

Stellenbosch University
Department of Industrial Engineering

The New Product Development Process: Small Firm Success by Studying Larger Firms

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of the requirements for the degree of
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Declaration

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety or in part been submitted at any university for a degree.

Ek, die ondergetekende verklaar hiermee dat die werk gedoen in hierdie tesis my eie oorspronklike werk is wat nog nie voorheen gedeeltelik of volledig by enige universiteit vir 'n graad aangebied is nie.

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Synopsis

The aim of this research was to investigate new product development practices for application to small businesses. Although larger companies, in general, have well-established practices from which smaller companies can benefit, product development in smaller businesses tends to be less formalised and less well described. Hence, this research is aimed at breaching this gap and addressing the need of the small business environment.

The first few chapters of the study describe the investigation of product development in its general form. This provides an overview of what product development and the execution of the process in particular entails. Control mechanisms that are used to counter and manage unwanted behaviours that may occur during the process are also discussed. A generic product development process is then discussed in detail, based on research carried out on small- and medium-sized enterprises.

The initial literature discussion in the first few chapters thus highlights the need to control and manage product development, and shows where pitfalls occur that could be detrimental to product success. This is followed by an investigation to establish the extent to which companies realise the impact the development process could have on product success.

As the focus of this study revolves around small businesses that are growing, the use of phase review criteria as it pertains to companies with well-established product development practices was investigated, together with the role of product development in other business activities.

The most important aim of this study was to develop a new product development framework that could be used in the small business environment. Seven key best practices were eventually identified, which are discussed in turn, together with their key underlying and component principles. The results are summarised and used to draw up the framework. The framework is summarised in a way that provides concise detail, which makes it useful even without any accompanying information.

The last part of the study was aimed at validating the results of the framework. This was done by means of a survey and one-on-one interviews with a group of carefully selected participants who were involved in small businesses developments. The participants completed a questionnaire indicating the relevance of the framework for their enterprises. Useful information was obtained through this feedback and this yielded positive results. Having validated the framework for application in the small business environment, the thesis ends with the proposals for improving the framework.

Opsomming

Die doel van hierdie navorsing is om nuwe produkontwikkelingspraktyke te ondersoek en dit op kleiner besighede toe te pas. Groter maatskappye, in die algemeen, het goedgevestigde praktyke waaruit kleiner maatskappye voordeel kan trek. Produkontwikkeling in kleiner besighede is minder geformaliseerd en word nie baie beskryf nie. Gevolglik beklemtoon navorsing die geleentheid om 'n deurbraak te maak en hierdie behoefte binne die klein-sakeonderneming omgewing aan te spreek.

Die eerste paar hoofstukke van die studiestuk ondersoek produkontwikkeling in sy algemene vorm. Dit bied 'n oorsig van wat produkontwikkeling behels en gee ook aandag aan die uitvoering van die proses. Verderaan word beheermeganismes voorgestel om ongewenste gedrag, in die proses aanwesig, die hoof te bied en te bestuur. 'n Generiese produkontwikkelingsproses, gebaseer op navorsing in klein- en mediumgrootte ondernemings, word in detail bespreek.

Die aanvanklike literatuurbespreking lei tot 'n gevolgtrekking, wat die behoefte uitlig om produkontwikkeling te beheer en te bestuur. Die voorkoms van slaggate met nadelige uitwerking op produksukses word beklemtoon. Laasgenoemde word opgevolg deur ondersoek in te stel in watter mate maatskappye die impak beseft wat die ontwikkelingsproses op produksukses het.

Die gebruik van fase-hersieningskriteria is verderaan ondersoek, wat betrekking het op maatskappye met goedgevestigde produkontwikkelingspraktyke. Ook die rol wat produkontwikkeling, saam met ander besigheidsaktiwiteite speel, is bespreek. Hierdie fokuspunt is gesentreer rondom klein-sakeondernemings, wat besig is om te groei.

Die belangrikste en hooffokuspunt van die navorsing is die saamstel van 'n produkontwikkelingsraamwerk, vir aanwending in die klein-sakeonderneming omgewing. In totaal is sewe hoof sleutelpraktyke geïdentifiseer. Laasgenoemde is saam met die onderliggende en sleutelbeginsels bespreek wat elke praktyk beskryf. Die resultate is opgesom en voorgestel in tabelvorm. Dit verteenwoordig die raamwerk, wat sodanig saamgevat is, dat dit saaklike detail bevat en dit maklik bruikbaar maak, sonder verdere bronne van inligting.

Die laaste deel van die studiestuk is daarop gemik om die resultate van die raamwerk se geldigheid te staaf. Dit is gedoen d.m.v. 'n meningsopname en een-tot-een onderhoud, met 'n noukeurige seleksie van deelnemers. Lede wat deel vorm van klein-besigheidsontwikkelings moes 'n vraelys voltooi, om sodoende die relevansie van die raamwerk aan te dui. Bruikbare inligting is deur hierdie terugvoer verkry met bydraende positiewe resultate. Ten slotte is gevolgtrekkings en 'n paar voorstelle gemaak, om vervolgens die bruikbaarheid van die raamwerk te verbeter.

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Glossary

CAD	Computer-aided Design
CAE	Computer-aided Engineering
CAM	Computer-aided Manufacturing
CASE Tools	Computer-aided Software Engineering Tools
CE	Concurrent Engineering
CPD	Concurrent Product Development
NPD	New Product Development
NPDD	New Product Design and Development
PD	Product Development
SDP	Structured Development Process
SE	Sequential Engineering
SME	Small and Medium Enterprises

1. Introduction

J. Paul Getty, former oil tycoon and once the richest man in America, made the following statement:

“There is only one way to make a great deal of money; and that is in a business of your own.”

To be an entrepreneur, to start and run a successful business of one’s own is the ambition of many! Getty’s words reinforce a common motivation behind becoming a successful entrepreneur.

One may dream of directing a Microsoft, yet it has to start with something smaller, instigated by an ambitious person; an idea put to practice through natural flair which many desire. Still, success is not guaranteed through talent alone; skill and knowledge are also required. The author of this study is himself driven by the entrepreneurial spirit and is searching for answers on how to take a product from cradle to grave with a high possibility of success.

Many succeed in achieving a good product and many don’t. Many set trends in design and development, while others only follow. The entrepreneurial aptitude may foster success, but what is needed in addition to that? Entrepreneurs have many ideas, concepts and solutions ready to deploy, but how much of the success resides within the execution process?

The former Federal Reserve Chairman of America, Alan Greenspan, noted:

“To succeed, you will soon learn, as I did, the importance of a solid foundation in the basics of education - literacy, both verbal and numerical, and communication skills.”

This study involves grasping the knowledge used by successful businesses in order to offer small entrepreneurial firms a better chance of success. The core theme investigates the process of realising successful products from good ideas.

1.1 Problem Statement

For small businesses, product development practices are poorly described, and the available resources provide little guidance on how to carry out this process. Hence, very little information is available on how to successfully design, develop and commercialise a new product in a small company. Too much emphasis is placed on making the business a reality and little producing the product that will bring in the money.

Small businesses are constrained by limited knowledge, skills, and resources. In addition, small businesses may depend on the successful development of new products to sustain their growth. Best practices from larger companies may provide

useful solutions to smaller companies. However, when trying to transfer these principles directly, the difference between the two types of companies poses many challenges.

1.2 Research Objectives

The objective in this study was thus to develop a new product development framework for small companies, by benchmarking the well-established processes used by larger companies. Such a framework should provide assistance to small businesses that are new to product development in their ability to take a new product successfully through a design and development lifecycle. This framework should also concentrate on the process of product development together with the related activities that are integral to its successful execution.

The framework also needed to be an easy-to-use tool for assessing and evaluating current processes and identifying opportunities for improvement. The aim of the framework was not to provide a detailed “how to” guide for executing new product development. The aim was instead to highlight current best practices that could be implemented to increase the success rate of product development of small firms.

1.3 Research Methodology

In order to develop the proposed framework, three main components were investigated. These are the product development process, the small business environment and finally, companies with well-established new product development processes, which are mostly larger firms.

Typical behaviours and methods of control used during the execution of the process were observed and are then discussed. From this, a conclusion was drawn that indicates there is high prevalence of badly executed product development projects. This is followed by a discussion on generic product development processes.

To clarify the significance of a new product development process within the two business environments, two instances were investigated. Firstly, the review criteria used to screen new products in well-established firms were looked at, and secondly, the resources available that offer support for small business development. The analysis of these two aspects reveals the use and relevance of product development practices within the two environments.

The discussion on the new product development process framework is preceded by a short discussion on the applicability of benchmarking of processes used by large firms to benefit smaller companies. This is followed by a thorough discussion of the framework itself, specifically focussing on the small business environment.

Finally, the framework is validated based on structured interviews and a survey with selected participants based on their expertise in this field.

In addition to the research methodology discussed in this section, the document structure is also discussed (See Section 1.6 Document layout)

1.4 Research Boundaries/Scope

The research investigates a well-established practice viewed from two perspectives. The two perspectives together with the process delimit the focus of the research.

The core focus of the study is the product development process, which comprises the development and commercialisation of new products. This process includes all the phases of development that involve the actual execution and management of the endeavour.

This process is prevalent in two types of business environments. The first is experienced businesses that deploy product development and make use of best practices to optimise the process. The second is the small business environment and entrepreneurial start-ups that embark on the development of new products. Hence, these two environments determine the area within which product development is researched.

1.5 Expected outcomes

The direct outcome of the research will include a new product development framework developed for small businesses. The framework will consider the process of designing and developing a new product. It will be based on current best practices that will provide a set of principles to guide and maximize product development success.

In the process of developing the framework, a thorough understanding of the product development process should be attained. In addition, knowledge should be gained in the approach and strategies followed to design, develop and commercialise new ideas.

A strong focus on lifecycle aspects should provide insight into understanding lifecycle impact, cost and issues of product support.

Finally, an understanding of the requirements of developing new products should be established, together with the behaviours and control mechanisms used to steer the effort to success.

1.6 Document layout

A graphical outline highlighting the logical flow of this document is shown in Figure 1. This outline will help the reader navigate the document and understand the logic followed throughout the research.

The document covers four main areas or silos, which are depicted in Figure 1:

- **Silo 1: NPD (New Product Development) process overview**

Introductory literature review - two chapters:

Chapter 2: Investigates the mechanisms used to control the product development process. The mechanisms control certain process behaviours and counter pitfalls that could influence the success of the development.

Chapter 3: A generic product development process is discussed in order to develop an understanding of the overall process and its related requirements.

- **Silo 2: The role of NPD capability and process-related factors**

Chapter 4: The role and emphasis placed on the NPD process is investigated in two different environments: large firms with well-established NPD processes and smaller firms that are new to product development.

- **Silo 3: Small business NPD framework**

Chapter 5: Development of the new product development framework, which focuses on small businesses and entrepreneurial start-ups.

- **Silo 4: Framework validation**

Chapter 6: The framework is validated by means of questionnaires and structured interviews held with experts in the field of new product development.

Throughout the document the reader will be referred to this graphical layout. In this way the reader will be able to keep track of the focus and aim of each chapter within the context of the overall research.

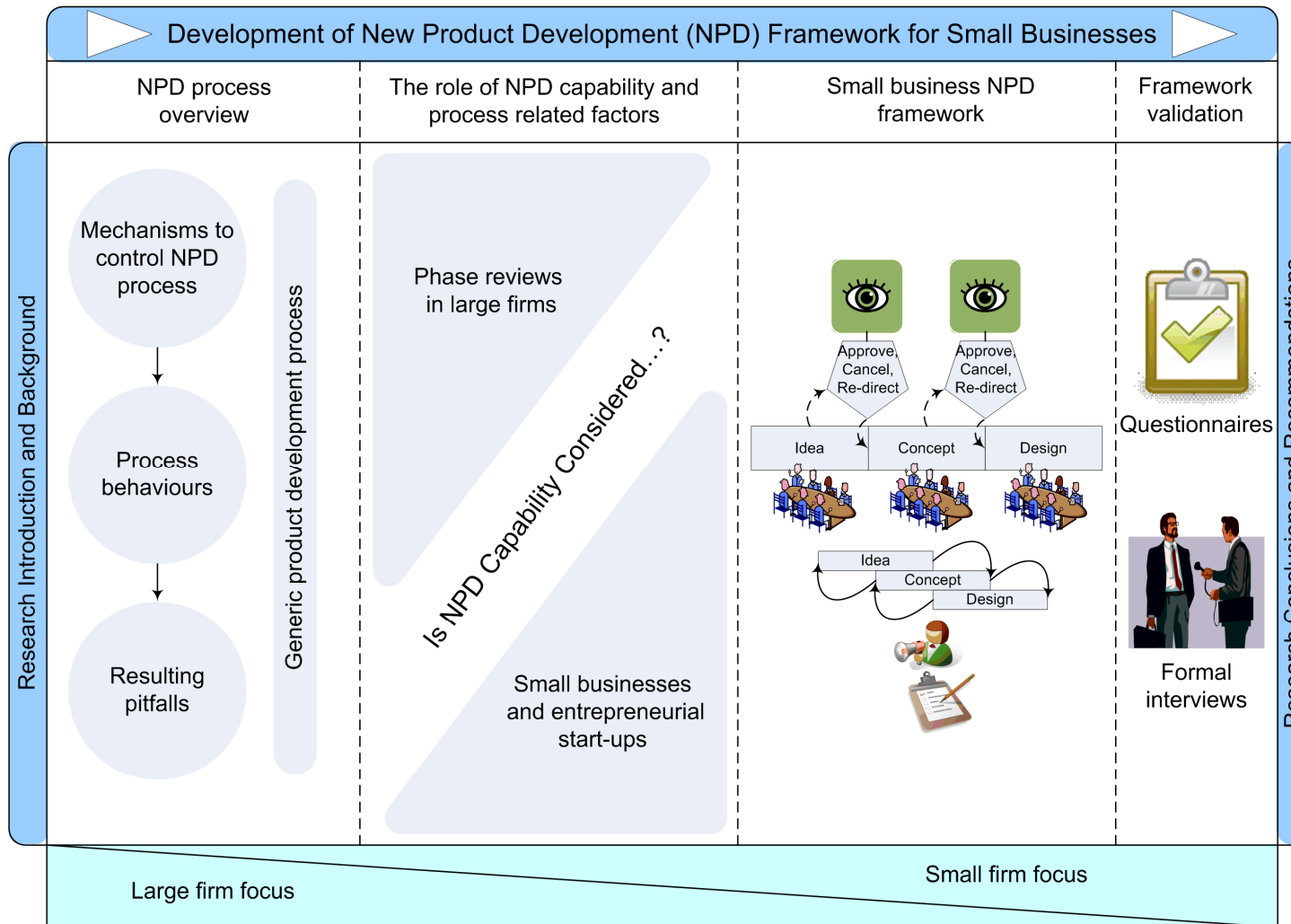


Figure 1 Document navigation

2. Overview of the Product Development Process

This chapter focuses on the first silo of the research. Product development is a complicated process with many aspects. It is therefore necessary to discuss the basic concepts that represent the process at the outset (Peters, Rooney, Rogerson, McQuater, Spring & Dale 1999). This will provide an overview of what product development entails as a whole.

The figure below is an extraction from Figure 1, showing the content of this chapter in context - See also Section 1.6 (Document layout).

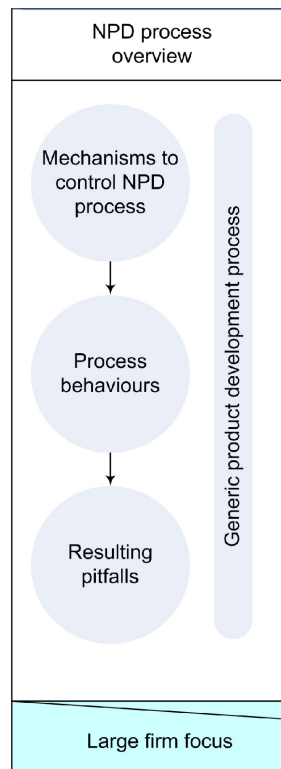


Figure 2 Document navigation – First silo

The research covered in this chapter is based on studies done in established innovative companies dealing with new product development practices. The following sections describe the process by introducing certain common behaviours in the process of product development. These behaviours need to be managed and for that reason several mechanisms have been developed to aid control of the process. These studies show that these control mechanisms are essential components of the process and they will thus be discussed in detail here. Both this chapter and discussion are very much based on generic product development models and frameworks.

2.1 Mechanisms for managing product development

It is important to appreciate the complexity of the product development process, as it incorporates many business departments, business functions, levels of management, a supply chain, customer input, resource and time-line constraints and many more aspects. The product development process, which normally aims at delivering a superb product to the market, is not just a normal project management exercise. Realising this, an intuitive question arises: What is done to manage and facilitate the current product development (PD) process? Do methods of control exist and what resources are needed to implement these?

Various sources agree on 4 mechanisms that should constitute, control and facilitate the product development process (Shepherd & Pervaiz 2000; Peters et al. 1999; Anthony & McKay 1992; Anthony, McGrath, Shapiro & Amram 1992). Shepherd and Pervaiz (2000) highlight the importance of these mechanisms and the common characteristics exhibited in new product development frameworks. These are:

- A *structured development process* that describes primary tasks, schedules and resource requirements, as well as the entry and exit criteria at key milestones in the programme; in other words setting out the “rules of the game”.
- A *review board* consisting of a team of senior management that oversee and control the PD programme. These people resolve cross-project issues, set project priorities and deal with resource allocations and make Go/No-go decisions.
- *Cross-functional teams* that report to the board and operate under a so-called product champion.
- *Phase or stage/gate reviews* performed at milestones in the development process. These are product schedules, funding, resources and other criteria approved or rejected by the review board (Crow 2004).

Many PD (product development) frameworks or new product development (NPD) frameworks have been developed. These differ based on organisational needs and markets. NPD frameworks aim at reducing cycle times, cost, and delivering products on time to market. Consequently, the business is optimised. In addition, this means that PD programmes can be managed better across the product’s lifecycle (Shepherd & Pervaiz 2000).

A NPD framework as developed by PRTM consultants – international operations management consulting firm for technology-based companies – is presented below (Shepherd and Pervaiz 2000). The framework illustrates the use of the aspects mentioned above. Shepherd and Pervaiz (2000) note this as a “best-in-class” NPD framework which PRTM calls PACE (Product and Cycle-time Excellence). The

framework depicts the four balancing and control mechanisms described by Anthony and McKay (1992). A structured development process is carried out by a cross-functional team, subject to a decision-point process under the authority of a review board. Should these four related aspects be executed in a balanced and effective way, it can improve the performance of NPD significantly (Shepherd & Pervaiz 2000).

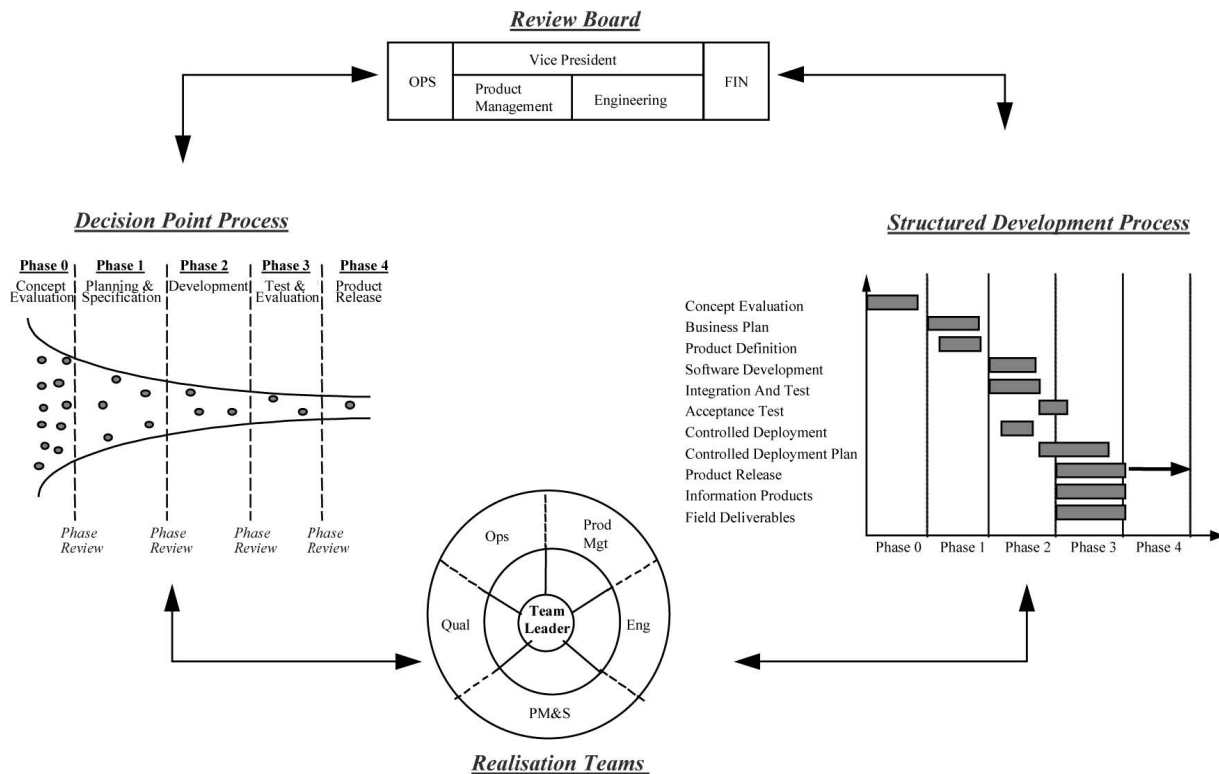


Figure 3 PACE NPD framework developed by PRTM consultants

These mechanisms are essential for process control in order to balance the observed behaviours in the PD process. Specific behaviours which occur in the PD process are discussed at a later stage (See Section 2.2 Product development process behaviours).

In addition to the four mechanisms of control, Peters et al. (1999) state that there are three more distinct issues that facilitate the PD process which need to be taken into account. These include:

- The availability and accessibility of common information
- Information management to support the information and to ensure that it is available and delivered as required, and
- Means and procedures for exchanging information and communicating.

The initial four control mechanisms are discussed in the following sections, however, the three additional management issues listed above are not discussed, as they are not relevant to this research argument. Nevertheless, since these control mechanisms do contribute to the successful facilitation and outcome of the project, they have been included in a summarised format (See Appendix A).

