to the original design since the previous stage and discuss the deliverables for review. The rest of the attendees are expected to listen to the presentation without interruption. At the end of the presentation clarifying questions are allowed but discussion is not. Then, a general discussion takes place
(maximum 15 minutes), which is led by the project leader. All participants are allowed to discuss the project, without serious attacks on the project. Discussion is needed to overcome any misunderstandings and ambiguities.

After that it is time for the voters (only) to score the project (maximum 15 minutes). This deliberation is led by one gatekeeper, and together they fill in the Gate document. A decision is made within this phase of the meeting. Thereafter, the other attendees are informed by the decision made, and what actions have to be undertaken for the continuation of the project (maximum 10 minutes).

Finally, the next hour is used to review and agree upon the next steps, assignments and due dates. All attendees know what is expected for the next Gate meeting, and if not they can consult the records from the meeting, which is made, and properly documented, by a team member of the project.
6 Realization design

Within the realization design, a change plan will be described, describing how the object design can be implemented within the current situation of Holmatro. The following elements will be described in this change plan (van Aken et al., 2007):

- The objectives of the change process;
- A description of the main changes;
- The actions to be taken.

6.1 The objectives of the change process

The designed NPD process, inspired by the Stage-Gate process from Cooper, can provide the company a standard of how to execute their development projects. Within the new process, clear Stages and Gates are described in order to improve the overview and the manageability of the projects. Each Stage describes what activities must be done for the execution of a project and how to document these within predetermined formats and content, with a quality check in the end, the Gates. Every Stage requires an integral way of working, because information from different departments must be present to complete the described documents. No department owns one stage, but the whole company is responsible for the success of the project. Especially, marketing and sales information is necessary to describe the specific needs-and-wants from the end-user, which is essential for the development of the product.

Objective decision making is the goal within the Gates, in order to decide if the project should be continued, killed, put on hold or that the Stage should be recycled. This objective decision making can be achieved by introducing the Gate documents, including a number of project criteria, to assess and score each project. These assessments are executed by a Gatekeepers team, providing more experience and knowledge into the decision making. Escalation of Commitment can be prevented by this team, because this experienced and knowledgeable team is better able to estimate the chance of project success.

An important condition for the Gate meeting is that the assessment of the project must be based only on the information as described within the specific Stage of the NPD process. Any information outside of the scope of the activities may not be taken into account. This condition should stimulate to document all the activities in a quality fashion.

Effective decision points are the power of the new NPD process, and in the end, the allocation of costly resources for promising projects can be better structured. Through this focus, an overload of projects can be prevented. Only promising projects are continued with the resources they need to complete the project in time. The new NPD process is effective and efficient, making it possible to commercialize new ideas very fast. This is needed to stay ahead of the competition.

Another result of these effective decision points is that the costly resources can be used for experimentation. This is needed to test innovative and creative thoughts within the employees minds, but also to test new means that are discovered during a development project, which might evolve into new innovative ideas for development. But a design of a new NPD process is not enough. A change-plan must be made to clarify how the object design can be realized within the company.
6.2 A description of the main changes

Because of the fact that the change-plan describes a lot of company specific information, the description of the main changes is omitted within this (publication) version of the Master Thesis.

6.3 Action plan

The designed process is just a design of how the business can execute their projects. The most important step is to implement the improved process into every department and activity of the firm, and that every person within Holmatro gets acquainted with the new way of working and also what they have to change in their activities. An action plan must guide this implementation. Within this plan, the steps, plus their timing to undertake for the change process, and the way of communication within Holmatro are described (van Aken et al., 2007). Finally, the action plan also describes the success criteria of the change process as an answer to the research question of what (success) criteria must be present to implement the improvements.

The importance of describing the communication of the implementation of the improved NPD process within the company is that the new process might be underestimated by the people involved. Especially, the information gap between themselves and the rest of the organization is a potential source of resistance, producing not only uncertainty but often also mistrust. A communication plan, as processed within this action plan, must overcome this resistance, by describing how to overcome the possible sources of resistance (van Aken et al., 2007):

- **Lack of understanding**: people may not understand there is a problem, or they do not understand the new system;
- **Differences in opinions**: people may understand the problem but disagree with the solution for technical, economic or personal reasons;
- **Lack of trust**: in the members of the change organization, either in their intentions or in their competences;
- **Low willingness to change**: direct stakeholders may not want to change because they fear the unknown, or fear that they will not perform well in the new system, or just don’t want to lose a familiar organizational environment.
- **Conflicts of interest**: organizational changes tend not to be neutral with respect to the material or immaterial interests of the various stakeholders.

As a starting point, the input from this Master Thesis is used for the action plan. Within this Master Thesis, a number of deliverables are provided to the company:

- **A new flowchart**: Stage-Gate is predicted to improve the efficiency and effectiveness of the NPD process, in order to improve the competitive advantage of the company;
- **Gate documents**: an important part of the Stage-Gate process are the gate documents, which improves the effectiveness and objectivity of the decision making process;
- **Templates**: within the Stage-Gate process, a number of templates are recommended to be used, in order to structure the process even better.

These deliverables can form the basis for the NDP framework, which describes what the change process exactly consists of. Within the last weeks of this Master Thesis, support for these templates was created. The templates were discussed with the Product Manager and the Project Manager R&D of how they can be used within the company and how they can elaborate on the researcher’s templates to complete the NPD framework as a starting point of the actual implementation.

The next step, and also the next success criteria of a successful implementation, is to form a NPD workgroup that is going to improve the NPD process. They represent the most important departments within the Holmatro NPD process, with a lot of experience on product development projects. This workgroup represents the NPD process and they should be responsible for the communication within
Holmatro. From the start of the action plan, till the formation of the NPD workgroup, it is expected this can be achieved within 1 month.

The first action of the workgroup is to capture the improvements into the daily activities of Holmatro. The NPD framework must be arranged within Holmatro, and to achieve this, a number of steps have to be executed (within two months):

- Change document structure project maps: the NPD framework has to be captured within the document structure of every new project. The deliverables within the NPD process must be found easily within the project maps. This can be achieved by implementing the Phase structure into the project maps or search for software tools, which can do the job;
- Inform Gatekeepers: within the NPD process, the Gatekeepers are very important for the success of the Stage and Gate structure. They have to be informed on what is expected from them and also how they can fulfill these expectancies within the Gates;
- Launch Key Performance Indicators (KPIs) of the NPD process: it is recommended to incorporate a evaluation of the change and its results towards the end of the change process to see what has been accomplished and what still has to be done (van Aken et al., 2007). By making use of a number of measurements, the success of the new process can be visualized. The measurements of the NPD process can be expressed in the: number of innovations per year, number of killed projects per year, number of Idea registrations and reliability of the project planning;
- Guarantee Top Management support: make sure that the Top Management supports the new process. If they don’t agree with the changes, chance of success is very low. By informing them on the progress of the change process, the actions to be taken in the near future, and by asking them for improvement points, commitment and support to the improved NPD process can grow, which are required to overcome the resistance of ‘low willingness to change’;
- Introduce NPD within the organization: every employee within the company must know what is going to be changed within the company. But also how these changes influence their work and what is expected from them. This introduction should be guided by a kick-off presentation, in which the workgroup presents the whole process to every stakeholder within the company. The workgroup must explain every step, activity, but most important, answer every question or concern which comes up. This session is very important to overcome the resistances of ‘lack of understanding’, ‘differences in opinion’, and ‘conflicts of interest’. After the presentation, the process must be made available on the intranet, so everyone can find the NPD process; including the templates. Next to that, everyone must know that the workgroup is available for recommendations, ideas, and complaints.