The work of Peters et al. (1999) provides good practical guidelines as they represent and summarise the seven management activities. These are key issues required for the effective operation of the PD process. The summaries of the management activities can be used as checklists to indicate the essential management practices evident at any stage in the process. The model proposed by Peters et al. (1999) highlights the use of these management activities or facilitation issues based on a process perspective (See Appendix B).

The mechanisms of facilitation and control are discussed in the following sections. The discussions are mainly based on the work of Shepherd and Pervaiz (2000) as well as Anthony and McKay (1992) and if not, an alternative reference is provided.

2.1.1 Structured development process

Many companies do not develop products in a formalised way. Hence, it is sometimes difficult to track the process and incorporate external participation. A structured process can provide an overview and frame of reference needed for those not directly involved in the development (Peters et al. 1999). Anthony and McKay (1992) indicate the need for a more structured approach to ensure good quality, by identifying symptoms indicative of unnecessary high costs. These symptoms can include:

- Inconsistent terminology and definitions, leading to the need for additional clarification and control, that will confound hand-offs, and result in misdirected and wasted effort.
- Struggling to determine resource requirements and schedules for projects that are essential for supporting the company goals.
- Excessive task interdependence, along with difficult and inefficient communication channels, which result in uncertainty about responsibilities and possibly conflicting decisions made between groups.
- “Fire-fighting” as a result of unplanned work that requires immediate attention.

To understand the NPD process better, Shepherd and Pervaiz (2000) highlight the structured development process hierarchy in Figure 4 following; it shows the functional decomposition of key phases. The *phases* are easily recognisable in the PACE framework as well (See Figure 3 PACE NPD framework developed by PRTM consultants). The structured development process reveals the *steps* executed within each phase and the *tasks* and subsequent *activities* follow from this. This approach is

equivalent to a work breakdown structure (WBS) in a project plan. As in any project plan, work has to be broken down into manageable packages in order to assign resources and responsibility. In this case, the cross-functional teams take on responsibility and execute the activities within each work package (Fourie 2006).

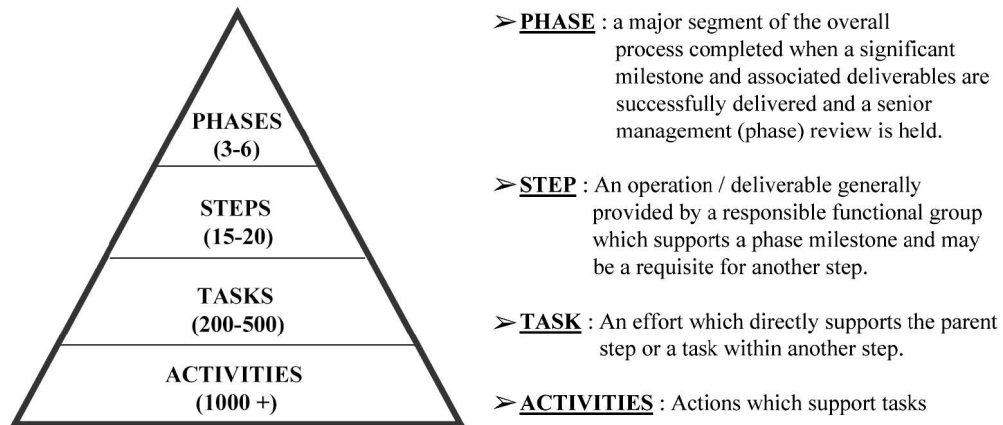


Figure 4 Structured hierarchy of the NPD process

With regard to the structured development process, each step of the different phases is defined by the following (Anthony & McKay 1992):

- Entry and exit criteria
- Primary tasks within each step and their sequence
- Interaction between and role of functional groups
- Estimated time required to complete each step.

Hence, detail and cost can be added when starting off with a high-level structured development methodology that resides within the development framework. Detail is thus helpful for execution at operational level, as well as for control at higher levels of management.

By structuring the PD process, a set of rules is determined that all departments/functions and levels of management should follow. The structured development methodology benefits mainly two parties:

- (a) The team executing the project, for whom it then provides the basis for project planning and defines the deliverables for each phase review;
- (b) The review board benefits by having a clearly defined set of deliverables for each phase review, and an objective measure with which to assess the progress of the project.

Consequently, by applying this to all development projects, expectations between the parties are aligned (Anthony & McKay 1992).

Peters et al. (1999) conclude that formalisation fosters effective communication. Not only is the influence of personal interests minimised, but more importantly, the creative activity can be maintained and better co-operation and co-ordination be achieved (Shepherd & Pervaiz 2000; Peters et al. 1999) The structured development process needs to be uniform and mandatory across the firm, so that they inherently become part of the company culture and can be regularly revised and updated. "Best in class" companies also create guideline documents around the structured development process to prevent mistakes being repeated and improve the chances of success in the future. (Shepherd & Pervaiz 2000; APQC White Paper 2000).

Shepherd and Pervaiz (2000) make the following statements:

Since different levels of management have responsibility for different "layers" in the structured development hierarchy, the management and control of the environment is greatly simplified and enhanced. As a result, everyone clearly understands what needs to be done, how it must be done and when it must be done. With such a process in place, rapid execution can then be facilitated.

In sum, the SDP (Structured Development Process) offers the guidance to execute the various activities in the company in an effective and co-ordinated fashion.

2.1.2 Review board

The role of senior management in the product development process is invoked in the form of review boards. Review boards are also known as product approval committees (PAC) or new product executive groups or resource boards. As shown in Figure 3, the general manager and the heads of various functions make up this board. This is the second important balancing control mechanism in the PD process.

The boards have authority to perform the following responsibilities:

- Initiate, approve and prioritise new product development projects
- Cancel and re-prioritise projects
- Ensure that products under development fit the company strategy, and
- Allocate development resources.

For optimising decisions regarding the future direction of development projects, the review board takes responsibility as a group. Phase review sessions provide the opportunity for the review board to execute their responsibility. This group should ideally remain small, with a dedicated percentage of time from each member being

allocated to oversight-related activities. Typical members and departments may include: CEO, general manager, marketing, engineering, manufacturing, finance, technology, quality and customer service or other operations. It is important that the projects are evaluated holistically based on several key aspects, e.g. product and project feasibility, financial measures, lifecycle cost perspective, etc.

Shepherd and Pervaiz (2000) point out some of the specific roles that may be expected from each of the members of the Review Board:

- *To establish a vision:* Create a vision for the company's products in order to cultivate a strategy and align development activities accordingly.
- *To make decisions:* Use decisions to provide senior management with direction.
- *To cultivate the product development process:* To continually improve and smooth process execution - a superior process may provide a competitive advantage.
- *To motivate:* For senior management to provide successful leadership and motivation, they are required to have achieved respect in their three previous roles.
- *To recruit the best development staff:* Key in securing individual skills and expertise.

New product development and commercialisation is only one process in the overall company (Rogers, Lambert & Knemeyer 2004). Therefore, senior management input is needed to align this in the context of overall company goals (Peters et al. 1999). It is important to match development requirements with company technology and process maturity. Peters et al. (1999) highlight the product design and development strategy as a critical facilitation issue in the process. They state that the framework that coordinates all process activities is determined by the strategic direction and long term vision of the product design and development process. A checklist of PD strategic factors follows below:

- Overview of the process requirements
- Future directions with respect to company goals
- Ethical issues
- Resourcing strategies
- Time and financial constraints
- General uncertainty and attitude towards risk
- Senior management support

- Definition of project boundaries, and
- Benchmarking.

Also, the review board, in conjunction with the core development teams, plays an important role in balancing product development process behaviours. This will be highlighted again at a later stage.

2.1.3 Cross-functional team

Two of the four control mechanisms that help to balance the PD process behaviours have been discussed. The third control mechanism is the core team or realisation team - as referred to in the framework (See Figure 3 PACE NPD framework developed by PRTM consultants). This team is a small autonomous cross-functional group. In effect, it is independent and self-directed with interdepartmental representation. The core team is a key enabler of the PD framework and is solely responsible for taking the development project through its phases.

In general, the key to achieving success with product development teams lies in how the teams are organised, with respect to streamlining effective communication, decision-making and co-ordination. The core team is the core around which the whole project team is built. (Figure 5 highlights the core team structure.) Each member of the core team represents and co-ordinates his/her functional area with regard to design and project decisions. Consequently, each core team member informs his/her functional group of design and schedule changes made by the core team. Information from all functional groups is also fed back to the core team. Importantly, the core team represent different functions that need to be fulfilled concurrently through all development phases.

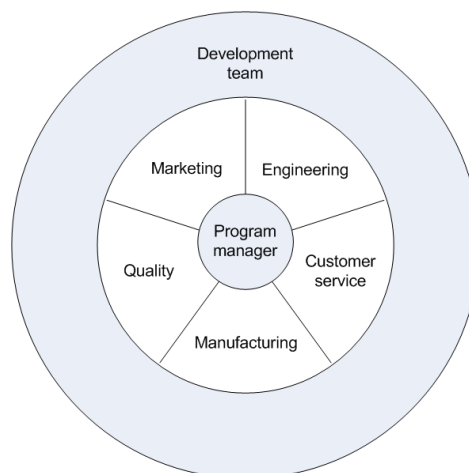
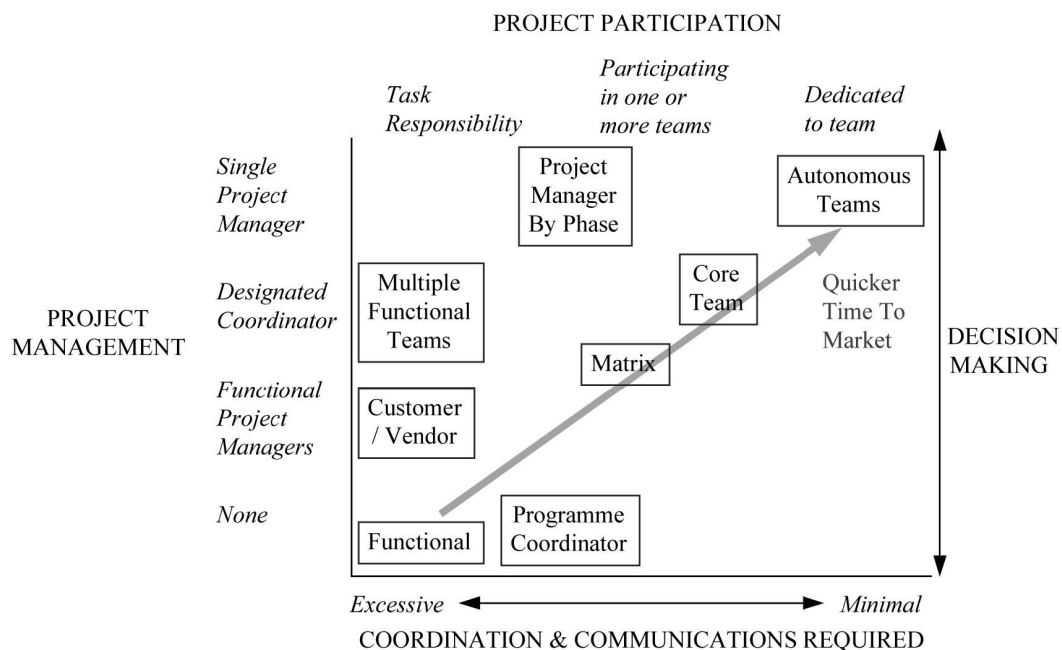


Figure 5 Core team structure

The program manager leads the core team by setting the direction and ensuring the design goals and project objectives are met. He is responsible for the overall project success. Unlike traditional project management, guidance and conflict resolution are provided for at an interdepartmental level under the supervision of the functional managers, and not in a high-handed fashion. In support of this, Trygg (1993) emphasises the great extent to which a product champion contributes to the success of these teams.

An important characteristic of the team is its structure. Core teams which make use of a matrix structure are considered to be most successful. The reason for this is that such a group is an autonomous group of people with a dedicated goal – and this reduces the communication and co-ordination required to a minimum. Furthermore, essentially only one project manager is needed, and this then maximises the group's decision-making capabilities. The possibilities for relational structuring within a core team are shown in Figure 6. The next paragraph explains the impact an effective team can have.



Source: Anthony *et al* 1992

Figure 6 Project team construction, empowerment and effectiveness

A key advantage of having cross-functional teams is the involvement of different functions early on in the PD process. This yields countless advantages, of which the author lists only a few: improved quality, reduced time-to-market, less iteration in design, improved feasibility decisions, reduced cost, improved adherence to customer requirements and many more. Trygg (1993) highlights that more than 90 per cent of

companies who had halved product development times, employed the use of cross-functional teams. Interestingly, traditionally structured functional organisations have the lowest overall results. Multi-disciplinary input means that many possibilities may be considered through all the stages of development as early as possible (Peters et al. 1999).

Cross-functional teams may also span the supply chain and include external team members as well, e.g. suppliers, manufacturers, distributors, etc. This can be useful, especially when functions are outsourced or for the purpose of integrating critical activities within the supply chain (Rogers et al. 2004).

Besides the exceptional effectiveness of these teams, a great sense of ownership and commitment is fostered among employees. Self-managed teams already are a well-proven concept in industry and are becoming even more prominent. Teams are an essential feature of leaner and more flexible organisations. Teams also provide creative solutions faster in an ever-changing environment and, at the same time, lower production and labour costs. Research on successful innovative companies shows that using multi-functional teams with dedicated team members is a critical requirement for success (Davis 1997; Griffin 1997).

The review board and core team are the two main bodies that take on final responsibilities. It is therefore important to keep a balance between management's authority and the empowerment of the teams executing the project. There is a form of control between the two that is related to the process behaviours, which are discussed later in Section 2.2.1 Locus of control.

2.1.4 Phase reviews

The last mechanism used to balance and control the PD process behaviours is phase reviews (See Figure 3 PACE NPD framework developed by PRTM consultants). Phase reviews provide management with control and insight into the PD process without the need for their actual involvement at a lower level. This activity is carried out at the end of each phase, as this signifies a milestone reached in the overall project progress – and is a strategic control point. The reviews include technical and business considerations. Interim reviews are also held should the project stray from the set measures or allowed tolerances.

A phase review process is the mechanism through which the review board (Section 2.1.2 Review board) fulfils its purpose. It is useful to keep the following in mind about the phase review process:

- Phase reviews inherently drive the other PD processes.
- This process provides points at which the overall projects can be evaluated.

-
- The process creates an opportunity for management to strategically guide a project.
 - The process marks the conclusion of phases and sets the scene for the upcoming phases.
 - It is decisive in determining project course: proceed, cancel or re-direct.
 - Phase reviews aid reliable decision-making and prevent delays in a company's development programme.

Shepherd and Pervaiz (2000) assert that decisions in the phase-by-phase development approach are generally guided by a list of deliverables and milestones that are expected to be reached in order to make a "Go/No-go" decision. The programme can be permitted to proceed to the next phase when the information presented to the review board has met the specified expectations. Along with this, the necessary changes and guidelines are then also set out. The aim of a review is to increase the likelihood of success of each development. Following this reasoning, phase reviews are based on three aspects that comprise a thorough review:

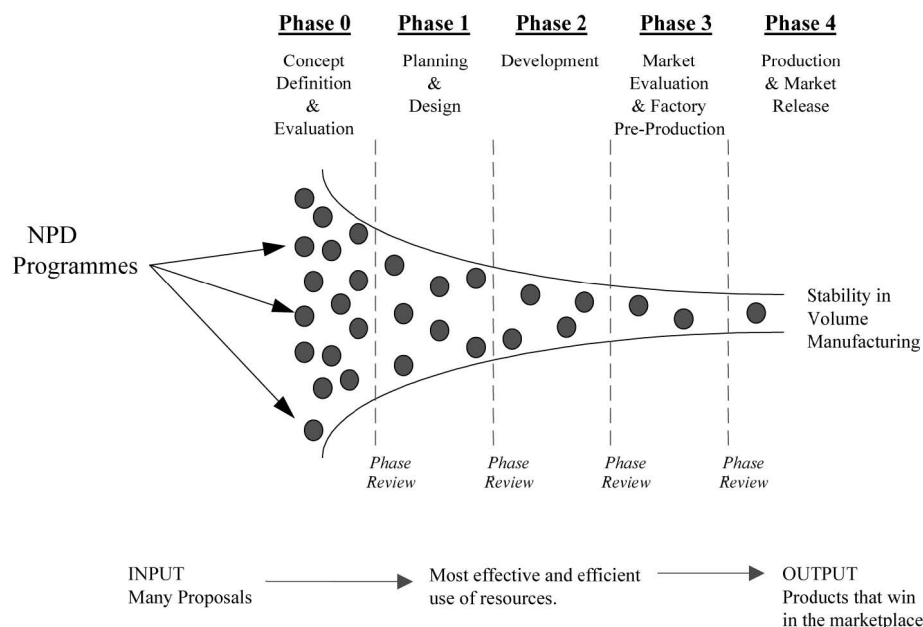
- Input – Deliverables from the current phase.
- Criteria – Decisive factors used to measure the performance of the project.
- Output – Go/No-go decisions and defining and planning the next phase.

The review board is responsible for allocating resources to product development efforts. Ideally, they allocate the most resources to those products with the greatest development potential. In addition, the board must provide direction to the team who will execute the project, and to this end, should also empower the core team to execute the project autonomously in order to reach the end of the next phase and review deadlines. Activities concurrently executed through various functions are brought together as phase deliverables in an appropriate form. Technical, marketing and financial aspects are reviewed together with the project budget, schedule and critical product performance and quality requirements. Updated measures are planned, defined and put into place for the next phase, as well as the necessary funding and commitment of resources. Within these parameters, the core team has full authority to pace the various projects until the next review takes place.

Accompanying each phase are the respective control criteria. These criteria set the boundaries for each phase and are different for each phase of the development. Without this means of control, members who execute the project have no guidelines that define the development course. Hence, the control criteria set the boundaries for the autonomous execution of the project. New product development research on SMEs provides some generic control criteria with respect to generic NPD phases (See Appendix B, Page V) accompanying the generic model.

As the phase review process is a recurring process, it creates a funnel that permits only the most promising developments to proceed to the next phase. Other projects that do not meet the criteria are then cancelled or re-directed. Currently, many new but unsuitable opportunities are snuffed out during concept screening and business planning, prior to development. Hence, phase review has proven to be an all-important part of the product development process.

Figure 7 summarises the process of eliminating unsuccessful projects (Shepherd & Pervaiz 2000). This is a key motivation behind using phase reviews in NPD process. Decisions that may have started off being long term and high level, may later become short term and tactical on a lower level, as development progresses (Hoffmann 2007; Anthony & McKay 1992). During the early stages of product development, projects are usually vague, incomplete and their potential is not fully realised. As the project progresses, information becomes more accurate and complete (Shepherd & Pervaiz 2000; Anthony & McKay 1992; Katsiadakis 2007). Hence, many projects are cancelled late in their development, when the full implications are better understood. This is not favourable as time, money and other resources are wasted on unsuccessful projects. Although portfolio management practices have improved, the need to cancel potentially unsuccessful projects as early as possible is still a major concern.



Source: Anthony *et al* 1992

Figure 7 Funnel effect of NPD processes

The funnel effect as a decision-making process is the key to identifying which opportunities a company should pursue and which it should not. Shepherd and

Pervaiz (2000) state that the effectiveness of a NPD framework is highly dependent on the successful application of this process. Hence, the following characteristics need to be present in a rewarding phase review process. It should:

- Provide a clear and consistent process for making major decisions on new products and enhancements.
- Empower project teams to execute a project plan.
- Provide the link for applying product strategy to product development.
- Provide measurable checkpoints to monitor progress.
- Establish milestones that emphasise a sense of urgency.

From this discussion it should thus be clear why the phase review process is so vital - all three mechanisms (structured development process, review board & cross-functional team) previously discussed either depend on it or interact with it. Well-defined review criteria thus improve the overall effectiveness. Very importantly, it helps to eliminate weak projects early on. Since many other issues such as risk, expenditure and revenue, time-to-market, feasibility screening, etc., have a definite dependence or relational interface with phase reviews, further investigation of this is seen as worthwhile.

2.1.5 Trade-off balance

Kahn (2005), in a combined work for the Product Development and Management Association, states that there are four new development project trade-offs. These trade-offs are interrelated, as depicted in Figure 8 and have a definite effect on each other. Deciding on, valuing and balancing these trade-offs, form an integrated part of managing the NPD process. The trade-offs are inevitable within each product development project.

Essentially, it must be realised that anything gained comes at a price. Many times the price is not worth the benefit. Developing a product faster can increase the cost and lower the value of the product offering. Likewise, the development speed determines the project duration that in turn determines the number of features that can be included in the offering; subsequently, the product cost and total program cost are also affected. These trade-offs can, however, be calculated analytically and traded off against one another. For example, if daily programme expenses amount to R1000 (delay cost) and one can increase the development speed saving a day's work at only R500 for additional labour or alternative freight, the trade-off becomes viable. The same goes for balancing the expected price to the market with the optimum performance and features to fit the package.

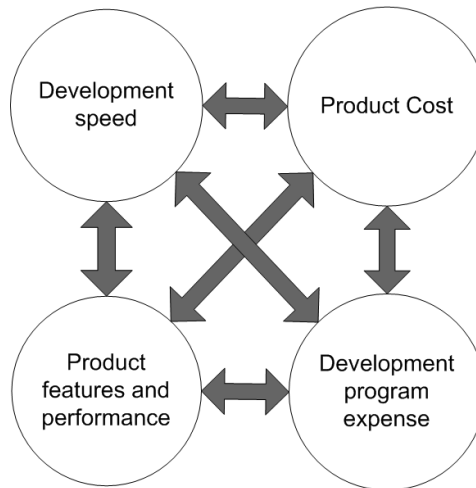


Figure 8 Project trade-offs for new developments

A mistake often made is by assuming that the faster a development takes place, the cheaper the project becomes. Indeed, there may be benefit in some way or the other but it will usually come at the cost of something else. Something frequently misunderstood is the false assumption that labour costs can be diminished significantly if development time is reduced. A fact that strongly contradicts this is the acknowledgement that one of the most powerful ways to introduce rapid development is to dedicate additional full-time workers to the team. In this way management may half the development time, but would be expending say double on labour costs.

However, product development speed is a key capability for success and provides a company with a competitive edge, resulting in a superior product in the market (Kahn 2005). It is thus necessary and useful to research and discuss this aspect of product development further. Finally, product cost, performance and features influence supply and demand. This, together with the product's potential to create a demand in the market, emphasises how important it is to have superior market knowledge.

2.2 Product development process behaviours

Due to the difficulty involved in the execution of product development, most companies are disappointed in the efficiency of their process (Anthony & McKay 1992). Anthony and McKay (1992) highlight common symptoms experienced in industry that lead to this disappointment, e.g. continuous design changes, low margins, excessive lifecycle costs, budget overruns, missed market opportunities, etc. Based on their research they attributed this to unbalanced control in the product development process, and problems in the interactive role taken on by top management and project execution team.

Anthony and McKay (1992) have identified four process behaviours that can be used to describe the behaviours observed in the product development process (PDP). These behaviours are termed:

- Ricochet
- Fine wine
- Rock game
- Big brother.

Next follows a detailed description of these behaviours of the product development process. The interaction of control and authority between top management and project teams, or the so-called locus of control, is also discussed. The *first silo* of the document map depicts the context of this section (See Figure 1 Document navigation) in Section 1.6 (Document layout)).

2.2.1 Locus of control

The process of product development can be seen as either being insufficient, overbearing, inappropriate or based on incomplete information. Anthony and McKay (1992) state further that the balance or the specific behaviour is determined by two factors, namely: (a) the locus of control between top management and the overall project team and (b) the extent to which this control is exercised. Figure 9 is used to show this relation and how they determine the outcome of the four process behaviours.

A major catalyst for a balanced PD process is project management and resource management. Anthony and McKay (1992) also make the following statement:

... The foundation for leadership in NPD is based on balancing product development and process control and its associated information needs between top management (responsible for the strategic direction and resource allocation) and the development teams (responsible for conceptualising, designing, testing, manufacturing, launching and screening new products).

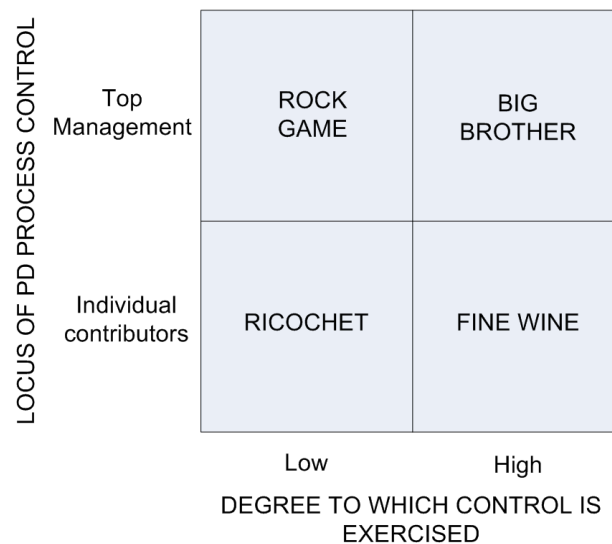


Figure 9 Locus of control for unbalanced process behaviours

Figure 9 shows that there exists a clear interaction between top management and low level operational people in terms of who is in actual control of the PD process at any given time. Also, the mix determines who has the authority to control and manipulate, hence this will influence process activities. However, a better understanding of the behaviours shown in Figure 9 is needed and the following sections thus elaborate on these four process behaviours.

2.2.2 Ricochet

The first behaviour relates to a lot of control centralised among individuals at operational level. Functions are strongly represented and this results in fragmented ownership and responsibility, and individuals who have authority but function separately. In effect, the design bounces off various functions as the development progresses, resulting in many product changes and inconsistencies. These dynamics mean that little control is exercised.

A few characteristics of this type of behaviour can be identified that are indicative of or may lead to Ricochet behaviour:

- Insufficient planning
- Little information transfer and exchange between groups and departmental functions
- Fire-fighting
- “Over the wall” approach of sequential engineering
- Lack of cross-functional interaction driven by core teams

-
- Poorly defined customer requirements, due to inadequate market- and competitive research, resulting in continuous changes
 - Vague product definition and requirements determined by marketing only
 - Design changes and re-designs
 - Manufacturability and technical design problems.

The process above also creates doubts as to its ability to deliver a quality product to market on time. In fact, it is known to produce products that are late to market, and offers unwanted product performance and features that do not correspond to the real needs of the customer. The Ricochet behaviour represents a lack of synergy normally counteracted through the use of a core team. The final product has a high cost when it reaches the market, resulting in poor profits. The need for after-sales services and support is created due to the ricochet effect in the design stages. The final product also differs a great deal from the initial concept. In conclusion, Anthony and McKay (1992) support the need for core teams (See Section 2.1.3 Cross-functional team). They state that the core team, at the centre of the project team, can eliminate the Ricochet behaviour by efficiently handling the definition, planning and execution of projects together with cross-functional trade-offs.

It is necessary to point out some critical pitfalls of the Ricochet behaviour:

- Product reaches the market later than anticipated
- Continuous alterations are made to the product's design
- Overall cost of the product is higher than expected
- Product struggles to live up to customer expectations.

The long-term effects of these pitfalls will be discussed at the end of this section.

2.2.3 Fine Wine

With the so-called Fine Wine behaviour, authority and ownership still is centralised among individual contributors but, in contrast to Ricochet behaviour, the project is over-controlled and not under-controlled. Hence, it is termed Fine Wine, as the product is not released until perfected. A common example of this is where engineering departments over-control the process, getting hooked in perfecting and optimising the technical design. This is also a common mistake made regularly by entrepreneurs, when they attempt to improve the design at the cost of activities like critical market research and related activities (Davis 1997).

Characteristics indicating Fine Wine behaviour can include:

- Top management are frustrated and need to control the development process
- Too much emphasis is placed on the engineering and technical aspects

- High development costs
- “One last improvement” or “just one more feature” approaches
- Continuously evolving product offering
- Manufacturability problems.

The Fine Wine behaviour results in a high risk. Inevitably, the overall product cost will increase as the product is often late to market and the critical window of opportunity in the competition and profit arena is missed. In effect, the technical excellence results in a product being unsuccessful in the market and of little use to the customer. Each additional specification added to a product should add value for the customer. Hence, marketing often needs to find new markets as the final products differ vastly from the initial concepts. This again may lead to redesigns, and developers hoping to grasp some portion of the market share that is left, but this usually is of no value. The net effect nullifies profit margins, as prices need to be slashed in order to stay in the market.

The structured development methodology, as discussed in Section 2.1.1 (Structured development process), may be used effectively to counter the Fine Wine behaviour. Clear definition of phases, consequent steps and deliverables for each phase will provide a commonly agreed upon plan. This means that engineering would understand their interaction with the other functions; management would be in touch with the design process, and process control would be spread across other functions besides engineering. The structured process aids in creating realistic development plans and tracks progress. Controls are no longer centralised around individuals over-exercising their authority.

In conclusion, the Fine Wine behaviour can have serious consequences, should its approach be part of the PD process. Characteristically:

- The product struggles to reach the market on time
- Too many refinements are made that increase product costs
- Technical product offering may be ideal but the result is not ideal for the customer.

These outcomes can be somewhat heavy, and may also be related to the consequences observed in the Ricochet behaviour.

2.2.4 Rock Game

With the Rock Game, the authority shifts to top management. However, here they then struggle to exercise the necessary control over the process. Anthony and McKay (1992) explain this as management ordering the project team to bring them a rock without providing further specifications or guidance. When the team presents the rock,

they are told it is the wrong one and not what management were looking for. The process recurs, where management continues to provide orders that lack specific direction. The project team, even after a dedicated effort, will continue to fail in providing what management wants. These wasted efforts cause demotivation among team members and the process is highly inefficient.

The Rock Game behaviour is characterised or identified by observing the following:

- Project teams provide the wrong solutions according to top management expectations
- Project teams are unsure of the required direction of their product development efforts since input from management is lacking
- Frustrated and demotivated team members
- Top management expects project teams to come up with the next perfect product without the necessary leadership
- Major redesigns and product changes take up a lot of effort
- Late market entries and extended cycle times
- Wasted resources - labour, money, time, etc.
- Management not informed of the progress and status of developments.

The occurrence of the Rock Game behaviour is often a feature of young companies in search of the next big winner; or firms struggling to define the next generation of products or instances where top management is incompetent in setting strategic direction. It is a great disappointment when the final product is a good solution, but reaches the market so late that the expected profits are not attained. The Rock Game results in the product concept being finalised very late in development stages, sometimes without having even been given final approval. Approval is simply assumed, but then at later stages when critical problems arise, management is reluctant to cancel or redirect the project due to the effort already invested. The efforts put into redoing product proposals tie up critical resources that lower engineering productivity. The frustration caused by this may lead to competent skills leaving the company.

Rock Game behaviour indicates the need for top management to provide strategic direction with limited boundaries, to guide the project team members. Specifically, a well-functioning review board representing top management can eliminate the Rock Game behaviour. If one refers back to Section 2.1.2 (Review board), it is plain that if top management were fulfilling the role depicted in the process, this clearly counters this behaviour.

Before discussing the last behaviour, the occurrence of the Rock Game also has some consequences one needs to be aware of:

- A great deal of effort is put into design changes and redesign.
- The final product needs to account for resources used by previous proposals.
- The product goes to market late.

Having reviewed the potentially grave consequences a poorly managed PD process can have, it would be sensible to take a more in-depth look into what the full effect of these might have on the overall project.

2.2.5 Big Brother

Big Brother behaviour is the common stereotype of authority imposed from above on a certain situation. Hence, this relates to a tendency of top management to be too involved in low-level decisions and dominate the PD process with rigid control. This behaviour frequently occurs later during the development process, when a major concern arises and management feel the need to take control. It typically is found in companies where top management are comfortable with the technical aspects, and thereby neglect their management responsibilities; in young companies with overly involved stakeholders; in larger companies that have excessive layers of management or in companies where there is poor communication between management levels.

Characteristics of Big Brother behaviour can include:

- Top management demanding detail and being involved in low-level decisions
- Inability to cover more than a few projects
- Core teams not operating autonomously
- Conflict between top management and teams as to what is seen as important
- Teams spending too much time reporting to top management.

Big Brother behaviour results in a severe problem: the ability of the company to grow is restricted because of management's inability to execute more projects simultaneously. The PD process is considerably slowed down. Members who were recently adding value through problem resolution, suddenly have to put a lot of effort into reports, meetings and presentations for top management; and decision-making has moved up the hierarchy. A snowball effect commences as individual contributors hold back critical information, since they fear the authority of top management. However, this results in management's increased involvement. Products are late to market and, because top management determined the product outcome without customer- and process insight, the final product offering is not ideal. Since management override the process, cross-functional interaction is minimised, reducing

serviceability and manufacturability. Once again, to the advantage of competitors, firms can expect to lose valuable expertise that would work better under behaviour characterised by delegation and autonomy.

Anthony and McKay (1992) state that an even worse scenario may exist when top management becomes accustomed to making detailed decisions. This leads to unrealistic schedules and project goals. To prevent this Big Brother extreme scenario, the phase review process has been developed (as discussed in Section 2.1.4 Phase reviews). Phase reviews provide top management with excellent control and good visibility from the start to the end of the process on a regular basis, but without micromanaging. Core teams are able to progress autonomously, keeping to specified boundaries determined by management at review sessions.

Finally, the Big Brother behaviour has also some pitfalls that are closely related to those of the previous behaviours:

- Inefficient use of development resources and low productivity increase costs.
- Final product offering provides unwanted features and performance.
- Slowed development increases development time causing a delayed launch.

While the full impact of these outcomes is still uncertain, the four process behaviours discussed certainly pose well-defined and inevitable risks and efforts should always be made to avoid them.

2.3 Managing process behaviours using control mechanisms

The product development process behaviours as set out by Anthony and McKay (1992) provide a good basis from which to evaluate the optimal locus of control for the process. Section 2.1 (Mechanisms for managing product development) – which explains the best-practice control mechanisms that have been developed – reiterates that the PD process can be optimised to better achieve its ultimate goal. However, it is essential that all four control mechanisms are integrated and implemented as a whole, otherwise improvement of the PD process will be minimal.

It is also quite clear by now that the PD process is very complex, and thus likewise, controlling the process also requires a great deal understanding. A great deal of possible variation, which is not always predictable, increases the complexity and need to be managed. Whether the process is over-controlled due to high stakes, or under-controlled because of a lack of knowledge or attempts to achieve the perfect product offering, the cost of getting it wrong can be considerable.

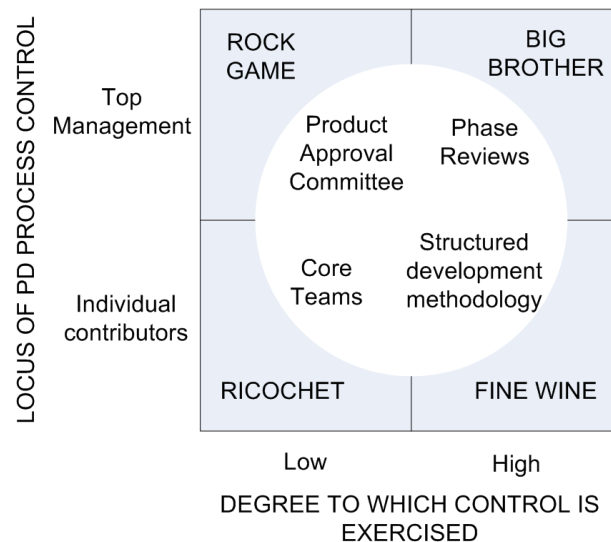


Figure 10 Balanced PD process and related balancing mechanisms

Figure 10 shows the broad aspects of the PD process and the four behaviours that result from the type of control exercised. Also, the control mechanisms used to counter corresponding behaviours to realise a perfectly balanced process, is shown.

By using a structured development methodology, companies can improve the performance of their PD process. Balancing the process behaviours is a critical factor in reducing time-to-market, which may increase market share and revenues. Thus by combining these two, it is possible to control the overall process and find balance between management and individual contributors. These techniques are used extensively in industry.

As all four behaviours do exhibit some pitfalls, and these seem to have a possible effect on the outcome of the product's success, it is desirable to prevent this at all costs. The section that follows describes shortly why these pitfalls are major obstacles in more detail, in order to highlight the vital need for better PD process management.

2.4 Consequences of a poorly managed PD process

The resulting pitfalls of an unbalanced process can be summarised into four main consequences that are common to all four behaviours described above. These pitfalls are:

- Ineffective design and development
- High development costs
- Extended design and development time
- Non-ideal final product offering.

A badly executed PD process results in ineffective design and development. An ineffective process limits the ability of the firm to produce superior products on time to market (Cooper 1998 & 1999; Cooper & Kleinschmidt 1995). Unfortunately, a PD process is not enough to ensure successful products in the market, as the nature of the process is also significant in determining success. Derived from the literature on process behaviours, the outcome of an inefficient process inevitably affects costs, design time and the final product.

The full effect of product design and development is often only realised during later stages of the product's lifecycle. However, during later stages the impact on the company and the product itself is much greater (Dimitrov 2006).

The problem with high development costs is that when the product finally reaches the market, it is more expensive than initially planned. The more expensive the product, the fewer customers will buy it. Hence, not only do market share decrease, but also the competitiveness of the product. As a result, the company may need to cut profit margins to keep it in the market, which in turn reduces project feasibility and overall company profits.

Another pitfall highlighted is that of extended design and development time. Due to a common trade-off between project cost and development time, the product's overall cost will increase, which echoes the situation described in the previous paragraph. A more severe result is that the longer the product takes to develop, the later it reaches the market. Once again, market share will decrease due to increased competition and initial lifecycle profit will fall into the hands of other companies.

Finally, ultimate product success is determined by how it performs in the market. If the customer does not feel the product makes a significant contribution to suit their needs and wishes, alternatives will be sought. Hence, the ultimate goal of the PD process is to deliver a product that will satisfy customer needs best out of all the competing products.

To conclude, it should be quite obvious what impact these pitfalls can have on overall product success. The reader is reminded that any of the PD behaviours discussed could result in one or more of these pitfalls and it can thus be concluded that the execution of the product development process plays a very decisive role in determining product success in the market. Hence, in order to draw up a framework that would increase product development success, further research was undertaken to investigate the requirements of a good product development process. This is explored in the following chapters.

3. *Generic Product Development Process*

This section discusses a generic model for the design and development of new products. The aim of this chapter is to better understand the overall PD process and its requirements. The context of the chapter is described in Figure 11, together with Section 1.6 - Document layout – the reader is referred to this.

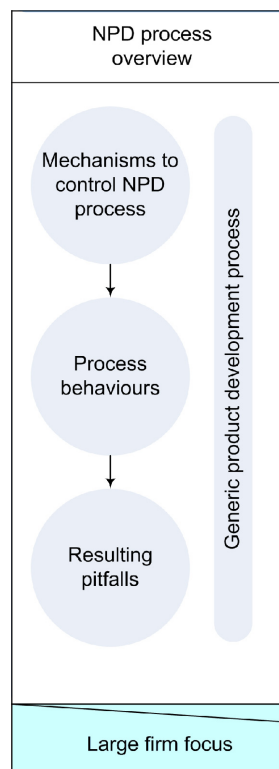


Figure 11 Document navigation – First silo

In order to improve the understanding of what is meant by a product development process, two definitions are provided:

New Product Development (NPD): The overall process of strategy, organization, concept generation, product and marketing plan creation and evaluation, and commercialisation of a new product. It is also frequently referred to just as "product development" (Kahn 2005).

New Product Development Process (NPD Process): A disciplined and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services (Kahn 2005).

Although this study focuses on the broader process of NPD, the discussion of the generic model approaches NPD based on the second definition. The model thus concentrates on the NPD process taking into account the specific steps encountered during execution of the process.

An initiative by the Engineering and Physical Sciences Research Council (EPSRC) was undertaken to develop a generic new product design and development model. Cranfield University and the University of Manchester Institute of Science and Technology conducted this joint project. The researchers found that current models lack a generic property, hence their aim to develop a true generic model. This was done for both design and development processes and specifically for small and medium sized enterprises. A generic model was needed that could be specifically tailored to suit individual company requirements and SMEs especially. In effect, the main focus centres on the process activities in NPD, including various best practices used from research and fieldwork done in a wide range of business sectors and diverse industries (Peters et al. 1999).

Peters et al. (1999) once again highlight the difficulty involved in developing a formalised NPD process, which is particularly the case in SMEs. From their research, it is apparent that the greatest difficulty lies in the initial identification of involvement and input in the NPD process. Practitioners' reluctance to formally describe the process is a major reason and indicates their lack of appreciation of the full benefits of a formalised process. They believe this will suppress creativity, although research highlights that this is not the case and that creativity can be maintained (Peters et al. 1999; Shepherd & Pervaiz 2000). However, many businesses are forced to formalise their NPD process in order to receive formal certification like ISO 9000 for their procedures (Peters et al. 1999).

The model chosen for discussion here (that will follow shortly) is aimed at developing an understanding of the product development lifecycle and more importantly the actual process activities. This model, previously researched by Peters et al. (1999), is discussed and compared with related work to clarify uncertainties (Indutech (Pty) Ltd. 2005; Product Development and Management Association 2007; Essmann 2007; APQC 2000).

This so-called 3-layered model is included together with its framework in Appendix B. The model has three main process identification sections, each comprising different phases:

- Pre-design and development
- Design and development
- Post-design/development.

The three layers indicate facilitation issues, a summary of the process phases and also various tools and techniques commonly used in the new product design and development (NPDD) process. In addition to the phases and activities, phase review definitions or controls are also shown in the accompanying framework, as well as their respective review and control criteria (See Appendix B, Page V). The review criteria are

used to evaluate the project performance (See also Section 4 Role of NPD Capability). The control criteria define the project boundaries for each phase. By providing the project boundaries a means of controlling the execution of the project is realised. Hence members of the development can make more autonomous progression, as long as the project stays within the determined boundaries. This chapter focuses on the second layer of the model which is the generic lifecycle phases of the process.

It is important to understand that the product development lifecycle is a virtual representation and not a sequentially executed process. In other words, the lifecycle phases are not chronologically executed, but should be seen as an iterative process, moving back and forth between phases as needed, with overlapping stages. Therefore a lifecycle within a lifecycle can also exist (Indutech (Pty) Ltd 2007).

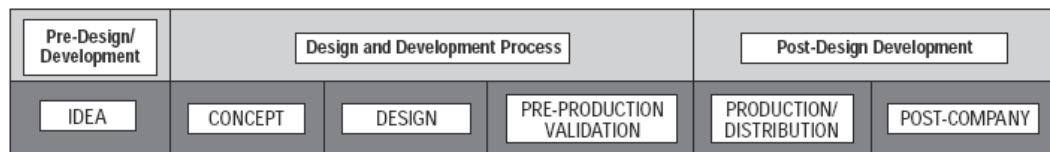


Figure 12 Generic product development process

Figure 12 illustrates the generic process under discussion. The following phases and the subsequent activities they comprise will now be discussed:

- Idea phase
- Concept phase
- Design phase
- Pre-production & validation phase
- Production/Distribution phase
- Post-company phase.

3.1 Idea phase

The idea phase is realised by the identification and evaluation of new ideas and does not include the actual development of the concept. This phase is known as the fuzzy front-end. Little is known about the product, market, client needs and project potential. The key here is to identify market opportunities and solutions that will best fulfil perceived customer needs. Hence, this phase involves a great deal of risk and many new product ideas are killed already during this phase. Developing a strategy for PD that will best suit end-user cost and performance requirements starts here.

During this stage it is already important that decisions are not taken based purely on in-house perceptions but also concrete market research based on direct customer

interaction. Peters et al. (1999) identified four distinct activities during ideation in their study. These include:

- Identification
- Collation
- Prioritisation
- Idea introduction.

Identification

Being customer focused and identifying customer needs, problems and benefits is the origin of NPD. The necessary mechanisms should be in place to enable the identification of new opportunities.

Collation

Collation is about how new ideas are brought to light and unfolded within the company for evaluation purposes. The importance of this activity is fully understood when companies recognise that new ideas may be introduced by any and all departmental functions and teams, and at any level of the corporate hierarchy.

Prioritisation

New ideas are evaluated and rated against certain criteria in order to determine the most lucrative. Typically a score model is used to rate the ideas (Cooper 1999). Since information at this stage is still vague, critical to the assessment are strategic factors such as synergy in business and NPD strategy, customer acceptance, commercial potential and technical feasibility (Carbonell-Foulquié, Munuera-Aleman & Rodríguez-Escudero 2004).

Idea introduction

The idea phase is structured around preliminary evaluation and feasibility studies. If an idea is seen to have extraordinary potential, the mechanisms to do a more detailed feasibility study should be in place. The idea phase thus aids in optimising the product concept by evaluating various concept solutions.

Summary of the Idea phase

The idea phase and preliminary evaluation marks the start of the lifecycle and lifecycle documentation. To obtain an understanding of the overall opportunity, deliverables should include preliminary information on the product offering, schematics, costing, competitor product evaluation, development process requirements, and the like.