After these actions, the improved NPD process can be tested in a real project, called a pilot implementation. This approach is used if there is insufficient design knowledge to predict the performance of the new business system ‘on paper’, and therefore very helpful to overcome the resistance of ‘lack of trust’ (van Aken et al., 2007). One big project is guided and followed by the NPD workgroup. Information of the NPD process is gathered during a period of six months.

All the information, gathered from the pilot implementation is used for the post-launch review. Within this review, the NPD process, templates, Gate meetings and the KPIs are reviewed on performance and recommendations are discussed. When the recommendations are decided to be changed within the NPD process, a revised NPD process is delivered within 1 month after the meeting. When the NPD process delivers the desired performance, the final step for this workgroup, before it is disbanded, is to rewrite the process within the ISO handbook. The estimated time for this action is 2 months.

So as an answer to the sub research question of what (success) criteria must be present to implement the improvements, this action plan provides a number of criteria which must be present to implement the new NPD process successfully. An NPD framework has to be set up, a workgroup has to be formed which captures the NPD process into the daily activities of Holmatro, a pilot implementation has to take place and finally a post-launch review is executed to check if the Holmatro NPD process fulfills the desired performance.
7 Conclusion

This chapter summarizes the answers to the sub research questions as described in chapter 3, which is used to guide the Master Thesis to the answer of the main research question. Limitations of this Master Thesis are described in the second paragraph and recommendations for further research and development can be found in the third paragraph.

7.1 Conclusion

The problem within Holmatro is that decision moments with a huge variety of stakeholders are not documented sufficient which makes it difficult to underpin these decisions in later stages of the project. The result, project specifications can easily be changed within the more expensive stages of a project. These changing variables might lead to the fact that costly and time-consuming corrections must be made in order to launch a high quality product into the market. Besides, scarce resources are waste at the expense of other promising projects which might deliver even higher value for the company.

Within the current situation, the Project Manager R&D wants to further improve the manageability, objectivity and time-to-market of the projects under his supervision, by improving the current NPD process. Also Top Management want to further reduce the times-to-market and costs-to-market.

Analysis has provided a number of root causes which can negatively influence the current NPD process. The CRT and the root causes are not described in this publication version because of company interests.

An ideal NPD process was designed for the company, based on the Stage-Gate process from Cooper. The designed NPD process consists of a number of Stages and Gates, which are passed during the development of a product. This process treats the most important, if not all, activities that are required in order to streamline an idea-to-launch process successfully. Within this design, the emphasis was on making the decision points more transparent and effective, in order to prevent Escalation of Commitment, and meanwhile improve the innovative performance by introducing the theory of Effectuation within the decision points and also to overcome a major shortcoming of a typical Stage-Gate process, namely that the fuzzy front end (the idea generation) is not included. Effectuation can be used to organize the idea generation within an organic organization. Creativity (through experimentation time) is stimulated to generate new ideas.

The Stage-Gate process is powerful because every stage ends with a Gate where the project is assessed based on a number of documents with a predetermined format and content, with in the end, a decision if the project gets the investments needed to continue or that it will be Killed, Recycled or put on Hold. This assessment at every Gate meeting can be structured by making use of scoring criteria, templates, a Gatekeepers team, Rules of Engagement and an agenda.

In the end, the Stage-Gate process improves the project overview, because it becomes clear in which Stage each project is, what is expected at each Gate meeting and how to collect specific customer needs. Besides, an integral way of working is stimulated to complete the activities and decisions. These improvements make it possible to have effective communication, needed to share knowledge to improve the quality of work, and finally to complete the documentation as required for each Gate. The designed process can enhance the competitive advantage of Holmatro, because effective decision points prevent an overload of projects. Only the promising projects are continued with the resources

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2 Stakeholder: a person, group or organization with an interest in a project (Wikipedia, 2011)
they need to complete the project in time. This is needed to stay ahead of the competition (competitive advantage) and to remain the market leader.