3.2 Concept phase

The concept phase highlights the start of the actual design and development process. The aim is to evaluate the opportunity in order to identify the detailed internal and external requirements of the proposed product. This includes different possible solutions, all aspects that relate to the proposed product and also necessary activities in support of its production. Through this phase, the concept is realised and specifications determined. A strategy for development is also determined. Three main aspects constitute the Concept phase:

- Feasibility studies
- Conceptualisation
- Peripherals.

Feasibility studies

Ideas that pass initial screening are committed to in-depth feasibility assessment. All aspects of development throughout the lifecycle are assessed. The key is to determine as soon and as accurately as possible the cost, schedule, performance and resource requirements. Feasibility assessment will reveal whether all elements of the process fit together economically and technically within the limitations of the development environment.

Conceptualisation

The feasibility studies yield the requirements of the product offering. Conceptualisation is the conversion of these requirements into a real solution. This activity is needed in order to think iteratively through proposed solutions with concurrent customer interaction and to assess the actual value of proposals.

Peripherals

Detailed aspects of the proposed product are considered, such as aesthetics and packaging, as well as storage and delivery methods.

Summary of Concept phase

The product performance and design specifications must be comprehensively described and should be an accurate reflection of the customer's needs and wishes. The development team should thus fully conceive and define the product prior to its introduction to the enterprise environment. The concept phase is also helpful for indicating areas of high risk and uncertainty that may occur during the uptake of the project.

3.3 Design phase

The finalisation of the concept phase establishes a set of detailed requirements of the proposed product. The overall aim in the design phase is therefore to determine the exact parameters of the product based on these boundaries. From this, a set of production instructions is then released. Prototype testing of the initial design is done to ensure that the requirements of the physical product are adequate and that the production requirements are met. The following aspects summarises the Design phase:

- Design
- Prototyping
- Tooling
- Alpha testing.

Design

This phase includes the processes that convert functional requirements from the concept phase into design parameters. These will translate into variables that deliver the final prototype-ready design. The design activity includes engineering, peripheral and industrial design.

Prototyping

A model is developed as a representation of the design. Prototypes differ in functionality and completeness depending on what physical or operational requirements need to be tested. Prototyping can aid in communication and the establishment of physical parameters and appearance.

Tooling

In order to mass-produce a new product, machine tools and related support devices are needed. By producing prototypes of the product, the tooling requirements can thus be determined. This may include methods of production and assembly.

Alpha testing

A product's functionality and performance should be verified. Alpha testing is normally performed in-house to confirm the physical requirements, functionality and capability, as well as the production and assembly suitability of the product.

Summary of Design phase

The design phase pertains to the actual realisation of the product based on conceptual parameters. More recent facets of product design generally also incorporate the environmental impact of the lifecycle. This is relevant not only to product disposal but also for minimising the impact of production activities, the product's design for

durability, disposability, disassembly and recycling. The aim of limiting the creation of waste prior to production should be emphasised in the design phase.

3.4 Pre-production and validation phase

The production process is the realisation of the detailed design to a final product produced in volume. Hence, consistency is a quality sought here. By deploying a trial production run, the product and production method can be assessed for optimal progression. The following are aspects typically addressed during this phase:

- Trial production
- Batch testing
- Beta/gamma testing
- Launch planning.

Trial production

Trial production confirms the manufacturing and assembly processes required to produce the product, and that the production equipment is capable of maintaining the product specifications.

Batch testing

This activity confirms that the final product meets the required specifications.

Beta/gamma testing

The product is tested based on potential or existing customers, and feedback obtained. In this way, unanticipated requirements can be addressed prior to full-scale production.

Launch planning

Preparation is done for full-scale deployment of the final product. Hence, timing of events, execution of the launch plan and synchronisation of the supply and demand chain are critical to ensure successful rollout. If old products are replaced, well-managed transitions can lead to improved revenue and minimised cannibalisation. A launch- and marketing plan is developed, as well as market entry points, release decisions and product announcements drawn up.

Summary of Pre-production & validation phase

The gradual development of the design and development process yields information for continuous updating and refinement of the project. This can include business case assumptions, manufacturing-, delivery- and overall product costs, market and marketing research, establishing customer needs as well as sales and final product

features and performance. Pre-production and validation can contribute much to this requirement.

3.5 Production/Distribution phase

The design and development process is finished once the product is introduced to the market and ready for launching. In effect, factors relating to the rollout of the product become important in addition to keeping it in the market and providing the necessary support activities. Supply chain activities varying from sourcing suppliers, manufacturing, assembly, packaging, sales and delivery to the end-customer is all realised simultaneously. Aspects commonly addressed during this phase include:

- Assembly
- Manufacture
- Launch
- Sales
- Delivery.

Assembly

Assemblies consist of products made up of various components and can sometimes be very complex. The involvement of various suppliers, disciplines and component interactions as well as different types of testing might be needed before the final product is realised. By developing procedural documents, assembly instructions are provided in order to obtain the final product. Picking and packing of the product is done in order to produce the desired customer orders, as well as preparations needed for storage and transportation.

Manufacture

Production in a manufacturing environment revolves around constructing, installing and scheduling manufacturing processes. Innovative small businesses in many cases outsource manufacturing activities. Hence, close collaboration between development and manufacturing personnel are needed to determine manufacturing performance specifications, procedures and assessments.

Launch

The launch marks the release of the product to the market and the culmination of all development work. Initially, the launch may be done in a test market (limited geography) or else on a full scale. Test launches provide valuable information on how to improve and change the actual launch. The launch contributes to the product success in the market and can increase the return-on-investment and revenues. It is thus important that clear goals and an effective launch process are established. The

process should be aimed at continuous improvement and the optimal team structure and roles should be used.

Sales

Product sales are a good measure of how well a product performs in the market place. Although solid pre-launch testing may have been performed, e.g. alpha-, beta-, concept testing, etc., feedback based on sales, however, is regarded as the acid test of performance. Weaknesses in launch marketing can be identified properly for the first time, along with product delivery problems, repurchase rates, customer satisfaction level, and so forth. Although early sales are not necessarily representative of an overall market, identifying issues before they show up in poor sales figures is important.

Delivery

Delivery pertains to the movement of goods from production facilities to the customer. Activities here may include storage and warehousing, picking and packing, transportation and overall supply chain management. Through efficient supply chain management, value may be added by integrating and optimising key participants and activities within the supply chain.

Summary of Production/Distribution phase

During production and distribution, activities such as procurement, production planning, start-up and quality management as well as many others required to produce, sell and deliver the product are finally integrated. This should be done smoothly with the backing of the necessary company resources and support systems.

3.6 Post-company phase

Once the product has been released to the market, it is necessary to sustain and continuously improve the mature product offering. Hence, measuring product performance and progress is essential. Other post-company objectives include managing the product's lifecycle and reducing costs, improving quality and extending the lifecycle as long as possible to maximise revenues. Other plans that should be executed are product phase-out and recycling. Research has identified three aspects that pertain to the Post-company phase:

- Performance
- Sales
- Disposal.

Performance

By measuring the performance of the product in the market regarding sales, customer acceptance, product value, market penetration, etc., initial projections can be validated. This also yields insight into the expected success of the product. The key to measuring product performance resides in understanding the consumer adoption process or so-called consumer response mode (Kahn 2005).

Sales

Products cross the so-called chasm when rapid sales growth is experienced – the chasm is a breakthrough point in sales growth. Hereafter, the maturity stage is reached and the sales curve starts to flatten due to market saturation. Hence, metrics and strategies to evaluate and renew sales growth need to be determined. The focus now also shifts towards product-related services rather than the core product itself. This activity involves sustained interaction with the product in order to support and keep it performing as expected during its useful life. An overview of after-sales product support requirements should have been done during the design phase and includes issues of maintenance, product recalls, warranties, updates, and the like.

Disposal

In the decline stage of its lifecycle, the retirement and exiting of the product becomes important. This may be the result of an altered market, new technology, regulatory changes or changes in competition. An assessment of the requirements and contingencies for the retirement, transition to a third party or replacement of the product is made. Customer and supplier interaction is important here, as well as the impact retirement will have on the overall company. Disposal also accounts for the physical disposal and recycling of the product, which include collection, disassembly and processing of recyclable materials of the product. The impact on the design and logistic processes is immense for companies who are diligent in their responsibility towards recycling products.

Summary of Post-company phase

Post-company activities may provide a basis for innovation, i.e. crucial new ideas, line extensions, enhancements and improvements to the current products and processes. This information can be sourced from positive customer feedback, complaints and aftercare enquiries, sales, product usage, lifetime and disposal aspects. Through this a better understanding of true needs and customer requirements is grown.

3.7 Conclusion on generic PD process

The research presented in this chapter highlighted the typical steps during product development and the basic activities this entails. Taken from small business practices, these steps and activities take the whole lifecycle of the product into account, including post-design and development phases, i.e. the phases after the product is released to the market.

Studying generic PD models provides insight into what product development entails in terms of all the process activities required, and help to develop a better understanding of the resources and time required. For small businesses, this is essential as they are severely bound by resource constraints. In summary, planning and optimising resource usage throughout the lifecycle is of vital importance to small businesses.

The generic model of product development discussed above provides a basis from which to work and discuss NPD. For small businesses that do not have this experience, this exercise may provide insight into this process, which would increase their planning and preparation beforehand. This in turn could increase the successful development of the product and the product's success in the market.

Finally, the discussion of this generic model contributes to the aim of this research study. This model is based on SMEs and not large firm practices. In addition, it was developed from surveys, hence is based on practical experience, and not merely derived from researching the literature.

4. *Role of NPD Capability*

The discussion followed till now has shown the vital importance of the NPD process, and it was emphasised that the successful execution of the process is as critical as is the final product offering. The literature reviewed provided insight into understanding why this is the case and what a typical NPD process entails. This chapter marks the start of a new focus point in this study, and is displayed by the *second silo* in Figure 1 (See Section 1.6 Document layout).

To build on the discussion thus far, the awareness of companies of the importance of the above processes was tested. In other words, do companies deploy mechanisms that exemplify their capabilities of executing the PD process? An additional motivation in researching this aspect was also to determine what emphasis is placed on the process during NPD.

Moreover, two areas were investigated. Firstly, the role of NPD capability was researched in large companies by looking at phase review criteria. Secondly, smaller companies were also investigated to determine the emphasis placed on NPD within this environment.

4.1 Phase Review Criteria accounting for NPD Capability

Common to product development across models is the screening of products. Products are evaluated and overall feasibility determined. The result of this exercise is a decision that then either cancels or approves the product's development. This does not pertain to the initial product idea only but also to each phase review throughout the physical development.

Previous literature highlights phase reviews as a critical component of the PD process. A partial objective of phase reviews is to assess and determine product feasibility and also overall project performance (see Section 2.1.4 Phase reviews). Each review, whether it is prior to or during design and development, is accompanied by a set of review criteria relevant to the specific phase. The review criteria facilitate this process by setting specific hurdles through which the development must pass. If these hurdles are not passed, further development is not approved.

In new product development, it is obvious that a more complex product requires a more complex process (Cooper, Edgett & Kleinschmidt 2002a & 2002b). Hence determining the capability of the current process to support a new development would seem appropriate. The product and the process do not exist as separate entities during development. Moreover, phase reviews form a decisive interface between the process and the product. Keeping this in mind, one should expect criteria used at phase reviews to incorporate process-related criteria as well. In effect, one should expect phase review

criteria to include some factors that assess process-execution capability in addition to product-related factors. The following section thus aims at determining this. If this is not the case, an explanation will be sought to clarify the result.

4.2 Evaluation of Phase Review Criteria

Literature reviews have been identified and are used to investigate typical criteria used at gate meetings. As discussed, phase reviews are not just a regular update and review of a project's progress or a status report. Reviews are tough decision-making meetings that act as quality control checks to ensure that the right projects are done and that the projects are done right (Cooper et al. 2002b). This partially facilitates the simultaneous management of several projects. This is called portfolio management, as it ensures that not only the right projects are selected for development but also the right number of projects. An effective stage-gate process is the first step in doing portfolio management (Noyen 2004).

Phase reviews, together with the review criteria, aid the decision process described above. The criteria provide a measurement system against which each development project is evaluated separately. Checklists or scorecards can be used to appraise projects based on these criteria (Carbonell-Foulquié et al. 2004; Cooper et al. 2002a & 2002b).

The usage of review criteria is influenced by several factors. Although not crucial in this regard is it worthwhile to keep the following in mind about review criteria (Carbonell-Foulquié et al. 2004; Saunders, Stagg & Wong 2002; Ajamian et al. 2007):

- Dependent on industry sector and product type
- Usage and importance differ based on the specific development phase
- Differentiate between initial fuzzy-front-end stage and structured stage-gate process which follows the fuzzy-front-end.

Ajamian et al. portray the difference between the fuzzy-front-end stage that precedes the structured stage-gate process (Carbonell-Foulquié et al. 2004; Ajamian et al. 2007). The first stages of development are unstructured, characterised by highly variability, high risk and uncertainty. This part of development is commonly termed the fuzzy-front-end. Hereafter, the more structured stage-gate process is initiated, typified by defined milestones and a project plan, together with increasing certainty and predictability.

Review criteria differ based on the industry sector and product type. The first main source of criteria that will be discussed is related to consumer products, and the second to highly innovative products. While Saunders et al. (2002) regard the first as a good source of criteria, and is thus included here. However, the second source was specifically chosen to include a broader spectrum of industries related to more disruptive technologies or innovative products.

In the literature, use is made of criteria dimensions that delineate broad categories that can then be populated by more specific criteria. The discussion here compares major review criteria dimensions and combines related ones, so as to provide an overall picture and thereafter make a conclusion of the findings. Various publications from Cooper also depict evaluation criteria (Cooper 1985; Cooper et al. 2002a; Cooper & Edgett 2007).

Criteria dimensions will be explained in the following sections. Furthermore, an assertion will be made on the extent to which each criteria dimension considers the NPD process.

4.2.1 Strategic fit

Strategy forms an integral part of business management. Hence, businesses need to investigate whether synergy exists between product development projects and strategic goals. This will determine whether the project needs are compatible with company resources. This pertains to the skills in the company, e.g. engineering, management and marketing research skills, and also to resources such as R&D, production, financial, sales, distribution and marketing capabilities. The project should also fit the current portfolio of products under development (Cooper 1985).

Indirectly, strategic fit does focus on NPD process-related factors, particularly the resources and skills required. Companies with successful NPD experience would most probably compare execution requirements with their current NPD capability and process knowledge. However, if companies are unaware of the impact NPD execution has on product success, this might be neglected.

4.2.2 Technical feasibility

Technical considerations are major determining factors in the successful outcome of the project. The first major consideration is how accessible the technology is to the firm; the technology needed during development should be readily available. Secondly, the technical capability of the firm to handle the complexity of the project is a major concern. Technical feasibility is the most determining and most frequently used criterion during the approval of product concepts (Carbonell-Foulquié et al. 2004).

Project complexity has a definite impact on the NPD process and product success, which is why companies rate this aspect as very important. As the product becomes more complex, so too does the required process. This creates the need for a proper NPD process in order to reduce the risk and increase the likelihood of success. The success of complex and technically challenging products thus inevitably become even more dependent on well-structured NPD processes. Hence, technical feasibility

criteria incorporate aspects of the NPD process that could be useful in assessing execution capability.

4.2.3 Financial performance

Financial criteria are used to evaluate the expected financial performance and requirements of the product. Typical indicators based on projections are used to evaluate the profitability of the market. The most popular indicators for new product selection are the payback period and discounted cash flow, which includes internal rate-of-return and net present value (Carbonell-Foulquié et al. 2004). Determining these indicators can be cumbersome during initial stages when project information is vague, so companies are reluctant to use them during early stages of development. Other indicators include return-on-investment, profit margins, sales growth and the investment required for the uptake and rollout of the project.

Financial criteria yield very little information which evaluates the NPD process, as the focus is specific to the financial aspects of the product. However, factors regarding financial investment required may consider the effort involved in NPD, but no obvious evidence was found in support of this statement.

4.2.4 Customer acceptance

Customer acceptance criteria are centred on the axiom, "The customer is king". Product success is determined by the extent to which it satisfies customer needs. The result is that the product is accepted in the market and its acceptance will be reflected in sales and market share growth figures accordingly. Businesses that have a strong customer focus, and that track and respond to customer preferences tend to perform at higher levels (Carbonell-Foulquié et al. 2004). These criteria are used throughout the development lifecycle and become even more relevant in the later stages. Their specific focus includes the quality and performance of the product in meeting the objective of satisfying specific customer needs. In the end, it is the ability of a product to uniquely satisfy user needs that differentiates it from competing products.

Customer acceptance review criteria do not focus on the NPD process. These criteria evaluate the ability of the product to adhere to the customer requirements and desires. Some criteria identified in the literature do however take into account the extent to which product features and performance are clarified upfront and how predictable the development is. One should realise that understanding customer requirements and linking this to product design is not a simple task. However, specific mechanisms are deployed within the NDP approach to ensure that these activities are incorporated, emphasising the value in using a proper NPD approach. Thus to conclude on customer related criteria, the NPD process plays a critical role in gaining customer acceptance, although the criteria themselves focus on the product.

4.2.5 Nature of the market

The market review criteria assess the market opportunity and current state. Long-term sales growth is of significant importance, as is the market share the company will own. The nature of the market is also described by the intensity of the competition regarding price, the number of competitors or the number of new product introductions. In the case of a consumer product, the resistance to changing brands should be investigated together with the market entry barriers. Some markets do have the ability to change quite rapidly and thus affect the product offering.

Market-related criteria focus on market potential and its characteristics. Hence, the focus is shifted to assessing product performance in the market. In rapidly changing markets, the NPD process must be capable of handling product changes and the role of configuration management also becomes more prominent. Besides this, the market criteria, although not directly related to the NPD process, have significant value.

4.2.6 Product differential advantage

Products with a unique advantage over others have a higher probability of success in the market. Product differentiation criteria seek to determine whether a product has a uniqueness needed to become a highly profitable business case. First of all the product must be superior to all other competing products. Unique features, better quality or an ability to perform exceptional tasks are important issues to users. Consequently, highly innovative or first-of-its-kind products start out with a competitive advantage. This is also true for products that can be patented or that have a tangible technological advantage. Favoured products are those with a superior fit to the user and the nature of the market. Lastly, value to the customer is of concern. In other words, does the product reduce cost and increase customer benefit?

This criterion has a specific focus on the product concept itself. During the initial phases, prior to design and development, feasibility studies and brainstorming are used among other methods to identify the product potential. These activities also exploit alternative concept solutions. The results of this will determine and indicate the superiority of the product. The role of the NPD process should instigate this and thereafter ensure that the final offering is realised and rolled out into the market. The use of this criterion seems to be most beneficial when seen mostly from the perspective of the product and less from the process perspective.

4.2.7 Product newness to firm

Product newness to firm is quite self-explanatory, and refers to the ability of the firm to produce a new product. Hence, one would also expect it to account for the firm's new product development process capability. This criterion aims at assessing which new areas the firm will have to enter to achieve success. Such areas include unknown

markets with different and new types of user needs, establishing a new product line and entering a new competitive environment. The sales force may need to change for new products, as well as new distribution and product support structures implemented. Technological requirements are assessed, which also include technologies that the product requires. Technologies new to the firm and new production processes are identified.

Indeed, product newness criteria do have a relation with the NPD process. The need for an as-is to-be study or gap analysis is confirmed. Keeping in mind that criteria determine the ongoing approval of the development, one should expect it to take all factors that could influence development success into account. Specifically, one would expect this criterion to include more NPD process aspects. This criterion reveals the product's impact on the firm. In addition, it should consider also the NPD process required to develop and bring the product successfully to the market. This, however, does not appear to be the case.

4.2.8 Market strategy

Market strategy refers to the strategic aim of the product on entering the market. Several strategies have been identified that may be assessed by these review criteria. These include new products that are developed in response to competitor- or market changes with the objective of maintaining market share. New products are introduced either to complete a product range or fill particular gaps. Some products are specifically developed with the aim of attacking and capitalising on a favourable market share owned by competitors. One last common strategy is that of new product introductions, derived from gaps in the market, resulting from particular needs identified in the market. In effect, the criterion determines if the product is market driven. If the product does not fit a particular strategy, the development may be knee-halted.

Following the discussion on market strategy and associated criteria, the importance of strategy in NPD should be emphasised. Market strategy criteria have no remarkable significance for the NPD process. Despite this, the ability of the process to adhere to a pre-determined market strategy should be obvious. A good market strategy determined by management of external entities is useless if the process is not capable of delivering the required product to market on time.

4.2.9 Product branding

Product branding appears to be an important evaluation criterion for consumer-based products. Consumer products are not known to have a competitive advantage by virtue of their breakthrough technology or such. Therefore, branding plays an important role in product differentiation within a highly competitive market, e.g.

consumer markets. Branding ensures the product is unique among both the other company products and competitor products. Branding criteria are used to evaluate a product's brand fit, potential for patenting and whether it is easy to recognise and recall. Also, its compatibility in the global market, where market- and languages differences need to be considered, is taken into account.

Product branding criteria play a key role in determining product differentiation, although the use of branding criteria is less relevant for highly innovative products. For this reason, it is highly unlikely that branding criteria consider the NPD process in any way.

The following example is used to indicate the possible impact the NPD process could have on aspects like product branding. The author observed this in a chain store and thought it to be a worthwhile example. Recently in South Africa, a company selling consumer brands launched a completely new product line. A simple mistake was made, as the released product did not show the content's volume on the label. It was temporarily added by means of a sticker, which did not reflect positively on the brand. The most likely explanation for this was that the NPD process was not ready to produce products that differed so completely from the company's existing ones. A proper process would have invested in the necessary market research and made use of checklists to ensure all these aspects were covered during development. Damaging a brand name in this way is not favourable in a competitive consumer market. This is a good example to highlight the importance of having a capable process to ensure a successful product offering the first time. Companies unfortunately do not realise the financial impact of product changes that may have to be made later on. This is especially true, when weighed against the upfront investment made to establish a NPD process that could prevent the need for such changes.

4.2.10 Conclusion on process related review criteria

This investigation yielded useful results and helped to answer initial questions. There is evidence of traces of the PD process being considered in the project review criteria, in addition to the product. While some criteria can be linked to the NPD process directly, one should be cautious in assuming that these have been included specifically to evaluate the process. Although criteria may be process-related, this does not imply they are process-focused, as the criteria overlap, and refer to other (non-process) activities as well. Thus, companies with proper NPD knowledge would probably take the process into account anyway, during the phase review, but would do so using criteria that are relevant to a broader spectrum of activities. However, in cases where companies lack this knowledge (of NPD), these considerations may be overlooked, highlighting once again the importance of having NPD process knowledge. Cooper (1999) also notes the value of having a process manager or

facilitator to specifically look after the process. According to Cooper (1999) implementing a new product process ideally requires a facilitator in order to be successful.

There is a strong tendency for technical and technological review criteria to be considered able to account for NPD capability. However initial discussion on the PD frameworks and the product development lifecycle indicate that technology as such merely provides the tools to assist in the execution of the process, and does form part of the fundamentals. Technical aspects also include a focus on the resources and capability of the firm, including technical support.

Product review criteria are used to make “go/no-go” decisions in NPD. Considering the role the NPD process plays in determining the successful outcome of the product, there was little evidence in the review criteria to account for this. Review criteria might therefore be too focused on non-process factors, and do not test the capability of the NPD process for producing a successful product.

There are two possible reasons which may explain why review criteria focus more on non-process related activities. The first suggests that certain larger companies may already have a well-structured and mature NPD process in place. Hence, they assume they are familiar with the process and shift the focus onto other aspects. In effect, the current process is used and the product optimised. The second reason could involve companies who are new to PD or who are used to following an unstructured process. These companies may not yet realise the importance of having a proper NPD process, and probably do not take the NPD process serious, purely from a lack of knowledge and experience in this regard. Hence, NPD capability is not considered for process execution.

Finally, the definite need for a framework that is more centred on the NPD process is evident, especially in small businesses at risk of failing in NPD due to their lack of process-execution capability and knowledge in this regard.

4.3 NPD process activities in small businesses

Up to this point, the focus of this research thesis has been on NPD within larger firms or the corporate environment. The discussion has centred on larger firms that have well-established NPD practices. The reason for this is that the main sources of information in the literature researched were typically larger firms. The motivation for this methodology was to first become acquainted with NPD in large firms and then to use this to enhance the practices in smaller firm. The context of this section is highlighted in Figure 13 - document map's *second silo*. The reader is also referred to Section 1.6 - Document layout.

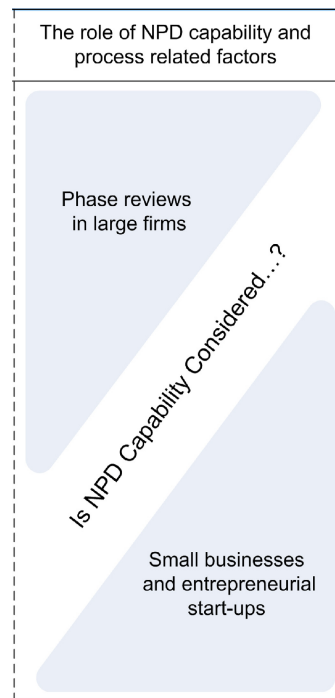


Figure 13 Document navigation – Second silo

In this section, however, the focus shifts. The aim here is to determine the context and emphasis of PD in small businesses. Do small companies also focus exclusively on the NPD process as larger firms do? Does NPD also play such a major role in the success of the product? Research was done on small business development and practises to find out what role the NDP process plays.

Studies with specific focus on entrepreneurial businesses and start-up firms were researched and analysed (Illetschko & Parker 2003; Bygrave 1997; Longenecker, Moore & Petty 2003; Ultimate Business Library 2004; Burke 2006; Hiduke, Ray & Ryan 1999; Parker & Osso 2000; Awe 2006; Burstiner 1997). Similarities and differences in viewpoints from various authors are discussed, with an emphasis on activities common to most viewpoints, as well as specific NPD activities. This will highlight the role and importance of the PD process within small businesses. Small business growth and entrepreneurial start-ups often originate from inventions seen as new product developments. Hence, it is important to understand and be familiar with NPD as well as the small business environment; this section focuses on the latter, e.g. small business environment.

A secondary aim of this investigation was to establish the interface between small and larger companies' NPD activities. This is required to determine the applicability of general NPD practices to small firms. What does NPD entail in smaller firms and is benchmarking helpful in improving the process? What are the differences that should be taken into consideration? If PD practices are to be translated from large firms to the

small firm environment, it is important to understand the context of both environments. In this section the role of NPD from an entrepreneurial and small business perspective will be described.

4.3.1 Main focus areas during small business development

Information regarding the main areas of focus during small business development was captured from the sources investigated (Illetschko & Parker 2003; Bygrave 1997; Longenecker, Moore & Petty 2003; Ultimate Business Library 2004; Burke 2006; Hiduke, Ray & Ryan 1999; Parker & Osso 2000; Awe 2006; Burstiner 1997). The results of the investigation that highlight NPD activities in small companies are provided in tabular format in Appendix C. The table indicates focus areas for business development within small companies, a general explanation of each area, specific topics related to the focus area and the sources that agree on this aspect. In the section that follows, more topics will be highlighted and discussed. These topics are included because they relate specifically to NPD issues.

By small business development the author means the general activities required to grow and manage a small business. This includes the founding of a start-up company and related aspects, such as the product and service development needed to accelerate growth.

The results of this investigation were validated with additional sources to confirm their relevance (Burke 2006; Parker & Osso 2000; Awe 2006). This was to ensure that the end result aligned with general practice. These resources yielded results that were in support of the initial findings.

4.3.2 NPD process relevance in small business development

The previous section introduced activities common to most small business and start-ups. These activities are shown in Appendix C. However, this section considers instances where authors denote practices specifically related to NPD. Hence, this section will be a further exploration of what areas of NPD, if any, are addressed during small business development. Each of the sources identified was researched and evaluated carefully to identify such aspects.

One of the concurrent activities within NPD is listening to the voice of the customer and this was revealed as a main focus area of small firms as well. The NPD process ensures this is achieved when a structured process is followed and this activity is vital to the success of products and services deployed to the market.

Some sources describe the product lifecycle but from a market perspective. These descriptions do not include the typical product development lifecycle but instead portray the phases of introduction, growth, maturity and decline (Illetschko & Parker 2003; Burstiner 1997). Hence, it highlights a market perspective in contrast to a PD

perspective. This trend is indicative of the management perspective often followed by authors when discussing small business development.

Similar to NPD, are the activities of identifying and selecting opportunities that are part of business growth in small firms. Small businesses appear to place a strong focus on service development in addition to product development. This largely corresponds to the idea phase of NPD, and to the concept phase as proposed by Peters et al. (1999) to a lesser extent. Assuming the business achieves a finalised product, a strong correlation is then again evident towards the end of the product lifecycle, when the product is already introduced to the market - See Table 1.

Process summary	Pre-design/ development	Design and development process			Post-design/ development	
Generic phases	Idea	Concept	Design	Pre-production validation	Production/ distribution	Post-company
Generic phase activities	Sourcing Collation Prioritisation Idea introduction	Conceptualisation Feasibility studies Peripherals	Design (incl. industrial/ peripheral) Prototyping Tooling Testing	Trial production Batch testing Beta/gamma testing Launch planning	Assembly Manufacture Launch Sales Delivery	Performance Sales Disposal
Small business focus	Strong	Partial	None	None	Partial	Strong

Table 1 Focus areas of small business development mapped to generic NPD process

The table above indicates where the foci of small firms lie based on the generic PD process proposed by Peters et al. (1999). The generic phase activities shown in the third row were compared to the focus areas in small business development, so that the focus of small business development research could be mapped onto the generic PD process. The result of this mapping is shown in the last row of the table above, and the focus is indicated on a scale: None (Not related at all), Partial (Some aspects are related), Strong (Significant relation exists). The results are interesting. It is evident that little emphasis is placed on the design and development process of products and services. Instead, start-ups and small business development concentrate mostly on pre- and post-design and development activities.

Authors also elaborate on pricing strategies, marketing and promotion, product mixes, and so on. These activities are all heavily dependent on the PD process. Hence, not understanding the impact of the PD process can lead to a skewed perception of these and other related business aspects. Underestimating the lifecycle cost impact of a product can be fatal, as is not knowing whether the business is capable of developing the proposed products.

Another point of concern is that the business plan, which should be the blueprint for achieving the goals of the firm, also provides little evidence of a NPD focus. Business planning is well known and a common practice. In small firms this is the roadmap to success, hence one would thus expect business plans to take more NPD related activities into account.

4.3.3 Conclusion on NPD process activities in small businesses

The previous section indicates that there is a general lack of emphasis on the role of new product development in small companies. These results were captured and mapped onto a generic PD process, which led to this finding. Once again, taking into account the decisive role NPD plays in the successful commercialisation of a product, one would have expected this finding to be different.

Another concern is absence of information about production, distribution and logistics. Only two sources elaborated on production aspects (Longnecker et al. 2003; Burstiner 1997). The motivation behind this statement is that any business deploying new products inevitably needs to look at these business aspects. This holds whether it is outsourced or handled internally. Hence, if businesses do not consider these aspects, this may be indicative of the low priority placed on product development within the current environment.

The reason why small business roadmaps proposed for start-up- and growth procedures lack a NPD focus is not clear. Many explanations for this could be offered but, aside from explaining this, clearly there is enough evidence of this in the literature. The overview of the various sources creates the perception that the NPD process is not seen as crucial when considering new businesses developments. Although the sources seem to hint at businesses' responsibility for NPD, small businesses seem to avoid actual involvement in and execution of the process.

The research discussion above clearly shows that the focus within small business development is centred around business management activities and, to a large extent, this focus does exclude product specific activities. However, as new products and services drive the initiation and growth of small firms, product development and commercialisation should be seen as a significant focus area. This oversight, combined with the risk factor of having poor NPD ability, makes the situation even

more severe. In summary, these findings highlight the need to develop a framework that will support product development as a focus area within the small business arena.

5. *NPD Framework for Small Businesses*

This study started off with a review of some of the general and main components of the new product development process. The main aim was to develop an understanding of the process and to find out what it entails.

A generic process was described and discussed, together with typical behaviours that accompany the execution of NPD. These behaviours revealed that there were some critical pitfalls that play a significant role in the successful outcome of the new product's success. Possible control mechanisms that could be applied to counter and manage these behaviours were also discussed. In further support of the need for a framework, how companies evaluate their NPD capabilities was examined looking at two instances: firstly, by studying whether the criteria used to assess new projects incorporates NPD process factors, and secondly, the environment of start-ups and small businesses was revisited to determine the context and the emphasis placed on the NPD process.

The research discussion has now arrived at a point where a new framework can be proposed. This chapter thus concentrates on the *third silo* depicted by Figure 1, the reader is also referred to Section 1.6 - Document layout.

5.1 Benchmarking large firm practices

As noted previously, the framework concentrates on NPD practices applied by firms that are proficient in this field. Inevitably, some of these are larger firms although the framework focuses on smaller companies. Literature about NPD in small firms was not found to be readily available (Ledwith, Richardson & Sheahan 2006).

In a study undertaken by Ledwith et al. (2006) specific interest was paid to investigating whether small companies could learn from the practices of large firms. The findings of the study indicate that small firms and large firms face different challenges in NPD but that only some of these are related to size.

More specifically, this research was based on a framework by McGrath (1996), which presents three major categories that influence NPD performance. These are internal to a business and include strategic factors, organisational factors and development process factors. The study concludes that large-firm concepts do apply to small firms, especially in the category of the development process and organisational factors. However, care must be taken, as large-firm strategic factors are not always directly applicable to small companies. Moreover, Ledwith et al. (2006) state that the process of NPD can and should be controlled regardless of the firm size.

Although Ledwith et al. (2006) propose further research to validate the generalisability of their study, it still provides solid support for the logic behind developing this

framework. In addition, the logic behind benchmarking larger firms to benefit smaller companies, can be followed if the necessary care is taken.

The research by Ledwith et al. (2006) also confirms the findings of the author's introductory literature study and its usefulness for developing the framework. Concepts such as project control, management, and customer focus among other topics indeed are relevant to the small business environment as well.

5.2 Framework background

The first few principles used to develop the framework, are based on the four control mechanisms of the PACE (Product and Cycle-time Excellence) framework (See Section 2.1 Mechanisms for managing product development). These are all related to the physical execution of the process and what should be employed in order to increase the likelihood of success. The framework depicts a combination of sound principles, best practices and critical success factors. By studying the underlying importance and motivation for using this in practice, its relevance for smaller companies can be evaluated. Since small companies have unique characteristics, an alternative approach can then be developed by applying the same principles, but to smaller companies. Therefore, a set of key best practices or key principles that were identified during the course of this study will be discussed.

The framework presented provides an indication of the relative importance of each key principle for small businesses and start-ups. In this way, the impact of the principle on the outcome of the NPD endeavour may be quantified. The following scale is used to describe the importance of the key principles, based on the author's knowledge obtained from the study:

- *Critical*: The principle is considered to be a critical success factor in the process of NPD.
- *Beneficial*: The principle, if deployed, may hold significant advantage. On the other hand, if it is not deployed it may also have a definite impact.
- *Uncertain*: It is difficult to determine the significance of the principle as it depends on too many variables that are beyond the scope of this research.

Although many companies are involved in NPD, a great deal of them does not follow a formalised NPD process. Of the companies that are regarded as being the most successful in new product developments, about 25% still follow an informal process or have no process at all (Griffin 1997; Barczak, Kahn, & Moss 2006). Hence, best practice studies convincingly provide enough evidence to support the fact that a formal NPD process is not essential to successful NPD (Griffin 1997). Therefore, this development framework does not aim to provide a formalised NPD process for small firms. Instead it concentrates on alerting the reader to current best practices, explaining

why each practice is important and how this practice could benefit a small firm. Studies indicate many firms adopt only some NPD best practices (Griffin 1997; Barczak, Kahn, & Moss 2006) which can partially be explained by an appreciation of how much effort is needed to deploy and maintain the process. The framework does therefore not present the ultimate NPD process layout but alternatively provides a basis for discussion. This could be used when deciding on what to incorporate in the NPD process, based on its relevance to the specific company or project type. Research supports this starting point and also highlights the value of such a framework in providing direction for further NPD process improvements (Barczak, Kahn, & Moss 2006). It also provides a context in which to describe a company's own activities and define process characteristics as favourable or unfavourable.

The four control mechanisms of Section 2.1 form the first set of key principles. These constitute a separate NPD framework as proposed by Anthony & McKay (1992). Hence, these principles are equally important and should be implemented as a whole (Shepherd & Pervaiz 2000). Furthermore, the interaction and relations between these have already been described (See Section 2 Overview of the Product Development Process). Anthony et al. (1992) state that freestanding implementation and piecewise improvement of these principles cannot contribute to sustainable improvement of the process. The most effective way to improve the NPD process is to implement and improve all elements in the process. From this it can be concluded that in order to support the successful execution of the NPD process, implementation of these initial principles are crucial.

The results of the framework have been reworked into a concise tabular format that can be used as a basic form of the framework together with the accompanying discussion that is presented in the sections that follow (See Appendix E). The framework does, however, provide enough detail so that it can be used without this extra information, as the objective was to develop a thorough, yet concise framework that could be used separately, presented in a tabulated form. This makes it easier to use and enhances the versatility of the framework, although it may seem somewhat overwhelming at first.

5.3 Framework: NPD principles applied to small firms

In the sections that follow the key best practices that were found to be applicable in the small business environment are discussed. The principles that underlie these practices have been summarised into six major aspects, which are:

- Structured development process
- Review board
- Multi-disciplinary team
- Phase reviews

- Concurrent product development
- Voice of the customer
- General.

Figure 14 provides a graphical description of the structure of the framework. The first four aspects are related to one another. To gain the most benefit, these four initial aspects should be implemented together. The figure illustrates how these interact to contribute to successful product development. In addition, three more aspects are discussed. These three also contribute to successful product development and support the first four aspects.

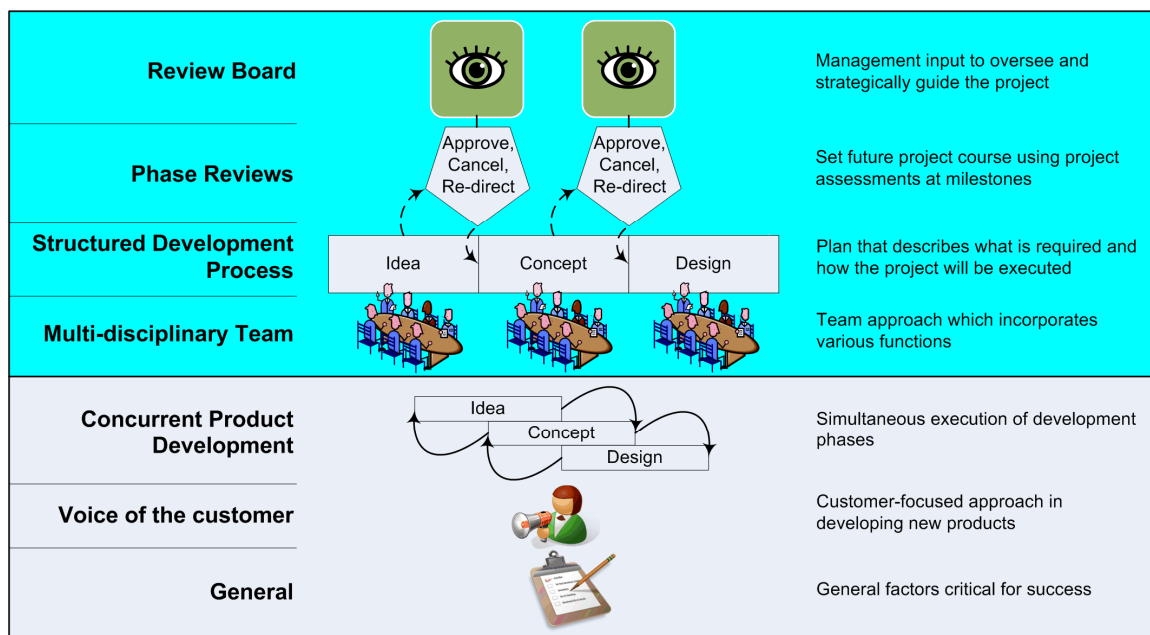


Figure 14 Layout of NPD framework for small businesses

The principles have been reworked to accommodate the limitations and constraints of small businesses. A summary in point form of each aspect is presented in a table (See Appendix E). This summary captures the essentials of each aspect and is also ideal for using on its own. In effect, the tabular summary aims to provide concise detail for use in a small business without the provision of any additional information.

5.3.1 Structured Development Process

A structured process provides a common basis that guides the development. This process is related to the practices used within project management and has already been discussed partially (See Section 2.1.1 Structured development process).

The structured process makes development transparent and easy to follow and also fosters more effective communication. This is important for outsiders or people who

are not directly involved in the development process but need to follow the process activities.

The structured development plan essentially breaks down the process phases into smaller steps. This helps to determine the required resources, time estimates and cross-functional interaction for different phases of the project.

The structured process is critical in ensuring a balance of control between the executors and the managers of the NPD process. Management interaction is realised and the effect of individual interests that could lead the project astray are countered.

One of the key ideas of the Structured Development Process is to develop a plan of execution that can be adhered to by all parties throughout the organisation. In this way, all levels of the company hierarchy can follow this common agreed-upon plan. The structured process itself is developed by people with PD knowledge and those more closely involved in the process.

Since it describes the process and realises the actual plan of execution, the Structured Development Process should be decided on and put into place prior to any new development project and applies for the entire course of the project, i.e. from idea to post-design and development phases and finally disposal.

Small companies have not always matured in their ability to do new product development, which is an issue that causes great concern. Companies new to NPD often follow an unstructured process based on intuition. This can slow development down tremendously, as upcoming activities are not known or planned for in advance, but just surface by themselves. In effect, this approach constrains development, and, what is more, the function that constrains progress the most tends to receive the most attention. This imbalance can result in the sequential execution of lifecycle phases (instead of simultaneous execution), which increases time-to-market and this is critical. The lack of adequate resources in small businesses is also a contributing factor but so are the absence of planning and an understanding of the lifecycle of development.

This situation should also alert companies that are following an unstructured process to their need to make use of generic models that can guide them into developing their own structured processes. Such a practice would also be beneficial for companies that engage in product development for the first time, as generic models provide a good basis for understanding activities that are commonly undertaken in the NPD environment.

Figure 15 illustrates the importance of having a Structured Development Process. It should be clear that this aids the effective implementation of the other aspects as shown.

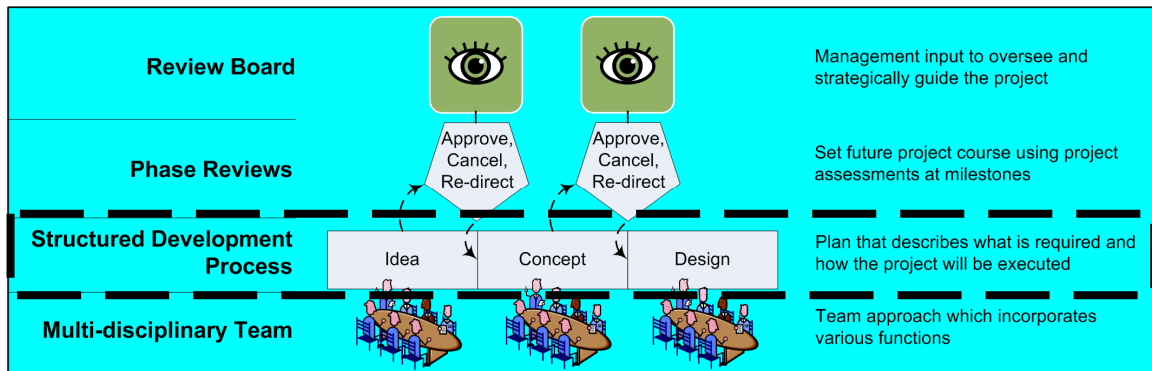


Figure 15 NPD Framework: Structured Development Process

The key aspects that constitute and form part a Structured Development Process follows below:

- Shared development plan - primary tasks and key milestones
- Collaboration and cross-functional interaction plan
- NPD Schedule
- Estimate resource requirements
- Entry and exit criteria at milestones
- Concurrent documentation.

Shared development plan - primary tasks and key milestones

A Structured Development Process inherently requires a well-defined plan that determines the execution of the process. This is very much like a project plan. Hence, it describes the project on a broad level with milestones. Normally the end of a phase will highlight a milestone. Each phase is broken up into many activities. Using this breakdown, the project can be planned. An important principle of this approach is to provide a common agreed-upon plan that may be used by everybody throughout the company. This fosters coherency in the execution of NPD projects with each and everybody involved.