The realization design was intended to implement the designed process, but because of the fact that the change-plan describes a lot of company specific information, the description of the main changes is omitted within this version of the Master Thesis.

In the end, an action plan was made, in order to describe how Holmatro can implement the new NPD process, and with that, how they can achieve the enhancement of the competitive advantage. A number of (success) criteria are discovered to implement the NDP process successfully. An NPD framework has to be set up, a workgroup has to be formed which captures the NPD process into the daily activities of Holmatro, a pilot implementation has to take place and finally a post-launch review is executed to check if the NPD process fulfills the desired performance.

In sum, a more professional NPD process is designed within this Master Thesis towards more professional innovation. The design includes a fuzzy front end, in which weak signals of new opportunities are absorbed from the market and where creativity is stimulated to generate new ideas combined with a mechanistic project management process in order to structure the NPD process and to design more routine into the process.

7.2 Limitations

The results within the Master Thesis could be biased through a variety of choices, made within the process. These choices can also be described as limitation for this Master Thesis.

Literature frame(work)
In a feedback session, with the R&D Manager, the Project Manager and Dr. J.A. de Keizer, an agreement was made of which literature to explore within the literature search. Stage-Gate was chosen as the most important theory for this Master Thesis. But as already described within this Master Thesis, the Stage-Gate process from Cooper brings in a number of disadvantages as well.

Most theories nowadays are more focused on open innovation, in which they involve customers and partners much more than Cooper ever described. By introducing other theories, this Master Thesis provides a number of ways to overcome the challenges of a Stage-Gate process. Effectuation, Escalation of Commitment and an entrepreneurial culture are all important to overcome the weaknesses of a Stage-Gate process and to sustain a flexible process instead of a bureaucratic solution, which slows down the whole development process.

Input of information
The Master Thesis concerns a qualitative research. This type of research contains the description, interpretation and explanation of behaviours and beliefs from the stakeholders. Through direct communication data is collected from the stakeholders who are involved. Through in-depth interviews with the most important persons within Holmatro, the opinions and beliefs of the employees about the context of the research area are collected.

But the output of this Master Thesis depends on the input of information. Within the Master Thesis at Holmatro most information is collected from the Rescue division, because this division provides the vast majority of the turnover. The divisions Industry and Marine are not included within this research and therefore research results are not obviously suitable for the Industry and Marine division. The research results could be verified by executing a survey with all employees involved, but due to the limited time of 21 weeks for this Master Thesis, this was not feasible.
7.3 Recommendations for further research and development

Further research and development is recommended in order to make the improved NPD process even more effective and efficient. Close collaboration is desired between the Marketing, Sales and R&D department. They all see an innovation project from a different perspective, and therefore it might be very difficult to understand each other or even lead to conflicts within the project. In order to ensure that all the departments think on the same level, research has to be done of how to improve this relationship.

As already described in chapter 2.2, Stage-gate is not stand alone. By making the innovation process much more visible and transparent, the other weaknesses in the firm’s approach and methods become even more apparent. Although Stage-Gate may bring some relief – the gates will kill some weaker projects and thus will free resources – the full solution is likely to lie elsewhere, perhaps via a resource capacity analysis or the implementation of an effective resource tracking and portfolio management system.

Therefore, it is recommended to further improve the performance of the NPD process by introducing Portfolio Management within the company. Portfolio Management is about how you invest your business’s product development resources (Cooper & Edgett, 2001). It is about resource allocation, to select the right projects which fit the business strategy. An overview is created on strategic level, which makes it easier to compare and rank projects against each other and to decide on which projects resources are allocated (Cooper, 2008). While the Stage-Gate process merely focuses on one project only, the portfolio analyses the complete package of development projects (the funnel). A better balanced project portfolio can be the result, through a distribution between radical innovations and incremental innovation.
8 References

- Eijnmatten, F.M. van (undated). Consensus/Consent Diagnosis, NADO Part 3, Participative processes of change, Overhead slides.