Collaboration and cross-functional interaction plan

The breakdown of milestones into smaller steps enhances the allocation of responsibilities and aids the management of the process. By this means, collaboration and the interaction of teams can be improved, as this information also forms part of each step of the Structured Development Process (See also Section 5.3.3 Multi-

disciplinary Team). A common tool used is the four fields' maps (Found, Francis & Hines 2006; Gosling & Maylor 1998). An example of a structured development plan is provided (See Appendix D). The plan indicates the stages and respective activities or goals within each as well as the employees and departments involved. Hence, this is used to plan not only the phase activities of the project but also the involvement of functions, e.g. team structures, which are critical for cross-functional representation and external participation.

NPD Schedule

By determining a schedule for the development, a better estimate of the time it will take to commercialise the product can be perceived. This is dependent on the resources the company has available because of a resource-time trade-off. This will lead to knowing how long it will take to do the development, what resources will be needed to execute it within time and how much will it cost. Since money and human resources is a major constraint for small businesses, the demands the project will have on these is realised by using a Structured Development Process. The usage of the project management methodology as a tool can also be highly beneficial (Lean Product Development Roadmap 2002).

Estimate resource requirements

Using generic models provides insight into the overall requirements and development phases and activities of NPD. Hence, it reveals the true necessities for optimising the success of the process prior to the uptake of the project. For small companies committed to NPD, the stakes involved in a NPD endeavour can have a severe impact on company growth and profitability. It is thus critical to understand the long- and short-term impact and requirements of the project before investing. An adequate process summary helps to identify and consider management and information requirements early in the NPD process.

Entry and exit criteria at milestones

Accompanying the structured process is the entry and exit criteria at key milestones. Once again, this requires an understanding of the activities and deliverables that need to be accounted for during the development. Also, specific deliverables should be finalised at certain deadlines. If not, the project should not be permitted to move on to the next phase. Experience reveals that when milestones are not finalised and reviewed, projects can stray across permitted boundaries with costly effects (Anthony & McKay 1992). A possible consequence of not having entry and exit criteria is project

scope creep. By setting milestone entry and exit criteria, the project is paced and each phase of the product finalised and approved according to a time frame, which is crucial. Simultaneously, the product may be evaluated for quality and performance.

Concurrent documentation

Small firms taking up NPD will most probably innovate again in future and hence repeat the process. In order to implement process methodologies successfully, the process needs to be repeatable (Jarvis 1999). A well-documented process can be communicated effectively to development personnel and consistently reproduced together with improvements – which is effective knowledge transfer. The PD process always leaves room for improvement, which accounts for companies that have done NPDs many times. Documenting the process and including additional useful documentation aids future executions and help to continuously improve the company's NPD capability. The Structured Development Process can be used as a skeleton or means of organising NPD information. It is easier to operate new projects when team members are informed and understand the process and their role in it. Within such a process, the flexibility to move and change project participation is also enhanced. Although it must be well defined, the NPD should always stay flexible, permitting tailoring to the changing needs of the project's complexity and demands (Jarvis 1999).

5.3.2 Review Board

The Review Board is responsible for evaluating the overall project at critical milestones. Review boards provide a mechanism for managing the process and acts as control levers for management (See also Section 2.1.2 Review board).

The Review Board is also known as the product approval committee, a term which also explicitly indicates their responsibility to approve products. The committee has to decide whether or not the development meets the project evaluation criteria. If it does not, it should be cancelled in order to cut losses and direct the company to rather invest in a more lucrative alternative. Since the information about a new development becomes clearer and more trustworthy as the development progresses, the evaluation is repeated with each phase review.

The review takes place by means of Phase Review meetings, scheduled at milestones throughout the development. The combination of the Review Board and Phase Reviews helps to obtain the perfect balance of involvement from management's side. Hence, the extent to which management interacts with the project resides in the realisation of these two mechanisms, i.e. the approval committee or Review Board and the review meetings.

An NPD project can have a significant impact on a company and business. Hence, senior management including the CEO, normally form part of this committee, which also includes other major stakeholders. Heads of departments that may sit on the core team dedicated to the NPD project should also be included, as they are best informed of the overall project. The Review Board normally meets at the end of each critical phase or whenever a review is scheduled.

The primary objective of the Review Board is to ensure the involvement of management in the NDP process. As discussed previously, the board has certain responsibilities, which will be explained in more detail. These mainly entail the board overseeing the project and ensuring that it stays within determined boundaries and aligns with the overall company goals.

Figure 16 depicts the context of the Review Board in the framework. It highlights the strategic input and role of management in overseeing the project. Also it shows that management's involvement is realised through the use of Phase Reviews.

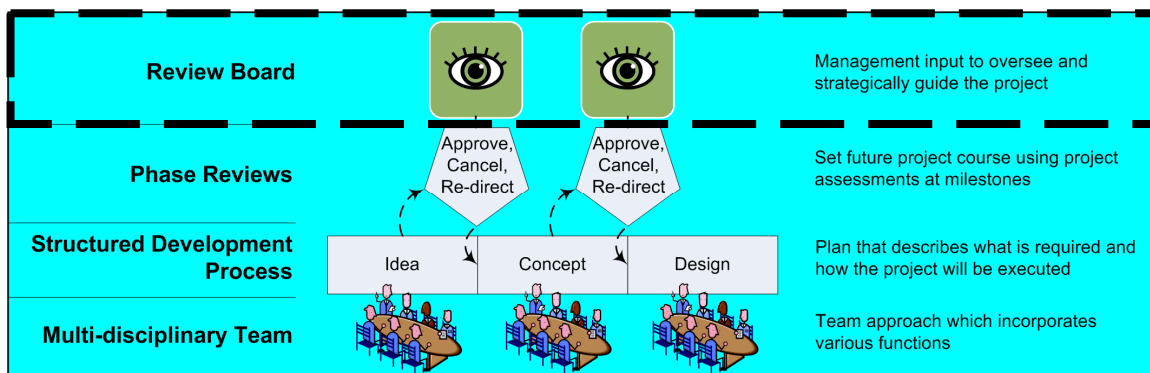


Figure 16 NPD Framework: Review Board

The literature reviewed highlights some important principles that constitute the use of the Review Board. Since members involved in the NPD project represent the Review Board, certain roles of responsibility form part of these principles. The most significant aspects relevant to small businesses include:

- Senior management involvement
- Phase Reviews
- Initiation, approval and prioritisation of new product development projects
- Continuous product approval - Go/No-go decisions
- Allocation of development resources
- Setting project priorities

-
- Project oversight
 - Determining levels and roles of responsibility.

Senior management involvement

The NPD project represents only one process within the overall company context. Hence, NPD projects should be aligned at strategic level. Due to the more basic organisational structures used in smaller companies, strategic synergy is easier to obtain. Typical strategic issues for this aspect have already been identified and listed (See Section 2.1.2 (A checklist of PD strategic factors)) and the involvement of management's strategic governance through the Review Board addresses these matters. Management also play an important role in providing strategy with regard to the NPD projects themselves, in both the long and short term (Griffin 1997). Management has a significant role to play in aligning the NPD projects with the goals of the company. This may involve dealing with instances where a NPD project benefits only the internal processes of the company and is not focused on commercialisation. Finally, the optimal level of interaction between management and project team members should be realised. This determines the input and control that management has on the NPD process to a great extent.

Phase Reviews

The mechanism through which the Review Board acts is Phase Reviews. Phase Reviews are discussed separately as they constitute one of the four critical control mechanisms of the NPD process which describe the first four aspects in the framework (See Section 5.3.4 Phase Reviews).

Initiate, approve and prioritise new product development projects

Very small companies or start-up businesses do not always have a portfolio of new products or developments. Whether or not this is the case, management directs the business to expand and become more profitable. Management, seen as a strategic source of information is in an ideal position to initiate and steer new product development projects. Thus the responsibility to instigate and optimise the NPD portfolio resides within the Review Board. Input from this source not only plays a vital role in the initial screening and evaluation of new projects, but also throughout all development phases.

Continuous product approval - Go/No-go decision

The board has the responsibility to evaluate NPD projects at review points to approve continued development. Should the realised benefit become too risky and unsure, it is critical that the board then cancels a project as early as possible. This exercise of continuous review is repeated until the end of the project is reached taking into account that project information becomes clearer and more detailed towards the end of its lifecycle.

Allocate development resources

In context of the overall business, the Review Board decides on the allocation of resources to the projects under development. Once again, management has an overview of the company and knows when and where specific resources would be most beneficial. If management is not involved, being objective in this regard can be cumbersome which can result in sub-optimisation. The project requires adequate resources to obtain the best product offering, this is therefore an important responsibility (Griffin 1997).

Set project priorities

As already mentioned, the NPD project is not necessarily part of the core business. Therefore the priority it has among other business activities within the company should be managed. Again, it is the Review Board who holds this responsibility. As these decisions also need to be communicated to the rest of the company, the review meeting held with other functional departments forms the ideal interface to diffuse this information.

Project oversight

For management to be well informed, dedicated time needs to be set aside for oversight-related activities. Management needs to have a bird's eye view in order to observe overall project behaviour and progress. Review meetings provide them with the opportunity to enhance their knowledge of the project. Not only do the participating team members provide feedback, but the evaluation of the project using the review criteria also provides information about the project status. Since the Review Board is not involved at a low-level, they possess the ability to observe the behaviour and progress of the project from a wider perspective, which is necessary for the good management of the NPD process.

Determine levels and roles of responsibility

Two factors are of importance. The first is to determine who is in control of the NPD endeavour, i.e. who leads or governs the process. Although management can provide input, normally other people in the company are more involved in the actual execution. The second is the extent to which this control is exercised in the development process. It is necessary to differentiate and understand that the extent of involvement, whether it is management or the executors, is not necessarily related to the amount of control they have. In other words, physical involvement in the project is not usually proportional to authority and should therefore be addressed separately.

A good balance needs to be obtained to maximise project success. If management becomes too involved in low-level detail, thereby over-emphasising their control, progress can be strained. On the other hand, if too little input is given by management and they don't use their authority to control the project, developments can stray beyond permitted boundaries. This and other related consequences of such imbalances have already been discussed (See Section 2.2 Product development process behaviours).

A word of caution by the author is that one should be aware of combining roles of responsibility. Management might take part in the execution of the development in the case of a very small business or entrepreneurial start-up. Due to limited human resources this may be inevitable, however, it poses a risk. Firstly, combined responsibility creates the risk that some responsibilities related to the distinct functional roles could be neglected. Secondly, having responsibility for a function does not necessarily imply proactive involvement in the detailed aspects of the specific function. Thirdly, the person responsible may be biased in fulfilling his obligations.

To conclude, management has an important role to play in NPD. If this role is not well executed, it can be at the expense of the project's success. It is therefore important that management's role is understood in this context, as well as how it should be realised.

5.3.3 Multi-disciplinary Team

Cross-functional teams include representatives of various parts of a business that collaborate to enhance the productivity of the PD endeavour. Hence, teams pursue common goals in contrast to individual interests. Their interaction on a continuous basis facilitates organisational integration and fast and efficient exchange of information (Duhovnik, Grum, Kusar, & Starbek 2004). Cross-functional teams are one of the main control mechanisms of the PD process as already discussed (See Section 2.1.3 Cross-functional team).

Cross-functional teams are composed of various functions within the company structure. A team manager is selected and normally the heads of the various functions represent the rest of the team. Team members may also be external to the company, for example, stakeholders of the supply chain or customers. Team structures reduce the effect of biased individual contributions and responsibility at the cost of product development success. All members of the group are liable for mistakes where there is inadequate decision-making (Duhovnik et al. 2004).

Teams play an important role in speeding up product development. Multi-disciplinary collaboration enables Concurrent Product Development. Hence, product development becomes more integrated across the development and all aspects of the development are considered from the start. Therefore, design and product changes are reduced because problems normally raised during manufacturing can be sorted out beforehand during the design stages. Multi-functional teams nowadays are an integrated best practice and a key factor in NPD processes (Griffin 1997).

Multi-disciplinary Teams are one of the building blocks of concurrent engineering (CE). Concurrent engineering is a well-established concept in NPD and is useful for both smaller and larger companies. The CE approach enables faster execution of the PD process in contrast to sequential engineering (Jones, Forrester, Tang & Nelson 1997). This dated approach implies that the design is passed from department to department as the development progresses. In other words, little interaction and collaboration exist between departments when following this older approach. Teams also help eliminate the so-called “over the wall” approach characteristic of sequential engineering.

Development risks can be reduced within a multi-disciplinary team because collaborative knowledge and experience empower those involved. Through multi-disciplinary input many possibilities can be considered through all stages of development, preferably as early as possible. Also, it provides creative solutions faster in an ever-changing environment and at the same time lowers production and labour costs.

Ideally, PD teams are dedicated to the project and direct themselves. Acting autonomously implies that they have a certain level of control and authority that serves to streamline the execution of the process. The broad knowledge attained through the team structure creates an edge in efficient collaboration.

The advantage of cross-functional teams may be realised already during the initiation phases of the project. During this fuzzy-front-end period, it is beneficial to incorporate as many different views on the situation as possible. This reduces the risks involved and also highlights factors of concern in the development. Once again, this can

become evident at an early stage when only the feasibility study of the development still is underway, thereby limiting risks.

The specific functions represented by the team may vary at different stages of development. However, cross-functional teams form an important control mechanism within the PD process and are used continuously throughout all phases.

Figure 17 illustrates how Multi-disciplinary Teams fit into the framework context. Ideally, a team approach is followed within each phase of development and this structure can change according to project requirements.

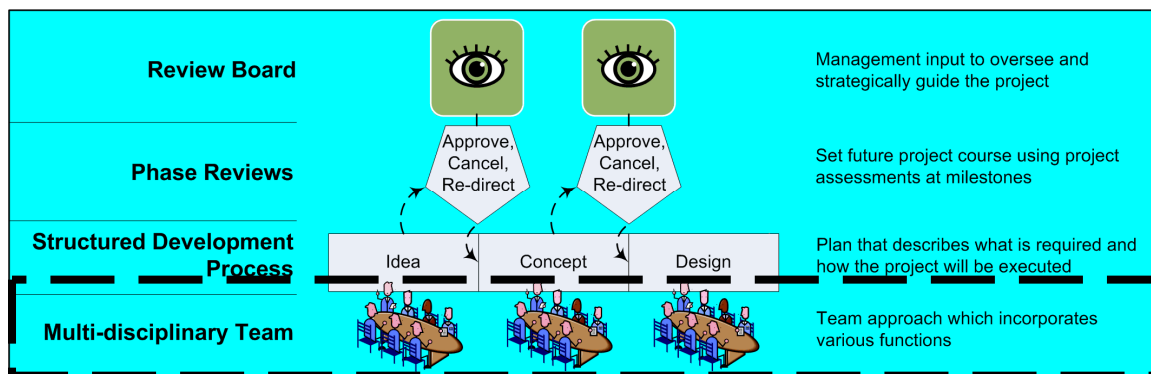


Figure 17 NPD Framework: Multi-disciplinary Team

Key multi-disciplinary aspects that play an important role in NPD success include:

- Multi-disciplinary input
- Early involvement
- Continuous collaboration and interaction
- Supply-chain integration
- Customer representation
- A product or process champion
- Fast, flexible and dynamic teams
- Dedicated team members
- Virtual teams.

Multi-disciplinary input

The motivation and need for adopting a team-based approach should be quite clear by now. However, it would be reasonable to state that, especially in case of start-up businesses, it is not always possible to have a dedicated multi-disciplinary team. In

addition, in very small businesses where the same personnel cover more than one department, the roles of responsibility for each business function still exist. In other words, the same person may represent various functions, as long as all functions are covered in some way or another. This is commonly known as the same role-player wearing different hats (Kahn 2005). Limited knowledge and exposure to NPD requires small businesses to incorporate all possible internal and external skills to participate in the process. This broader perspective provides input that is critical to success in NPD. If neglected, many aspects of NPD would be left untouched only to appear as critical during later stages – many times at great cost. Continuous collaborative interaction should span the lifecycle of the NPD project, i.e. from idea to launch and across post-launch phases as well. Small businesses, in particular, have much to gain in this regard as the approach increases the thinking power of the company.

Early on involvement

The team concept provides a means of bringing together the various aspects of the overall lifecycle, early on, into a group that acts as a single body, combining knowledge and skill to address the same problem. This group liaises on a continuous basis making sure all lifecycle aspects are taken into account at all phases. Also, future critical aspects are identified well in advance.

Continuous collaboration and interaction

A team-based approach also provides an effective means of communication. In effect, this ensures that everybody in the company stays informed of the development, and other overall business activities. This provides the benefit of reducing the need for formal communication methods and processes, e.g., document distribution, meeting room requirements, local area networks, workstation and software requirements, and so on. Reducing this need may benefit small firms. In essence this approach allows fast and efficient exchange of information (Jarvis 1999; Duhovni et al. 2004).

Supply-chain integration

Small businesses may rely much more on supply chain activities, as functions inevitably need to be outsourced to compensate for limited resources. Putting up factories, fulfilling customer orders and setting up a distribution network is not easy to do all within one small company, as this requires time and money. Therefore, collaborating beyond company boundaries may be critical. Creating ways of collaborating with external role players is necessary. The roles that are not filled by internal players may be overcome through supply chain liaising. Such roles in a small

company can include engineers, distributors, marketing, customer services, product support, and so on. Liaising in such a way means that critical supply chain activities are then integrated into the NPD process to optimise stakeholder benefit. Normally long-term relations are a prerequisite in establishing such interaction. In addition, mutual benefit and incentives may be required (Jarvis 1999; Kalyanarum 1999).

Customer representation

Including the Voice of the Customer is critical to the success of any PD project. The most superb way to realise this is through direct customer contact. Direct contact overcomes communication gaps and ensures nothing that is of importance to the customer gets lost through poor indirect customer feedback. This principle is covered in more detail at a later stage (See 5.3.6 Voice of the Customer).

Product or process champion

A product champion is like an entrepreneur who acts as the main driver behind the overall endeavour. A product champion is someone that buys into the development and takes full ownership of the project. This person understands the PD process, knows what it entails and should have good knowledge of the process. Being a natural leader, a champion has the ability to cross hurdles of resistance and motivate people. Also, this person should ideally be energetic, have the support of management and others and be able to envision the final product deliverable. The role of the champion highlights the need for proper training or self-study to increase competency in this regard (Kahn 2005).

Fast, flexible and dynamic teams

In big companies the team composition changes at different stages of the development. This is because various functional inputs are required at different phases. Also, roles and responsibilities change over time. However, a core team that represent all functions on a full-time basis is generally preferred, e.g. to make use of functional departments to fulfil key roles. Small firms have the ability to be more flexible and adapt to changing environments more easily than larger firms. This principle is thus already invoked in the normal composition of small organisations. However, factors such as limited resources constrain small firms' abilities to react responsively to the requirements of NPD. Team members need to understand the process as well, hence informative meetings or training maybe beneficial when taking their autonomous actions into account (Kahn 2005).

Dedicated team members

Research done by Duhovnik et al. (2004) on reducing NDP time, highlights the ideal team structure for NPD in SMEs. Core team members used throughout the project result in good relations, improved communication and decision-making capability (Jarvis 1999). Since there are fewer employees in SMEs, it is not always viable to have dedicated team members. Hence the ideal proposition is that of a matrix structure. The main ideas are as follows:

- Heads from the various business functions represent the core team as a fixed structure.
- Members from the various business functions are employed in the project execution team on a part-time basis and thus still belong to their functional departments.
- The composition of the team members changes as the development progresses through its different phases and is not fixed like the core team. Also, the roles and responsibilities of participation or coordination change over time.

Virtual teams

The dynamics of part-time team members, external members, and so forth create an ideal opportunity to exploit virtual teams. By using internet technology (internet information systems) and similar information technology solutions, effective collaboration can be achieved. Hence, this could be a solution in overcoming the challenges in applying this key principle. Virtual collaboration enables representatives of strategic suppliers and customers who are geographically distributed to use the same tools and techniques as members sitting within the company and vice versa (Duhovnik 2004). Video and conference call applications like Skype and Windows Messenger provide low cost solutions to virtual team meetings. Other applications are also available (See Section 5.3.5 Concurrent product development - Technology related supportive tools).

5.3.4 Phase Reviews

A process wherein phase reviews are deployed is generally termed a stage-gate process. The stage-gate method is a stepwise process through which each significant phase in the product development process is evaluated before going on to the next phase. Management approval is needed to proceed with the next phase of development. This ensures that the development adheres to the necessary requirements before entering the next phase. It is the blueprint for managing the PD process and makes it more effective (Cooper 2007).

According to Crow (2005), two mechanisms have been developed that provide oversight and control to management. Both are used extensively in industry today. The first is gate reviews, which aim to helping management, and the second is technically orientated, referred to as design reviews.

Phase Reviews are a control mechanism needed to realise the role of the Review Board. In other words, the Review Board can only operate effectively should the method of Phase Reviews be implemented. Each review meeting also includes representatives from functional departments. Hence, this also establishes a means through which management and low-level or operational project participants can interact.

A review is scheduled at critical milestones during the development, e.g. at the end of each phase depending on the complexity of the product. If it is a high-risk project and complex product concept that includes various role players external to the company, it is appropriate to schedule more reviews. For low-risk projects, the number of reviews may be reduced. Figure 18 shows three scenarios varying from two to five phase reviews, depending on the type of project (Cooper 2006). Smaller interim reviews can also be held if required.

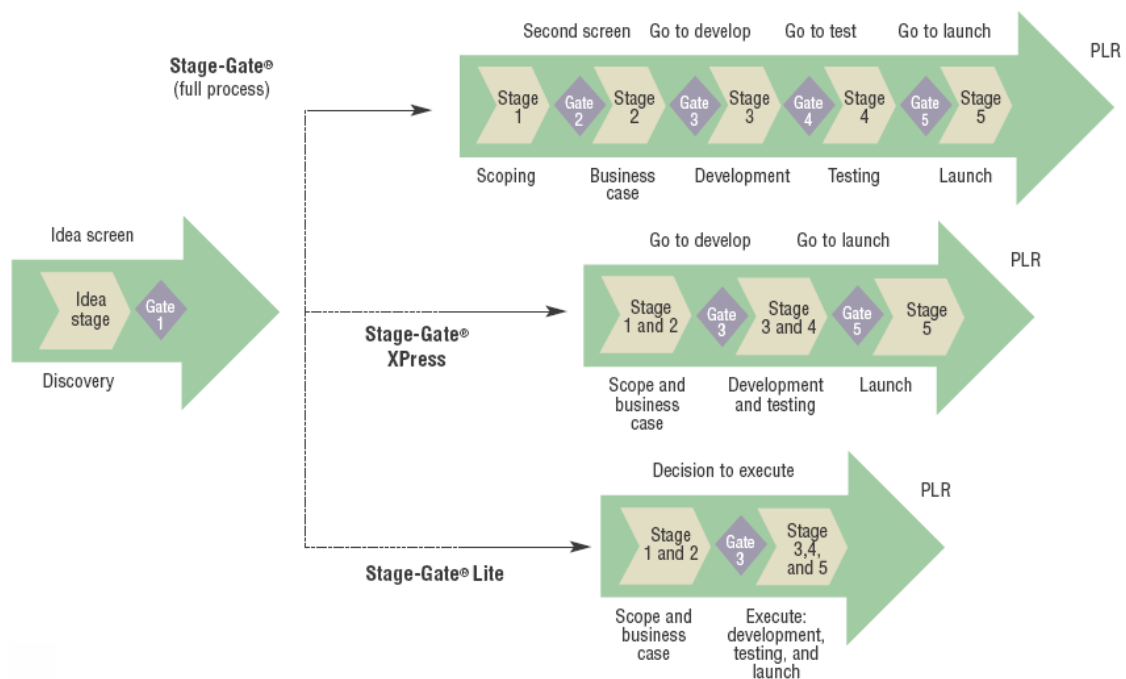


Figure 18 Variations on the stage-gate process

It is important to understand why Phase Reviews are deployed. Phase Reviews play an important role in pacing the product development project. Reviews force the

completion and finalisation of deliverables on a continuous basis. The process of NPD is managed through Phase Reviews. This also is the mechanism through which the company strategy and NPD strategy is synchronised. The NPD process has a significant impact on the rest of the company as well as its lifecycle. Hence, reviews aid in the assessment of this impact, together with preparing and planning contingencies, the changing of plans and mitigating risks. The last important reason for deploying Phase Reviews is to provide an interface between management who determine project cause and deliverables, and the teams who execute the project. In this way, teams are empowered to take on responsibility and realise the full potential of the development, yet still keep to management's set boundaries. Design reviews reduce the overall risk in NPD. (Crow 2005; Cooper 2006; Cooper & Edgett 2007).

Figure 19 highlights the context of Phase Reviews in the framework. A clear interface exists between the Review Board and Structured Development Process. As mentioned, these three aspects help the Multi-disciplinary Teams to execute the projects more autonomously.

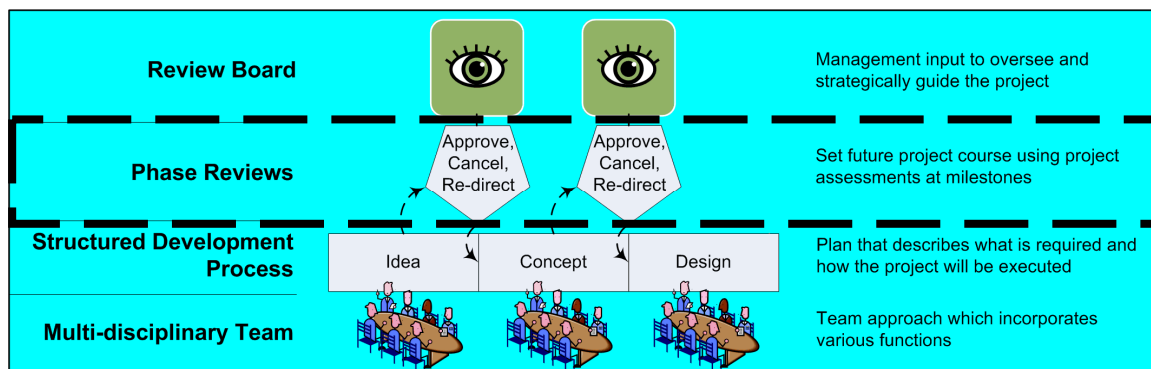


Figure 19 NPD Framework: Phase Reviews

Key principles involved when using Phase Reviews include:

- Establishing review criteria
- Driving other NPD activities
- Project review points
- Strategic input from management
- Phase conclusion and planning
- Setting project course
- Decision-making process for new products and enhancements
- Empowerment of team members
- Establish pressing milestones

- Assessing product lifecycle impact on company
- Project assessment from a functional perspective
- Lean, scalable and adaptable stage-gate process.

Establish review criteria

A partial objective of Phase Reviews is to assess and determine product feasibility and overall project performance. This is done by making use of review criteria relevant to the specific phase. The review criteria assist this process by setting specific hurdles for the development to pass. If these hurdles cannot be passed, further development cannot be approved. Review criteria are required to evaluate and set standards with which the product needs to comply in order to gain continued development support. Without review criteria, the project cannot be properly assessed.

In addition, control criteria play an important role in setting the boundaries of the project. Each phase is normally accompanied by a set of control criteria. The criteria set guidelines for the progress of the project. Management's involvement can remain limited as long as the development stays within these boundaries. Hence, members taking part in the development use these as guidelines to perform autonomous product development and still meet management expectations.

Drives other NPD activities

Phase Reviews mark critical milestones in the NPD process. In order to reach these milestones and proceed with further developments, certain steps need to be completed and finalised. In such a way, the development is paced to deliver and conclude on phases at regular intervals. Since NPD execution extends across a significant period of time, intermediate milestones and project reviews keep the project on track and make it more manageable.

Project review points

At each review an overall glance of the project status is obtained. This is needed to manage the development project sufficiently. Measurable checkpoints facilitate the monitoring of the progress. Review points force the company to look at the project at a high level. It is a potential risk to become too involved in detailed and low-level operations within small companies, however this may be the case where strategic decision makers also form part of the executors of the project. Hence, review points enable start-up companies to keep strategic direction with regard to the project and

the overall company context. Phase Reviews aid reliable decision-making and prevent delays in the development programme.

Strategic input from management

Phase Reviews are the main mechanism through which management participates in the development. A Phase Review meeting is held by the Review Board, which, as discussed earlier, represents the necessary management role players. This involvement provides the link for applying strategy to product development. An NPD process is most valuable when it contributes to overall company strategy (Cooper 1999; Saunders et al. 2002).

Phase conclusion and planning

Checklists are commonly used to make sure that all phase deliverables that are due for review are finalised (Noyen 2007). In order to conclude a phase fully, the deliverables are assessed according to a predetermined set of review criteria. If the criteria are met, the phase is approved and the next one planned. The upcoming phase is then planned by determining the budget, deliverables, planned schedule, tradeoffs and allocating the necessary resources to fulfil the required objectives. Phase conclusion ensures and finalises a milestone in development. Phase planning sets guidelines for the upcoming phase within which the project should progress. This enables employees to act more autonomously.

Set project course

Each review meeting yields a decisive point in the development progress. These are the only points in the development where the overall project performance is assessed. This performance includes updated market research and information gathered during the previous phase, which provides the revised potential of the project. Based on this assessment, a firm decision about the future direction of the project can be reached. This decision will determine whether the development moves forward as is or needs to be re-directed. In cases where the review yields challenges that are too hard to overcome, the project should be cancelled in order to cut losses and stop further investment.

Decision-making process for new products and enhancements

Phase Reviews are built into the structured development plan. They provide a clear and consistent process for making major decisions about new products and

enhancements and thus support the use of a well-defined NPD process. The use of the NPD process must be company-wide as it accounts for the process of stimulating innovation, bringing the ideas to light and introducing it to further development actions (Peters et al. 1999).

Empowerment of team members

Phase Reviews empower the employees executing the development by setting the guidelines that determine the project boundaries. While the project stays within these boundaries the core team can perform autonomously, and the role of management can be limited to review meetings.

Establish pressing milestones

By setting reasonable goals through Phase Reviews for the upcoming review, the development can be paced to increase productivity and efficiency. Also, extended goals running over extensive periods appear more manageable, as Phase Reviews emphasise shorter-term goals. In effect the process is simplified. In the case of small business where little prior NPD knowledge and skills exist, this can reduce risks and increase the likelihood of success.

Assess product lifecycle impact on company

The product development endeavour may be owned by one or more companies. The development is the responsibility of the company to which it belongs; hence it provides the context and overall environment in which it is executed. Each phase of the product development lifecycle impacts the current and future status of the company. The inverse of this is also true. External factors influence the company and so do internal processes other than NPD. This results in a dynamic environment that changes continuously. Review meetings provide the opportunity to assess this impact and plan accordingly. Synergy and alignment of the NPD activities and overall company activities are necessary. Through lifecycle contingency planning, the adverse impacts of NPD and the company can be managed advantageously (Noyen 2004).

Project assessment from a functional perspective

Phase Reviews evaluate the overall project performance at intermediary stages. Hence, an overview of the progress is obtained and the project is assessed to make sure all necessary aspects are taken into account. The challenge of the same

employee representing more than one business function in small companies can be addressed in this way. In effect, reviews provide a review point where a project can be assessed from various perspectives as required.

A review meeting presents an opportunity to look at the NPD project from the perspective of each business function. This may also include the involvement of external suppliers as adept representatives. The Structured Development Process plan outlines the involvement of each function typically by means of a four-field map. Hence, with the review the evaluation criteria should enable project performance assessment with respect to each business function and external participation.

Lean, scalable and adaptable stage-gate process

Cooper (2006) highlights this principle and claims that it is used by up to seventy percent of highly productive businesses and by some forty percent of low productivity businesses. This principle was identified through an APQC (American Productivity & Quality Center) best-practice study as one of seven NPD principles common to high productivity businesses. The logic behind this principle shows that the process approach that should be followed is dependent on the type of NPD project. Projects differ vastly, based on the product's complexity, type, technology used, whether it is an improvement or new product line, as well as other factors. Cooper (2006) states that too many NPD processes follow rigid procedures and demand too much paperwork, forms, meetings and committees - too many activities do not add value but strain progress. Once again, this highlights the importance of consciously thinking about the NPD process and managing it accordingly. The NPD process should only include the necessary activities and nothing more; it should be scalable to accommodate both basic and extensive projects and at the same time should be adaptable to internal and external business demands (Cooper 2006).

General comments

The NPD funnel approach of phasing out less convincing projects is realised through reviews. Mediocre projects eat up development resources. Cancelled projects make way for the development of more promising new product concepts (Cooper & Edgett 2007).

A well-structured and established phase-gate process does not result in sudden stoppages during the development, as can be the case with an ill-defined NPD process. In the case of a review, the latter causes a halt in the development. However, this increases development time. In contrast, with a well-disciplined review

process, preparing for and conducting the review runs parallel to the development and this thus shortens development time.

Another benefit of having Phase Reviews is that they ensure that new products are actually approved for development. If products are not approved, the likelihood of cancelling a project later during development when challenges arise, are low. Hence, this leads to a sub-optimal product portfolio.

Finally, achieving balanced management involvement in the process is crucial for optimising success.

5.3.5 Concurrent product development

Nowadays markets are driven by the wishes and demands of the customer. Products with the best performance, features and quality earn the most customer attention. Hence, products that are not developed with this in mind struggle to succeed in the market and need to take second place. Also, products not conforming to competitive pricing and that are too expensive or those that enter the market too late tend to follow the same path. Concurrent product development (CPD) is a practice used to counter these pitfalls of NPD. Specifically, CPD aims at reducing the development time of new product developments, better incorporating the voice of the customer and reducing the cost of NPD (Duhovnik et al. 2004; Grum & Starbek 2002; Kalyanaram 1999).

Concurrent product development is also known as concurrent engineering, simultaneous engineering or similarly integrated product development. Since CE seems to limit the use of this approach to engineering activities (although it actually applies to the overall PD process) the term concurrent product development has been adopted (Chowdhury et al. 2002; Duhovnik et al. 2004; Kalyanaram 1999). It takes into account all aspects of the NPD process from start to finish. Therefore, the use of this approach incorporates the participation of many departments and teams, internal as well as external (suppliers and clients or users of the product). The role of project managers also becomes a great deal more to the fore.

Concurrent engineering is defined as taking into account all aspects of the product lifecycle from the outset of the development. In addition, this also includes aspects of quality, cost, project schedules and user requirements (Jarvis 1999). The CPD methodology concentrates on the process of NPD and how to manage the process efficiently to bring about the most effective and desired product offering. Research highlights that both the academic literature and practitioners agree on the potential benefit of this approach (Gosling & Maylor 1998). All in all, this provides sufficient reason to investigate and discuss this PD practice.

Inevitably, the use of this approach spreads further than just NPD process related activities. The CPD methodology ideally needs to form part of the company's culture

to be effective. Specifically, for companies not used to team-based approaches in product development, this can cause a great deal of resistance. The reason for this is that part of the essence of CPD lies within the integration of employee knowledge throughout the firm, even those who are not always directly involved in the NPD process. Hence, changes and functional participation can provide the greatest deal of resistance. In short, the impact of CPD is company-wide and may even affect parties external to the company, e.g. suppliers and customers (Gosling & Maylor 1998).

The basics of the CPD methodology originated from a shift in sequential NPD to activities being executed in parallel. Past practices involved the sequential execution of lifecycle phases. This approach is known as sequential engineering (SE). Within sequential engineering the phases of the NPD process follow a sequential pattern and hence are executed one at a time. Also, no new phase can start before the previous one is finished. This approach has also become known as "over the wall engineering", as the development is blindly thrown to the next department after one department has finished its responsibilities. CPD is aimed at exactly the opposite. Inter-departmental interaction is essential, as well as the concurrent execution of activities using a collaborative approach.

The concurrent approach of CPD is shown in Figure 20 (Duhvonik et al. 2004). Unlike sequential engineering, there is interaction among individual phases of the development process. The figure also shows the use of the so-called track-and-loop approach, which was developed specifically to enhance the interaction between activities. The logic behind the loop procedure is that activities are interdependent; hence each activity relies on knowledge generated from other activities as well. Since activities run in parallel, various activities grow in knowledge over time, which in turn has to be integrated into other activities. Therefore, the loops are designed so that the output of a specific activity is used as input to update along-going activities. This procedure ensures interaction between all the activities and keeps related activities up to date with all the necessary information. The same basic approach is used to constantly test the development of the product with the customer (Duhvonik et al. 2004; Cooper 2006; Kahn 2005).

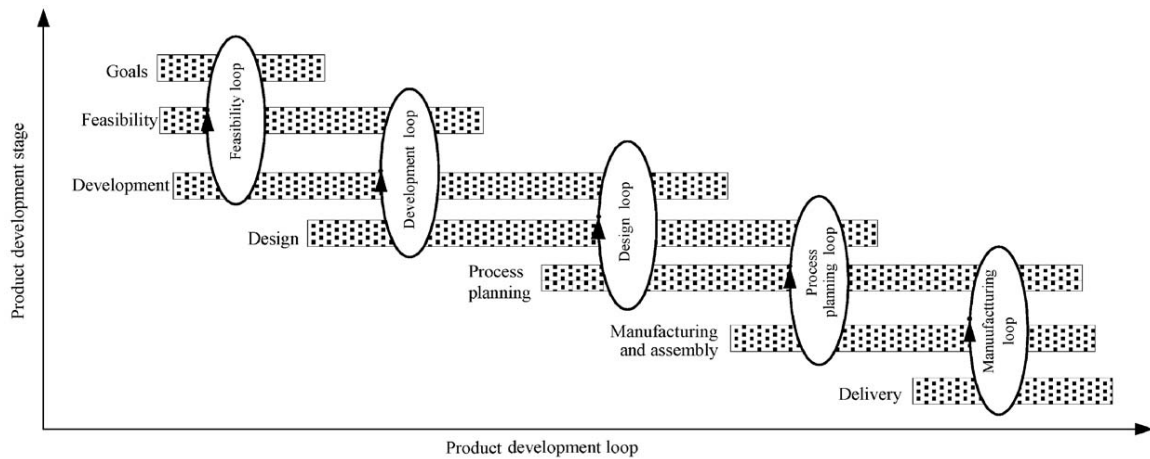


Figure 20 Track and loop approach in CPD

5.3.5.1 Time-to-market

The reality is that product lifecycles are shortening and so are development cycles. Products become obsolete much faster due to changing markets and technologies. The challenge of producing products faster is becoming more important than ever. Time-to-market is now identified as a key source of competitive advantage in markets (Kalyanaram 1999).

The advantage in the marketplace belongs to companies that can shorten cycle times in order to arrive at markets earlier. The benefits of reaching the market earlier involve obtaining a greater market share, increased product variety, premium prices and lower costs, to mention a few (Kalyanaram 1999).

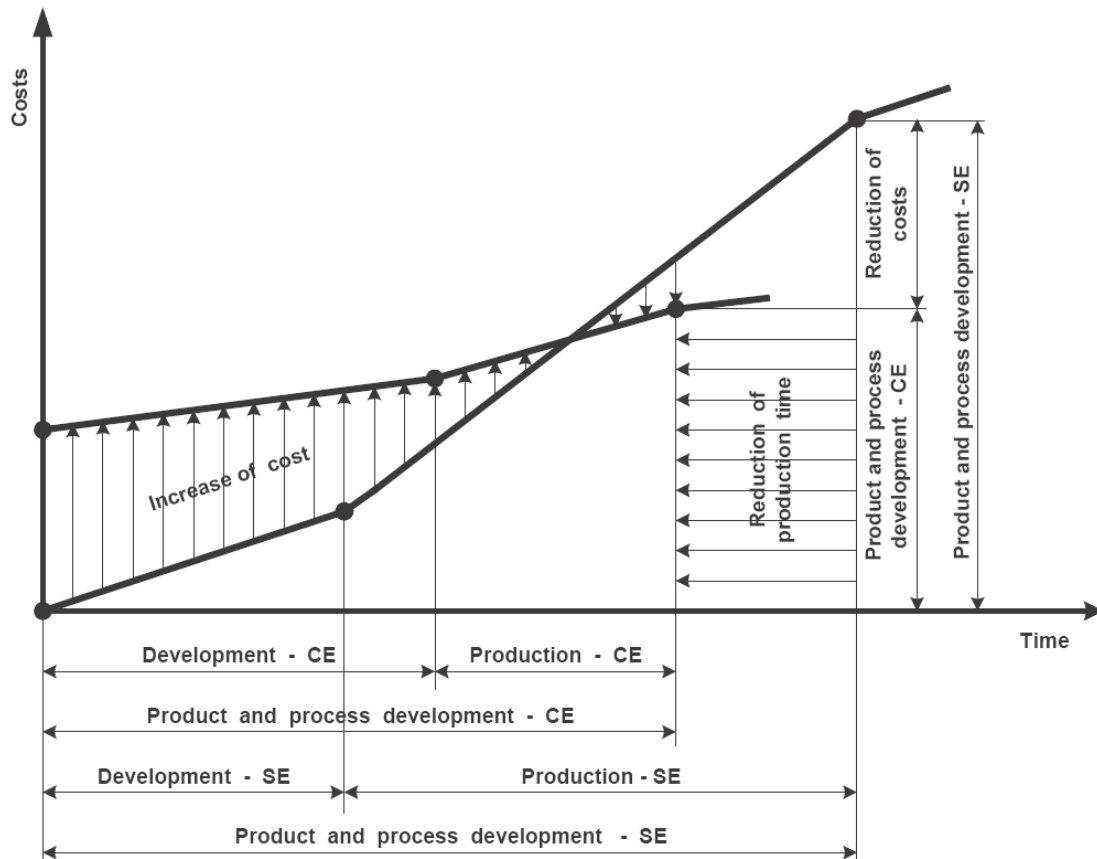


Figure 21 Costs of sequential and concurrent product and process development

The benefit in cost reduction and reduced cycle time is shown in Figure 21 (Gosling & Maylor 1998). The figure displays the difference between concurrent engineering or CPD and traditional sequential engineering. Firstly, CE requires greater investment during initial stages. This is the net effect of executing activities in parallel from the start, opposed to a gradual increase when executing them one at a time. Also a greater effort is put into the development stages. The benefit of greater commitment upfront is realised only later in the product's lifecycle. The second benefit of CE is cycle time reduction. This is clearly shown as the production time of CE is cycle time reduction. This is clearly shown as the production time of SE exceeds that of CE. The author would like to point out the difference between development and production times with respect to CE and SE. The greater and extended effort put into CE development phases pays off with a significant reduction in production process development time towards the end. The outcome of CE is thus a total reduction in the product and process development cycle.

Another reason why the CPD approach requires more investment during initial phases is illustrated in Figure 22 (Dimitrov 2006). The figure shows two important aspects of NPD. The first is indicated by the "cost committed" curve. This curve

indicates the rate at which costs are allocated or assigned to the product's lifecycle. The result of an evolving project is committed costs. Decisions tie the project outcome down thereby committing expenditure to the project. It is important to note that the initial stages of development contribute most to committed costs. On the other hand, the "cost incurred" curve is a representation of how costs are actually expended during the development's lifecycle.

The second important curve is the "ease of change", which indicates the flexibility of the development with regard to possible changes as the development progresses. The impact of product changes increases quite rapidly after the finalisation of the concept. This impact can be translated to cost, increased development time, additional resource requirements as well as the market, suppliers and customers. Hence, this declares the reason why the SE approach results in a much higher lifecycle cost; too much activity is extended towards the end of development when alterations should be limited. In contrast, CE addresses this and commences with more thorough work during initial stages of the lifecycle.

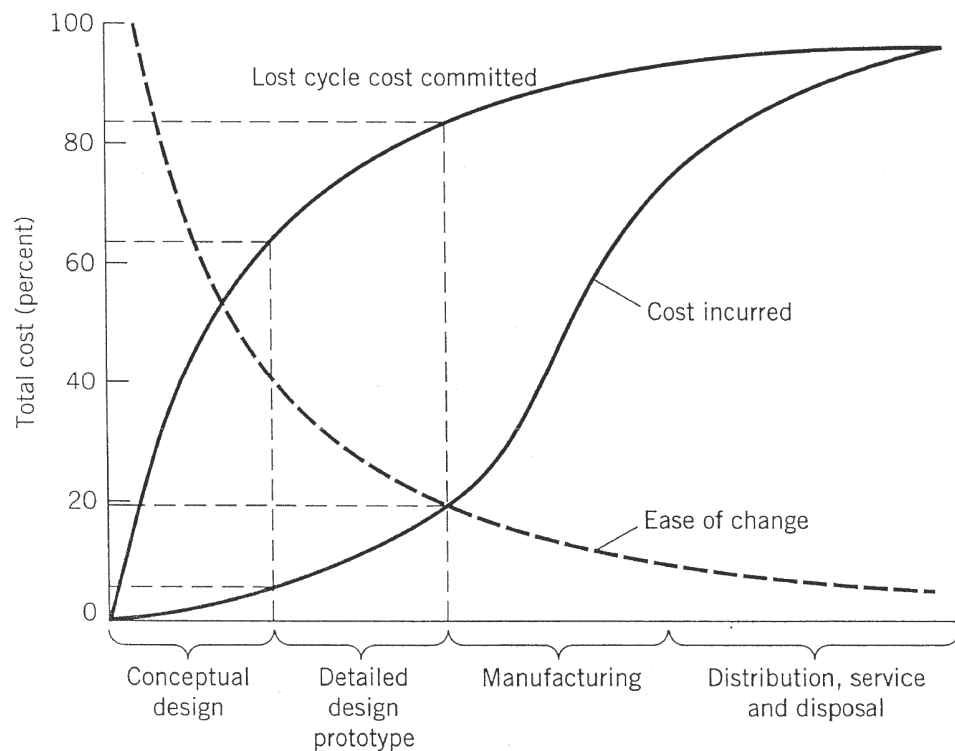


Figure 22 Product lifecycle cost and ease of change curve

By following the discussion of these aspects, the importance of deliberately providing more resources to initial stages of development becomes clear. It also signifies the ability of the CE approach to provide a noteworthy advantage in NPD.

Time-to-market is important. However, one should be careful to remember that the main objective of NPD is to earn significant profit from a good product. Reduced development time is an interim objective and should not be realised at the cost of the product's success. Thus, time-to-market is important but quality of execution, which brings about the product, is even more so (Kahn 2005).

Over and above the benefits related to time-to-market, CPD provides definite benefits with regard to customer satisfaction and other aspects. In a study done by Gosling and Maylor (1998), feedback from a survey was obtained which presented the average benefit gained through using CPD. The results are shown in Table 2. The table depicts a broad range of direct and indirect benefits. It is evident that industry feedback consistently supports the use of CPD as it has many advantages to the company as a whole and not only the NPD process. Ratings follow a 0 to 10 scale – 0 being “no benefit”, 10 being “significant levels of benefit obtained”.

Benefit	Average level of benefit obtained
<u>Direct benefit</u>	
Product meets customer needs	7.19
Time-to-market	7.00
Improved product quality	6.88
Product right first time	6.36
Increased market share	5.90
Lower product costs	5.77
Improved serviceability	5.55
Increased product performance	5.20
Longer product life	3.55
<u>Indirect benefit</u>	
Improved manufacturability	6.62
Lower product overhead costs	5.44
Fewer change requests	5.29
Reduced development costs	4.93
Reduced part count	4.83

Table 2 Benefits of CPD

5.3.5.2 Incorporating the Voice of the Customer

The product is developed for the customer, hence it would be ideal if the customers could develop the product themselves, or at least provide the knowledge for development. The best solution to this is to obtain the greatest amount of knowledge possible that will translate the customer's ideal to the NPD process.

Obviously this is not an easy task, but rather cumbersome and comes at no reasonable cost. Taking into account the trade-off between NPD activities and the fact that a resource crisis will occur at some stage, it is a challenge to optimise the process to include the customer aspect (Jarvis 1999). Incorporating the customer's voice is a core activity of Concurrent Product Development and carries significant importance (Jarvis 1999; Trygg 1993; Grum & Starbek 2002). However, the value of this is often not realised since the majority of firms still lack a strong market orientation (Kahn 2005). Figure 23 marks the role of CPD as an additional aspect in the framework. Although this approach inherits principles from the first four aspects, it does not necessarily have a direct interface with the former.

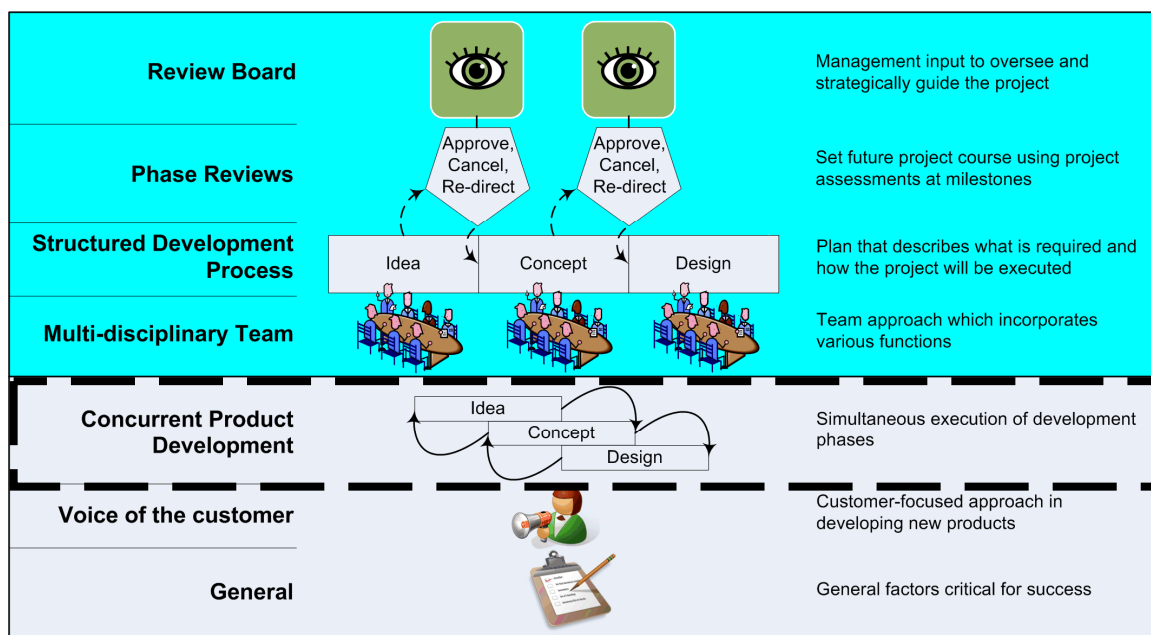


Figure 23 NPD Framework: Concurrent Product Development

5.3.5.3 Key principles

Next follow the key principles identified for CPD which are drawn from best practices within the NPD domain:

- Activities run in parallel
- Updating and knowledge sharing among concurrent activities
- Stability in product specifications
- Team members have regular meetings which allow fast and efficient exchange of information
- Teams take on responsibility

-
- Cross-functional teams
 - Incorporate the Voice of the Customer
 - Supplier integration and outsourcing
 - Technology related supportive tools
 - Higher investment upfront.

Activities run in parallel

The basics of CPD are to execute development activities concurrently. This is done even though a task may seem to require knowledge from another task that is not yet completed. In other words, feasibility studies, conceptualisation and design activities can start simultaneously. Doing this effectively will result in a reduction of cost and reduced development time. Hence, the product will reach the market faster, which can yield financial benefit. Small firms, especially start-ups, normally take a plunge due to the period of little or no income prior to product launch. One has to keep in mind the product has to cross the so-called chasm in the market before it booms. This period holds significant risk for a company and it is basically impossible to predict the market and determine the time it will take to pass. The sooner the product hits the market, the lower the risk and the sooner income is generated. In order to deploy concurrent execution of activities, early involvement of the project team members is thus required.

Updating and sharing knowledge among concurrent activities

Since CPD executes activities in parallel some activities that depend on others for support, may start before they have all the required information. The so-called track-and-loop approach can then be used to consistently integrate parallel activities. This iterative process forces activities that are already underway to obtain updated and new information from related activities. In this way, all activities are kept up to date with the latest development information as the project progresses. This approach also enforces the collaborative activity within CPD, which plays a critical role in enhancing the performance and quality of the final product offering to the customer.

Stability in product specifications

The dynamics of executing activities in parallel, using cross-functional representatives and relying on collaborative working requires that product specifications are kept well-defined at all times. Cooper states that two of the most

time-wasting factors in NPD projects are "project scope creep" and unstable specifications (Kahn 2005). Therefore, a critical success factor in NPD is having accurate, early and stable definitions and specifications for the project and products.

Team members have regular meetings that facilitate the fast and efficient exchange of information

This aspect was covered earlier when cross-functional teams were discussed, with reference to work done by Duhovnik et al. (2004) and Jarvis (1999). See Section 5.3.3 Multi-disciplinary Team (Continuous collaboration and interaction).

Teams take on responsibility

No individual member is solely responsible for the NPD endeavour. The CPD approach emphasises the responsibility of the team as a whole, as this reduces the potential blame on individuals and general company politics. If the project is a success the whole team takes credit; if not, the whole team is held liable and must correct their mistakes. This feature of the team approach may also increase general morale and motivation.

Cross-functional teams

Cross-functional teams are critical and form the basis of successful CPD (Jarvis 1999; Trygg 1993). This aspect of CPD is so significant that it is seen as a major distinguishing aspect of NPD frameworks, and is therefore discussed separately in Section 5.3.3 (Multi-disciplinary Team). Cross-functional teams have the ability to exploit "hidden knowledge" in a company as it integrates representatives from all aspects of business in the development process (Gosling & Maylor 1998). For small businesses that have to rely on limited knowledge and skills, this can be extremely beneficial.

Incorporating the Voice of the Customer

Concurrent product development also considers the integration of customer requirements as a critical success factor in NPD (Jarvis 1999; Trygg 1993). Both small and large firms need to consider how the voice of the customer will be built into the NPD endeavour. This aspect is also so important that it receives special attention as a separate section further on (See Section 5.3.6 Voice of the Customer).

Supplier integration and outsourcing

The principles of CPD enable companies to integrate the voice of the suppliers and other members of the supply chain better than other approaches. The limited capability of a small firm also makes them dependent on outsourcing strategies and here too, CPD strengthens this capability of the firm and enhances supplier involvement (See Section 5.3.3 Multi-disciplinary Team (Supply chain integration)) (Kalyanaram 1999).

Technology related supportive tools

The success of Concurrent Product Development may be improved by using technology related tools and software (Trygg 1993). Many of these are expensive as they include software packages, CAD, CAM, CAE and CASE tools. However, technological solutions provide unique virtual ways of implementing, testing or simulating prototypes of the product. This reduces time and costs, as physical prototyping and testing are not required. Examples may include event simulation, 3D rapid prototyping, simulation of manufacturing processes and many more. The use of these tools can significantly reduce development time and cost for small firms who are constrained by resources.

An important tool in CPD is a centralised source of information normally, driven by a computer network. This is relatively inexpensive and makes a single common source of information readily available to all participating parties. Internet-based collaborative platforms can also be used to share information with external suppliers and drive virtual PD. Virtual network computing applications like RealVNC and Microsoft's Remote Desktop enable users to view and work on a computer from any location in the world via an internet connection. These are often included in standard software packages or are obtainable at little extra cost. Other solutions include platforms like TeamCenter from SIEMENS UGS, which was developed for small business environments. In terms of collaborative product management, these technological options present more advanced solutions.

Higher investment upfront

For the successful exploitation of the CE approach and in contrast to traditional developments, greater resource commitments are required during the initial stages of development. For small companies this might not seem plausible. However, the principle of CPD is well supported and has been proven in industry over many

years (Trygg 1993; Duhovnik et al. 2004; Kahn 2005). The main reasons for this increased upfront commitment are:

- Parallel execution of activities require more resources than usual
- Total development is compressed into a shorter time span
- Solid upfront homework is a key best practice in NPD and requires additional resources.

Finally, the benefits of achieving rapid time-to-market as a result of CE usually outweigh the cost of the increased level of resource commitments during initial development phases (Jarvis 1999).

5.3.5.4 Summary

To conclude this discussion on CPD, the author comments on the overall feasibility of implementing CPD in small companies. The use of CPD in small firms was investigated and the literature available confirms its positive outcomes (Jarvis 1999; Kalyanaram 1999). Gosling and Maylor (1998) specifically point out that the small size of a firm is not a significant success factor in CPD, and when considering the key principles constituting CPD, it is clear that this approach does not necessarily require significant additional investment. CPD also includes many of the other key principles identified. In contrast to a costly enterprise-wide implementation to enhance the NPD process, CPD's success revolves instead around its distinct approach to NPD. It should therefore be incorporated into the general and permanent company culture rather than be considered as an application tool to be used when needed (Kennard 1991).

5.3.6 Voice of the Customer

Incorporating the customer's voice has a clear goal - to determine what the true needs, wishes and requirements of the client (Jarvis 1999; Grum & Starbek 2002). This fits in with NPD processes, which have a strong market orientation; hence this aspect is driven by the market and is focused on the customer.

These days' customers take great care in selecting products. Users have been exposed to too many marketing gimmicks in the past; hence quality products that are designed with the customer in mind are beginning to differentiate themselves with a resulting competitive advantage (Found, Francis & Hines 2006). A strong customer focus thus will improve product success rates and profitability. In addition to this, it also reduces time-to-market (Kahn 2005; Cooper 1999).

A key question here is what the best time is to concentrate on this important aspect. Forty to sixty percent of low and high productivity businesses respectively conduct a lot of upfront homework, even before development begins, although this is not where

customer focus stops, as a strong market orientation should form an integral part of the entire development process (Kahn 2005). Every stage of the development process should include a conscious commitment to hearing the customer's voice (Strategic Direction 2007; Carbonell-Foulquié et al. 2004).

In order to practise this principle, firms have to include this approach in their NPD process. However, this activity takes up resources and requires a dedicated effort. Fortunately, a tool has been developed that has been used widely for many years now and that goes hand-in-hand with CE. Quality Function Deployment (QFD) originated from Japanese product development practices some 30 years ago. Together with CE, this was ranked in the five most used tools and methodologies, with CE ranking second and QFD fifth in the PDMA's Comparative Performance Assessment Study, 2003 (Kahn 2005). The QFD tool is easy to use and provides a means of transforming the customer's needs into the design specifications of the product (Kahn 2005; Duhovnik et al. 2004; Kalyanaram 1999; Kennard 1991).

In addition, there are many common techniques that can be used to get customer input, including focus groups, market-based concept testing, preference tests, trials, well-targeted market launches, lead users, web-based tools, ethnography and direct interviews with customers (Cooper 1999; Kahn 2005).

Also, incorporating the Voice of the Customer is an integrated principle of CPD, although it has been discussed separately. The basic principles of CPD contribute to incorporating the customer's voice into the NPD process.

Figure 24 relates to this, the second last aspect that enhances product development capability of the framework.

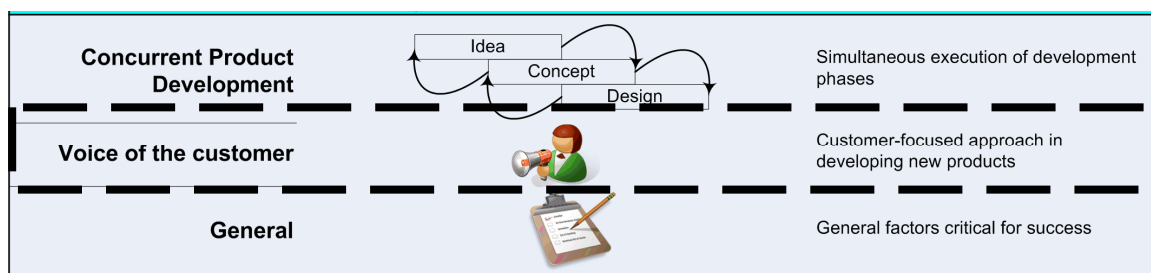


Figure 24 NPD Framework: Voice of the Customer

Next follows the key principles of best practices within the NPD domain:

- Strong market orientation - Market driven and customer focused
- Quality Function Deployment
- Direct customer interaction

- Customer focus in each phase of development
- Market research tools and methodologies.

Strong market orientation - Market driven and customer focused

An NPD process that is orientated towards the market reveals two traits: the process is driven by the market and has a strong focus on the customer. (Kahn 2005). A market-driven approach investigates the competitive situation and nature of the market. Failing to undertake a market assessment has led to many PD failures. Taking into account the nature of the market can increase the lifecycle of the product and make it more sustainable. For product success in the market, the specific customer must have been identified and understood. Whatever the case, strong customer-centric culture and the setting up of customer feedback and satisfaction loops are always necessary (Kahn 2005; Gordon et al. 2006; Strategic Direction 2007).

Quality Function Deployment

Gosling and Maylor's research (1998) highlights the benefit of CPD associated with the use of quality function deployment (QFD). QFD is a technique used that places specific emphasis on the customer's needs and requirements. QFD is a well-established technique that can be adopted by most small firms. Information is readily available on this topic and it does not require significant knowledge and skill to use this technique. QFD is a systematic process that deals with issues such as what exactly will satisfy the customer, how this compares with to the offerings of the competition and how the process can ensure it will meet the demands of the customer (Kennard 1991). A properly executed QFD will leave no stone unturned in these areas. Obviously the quality of the information that is used as input will determine the value and usefulness of the final result.

Direct customer interaction

When focusing on the customer, the more direct the interaction, the more beneficial the results will be. This has especially been proven by Japanese businesses that literally organise interactive sessions between clients and the development members. The information is thus received firsthand. An alternative method is to use salespeople to obtain valuable user feedback. Direct contact with the customer and the particular social or physical environment in which the product is going to be used may provide significant insight and benefit. Direct contact also helps to overcome communication gaps and ensures that nothing that is of importance to the customer is

lost through poor indirect customer feedback methods (Kennard 1991; Farneti, Hassan, Johnson, Mullins, & Zott 2007; Strategic Direction 2007).

Customer focus in each phase of development

The role of customer-orientated NPD is so significant that researchers highlight it as an essential element that should be consciously built into each phase of development (Strategic Direction 2007; Carbonell-Foulquié et al. 2004; Cooper 2006). This especially pertains to small firms who do not necessarily have the services of customer representatives on a continuous basis as part of a development team. Hence, part of the execution plan should include activities that will meet this fundamental requirement within each phase. A process proposed is to use the iterative track-and-loop principle or spiral development, both of which constantly check product performance against the customer or users' requirements (Kahn 2005; Duhovnik et al 2004; Cooper 2006).

Market research tools and methodologies

Next follows a list of the 15 most-used market research tools and methodologies based on results obtained from the PDMA's Comparative Performance Assessment Study of 2003 (Kahn 2005). These tools may be used to incorporate the Voice of the Customer at any phase of the development:

- Beta testing: Tests of working models by users
- Customer site visits: Observe and interview them at their workplaces
- Voice of the customer: In-depth personal interviews
- Alpha testing: Early tests with users
- Focus groups: Interview as a group for user needs
- Concept tests: Customer evaluation of concept statements
- Lead users: Analysis and/or inclusion
- Gamma testing: Testing with the ideal product
- Ethnography: Observe customers and their environment for needs
- Test markets
- Concept engineering: Formal method for concept development
- Trade-off analysis: Conjoint, discrete choice modelling - optimise product characteristics

- Pre-test markets: Estimate sales potential of products based on consumer research and collective data
- Creativity sessions: Professionally facilitated
- Web-based versions of these tools.

Many of these are low-cost, easy-to-use principles that are well suited to small businesses. Making use of these proven tools may increase the efficiency and effectiveness with which market research is completed.

5.3.7 General

This section includes some general key aspects of successful new product development that do not belong to specific frameworks or methodologies but originate from practical experience and have been documented. Cooper (1999), in particular, lists success factors that pertain to the internal process of NPD that provide a perfect fit to complement the framework presented in this study. Nearly half of the factors mentioned in Cooper’s study as crucial, are already included in the framework. A discussion of the additional key success factors and how they relate to the small business environment now follows.

Figure 25 once again depicts the framework as a whole, highlighting some of the General aspects that are also considered critical success factors in product development, but that do not fit neatly into any of the previous aspects. Hence, they are included as General aspects.

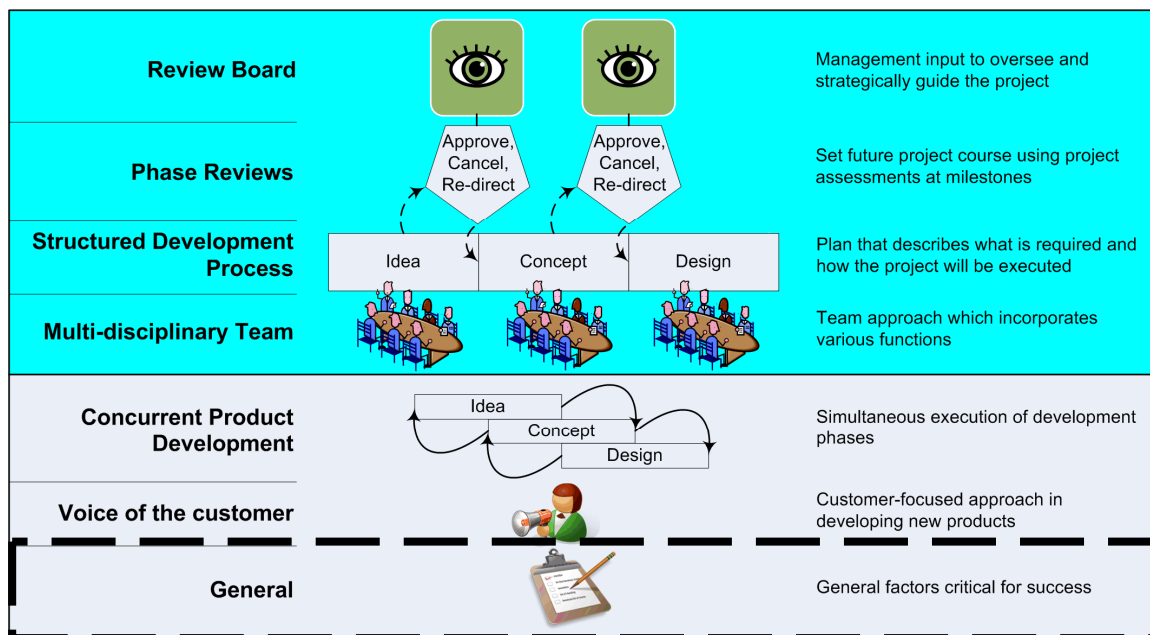


Figure 25 NPD Framework: General factors critical for success

General aspects that play an important role in NPD success include:

- Commit to heavy upfront homework
- Seeking differentiated superior products
- Planning and resourcing the market launch early in development
- Incorporate tough gates in the stage-gate process
- Build in an international orientation into new products
- Acquiring the necessary process knowledge and skills
- Executing the process thoroughly as required
- Deployment of the optimal process

A commitment to heavy upfront homework

This principle relates to the approach followed in Concurrent Product Development, which, as discussed earlier, also requires greater resource investment upfront. Companies allow new ideas to proceed to development without thorough investigation, as they may be concerned about putting too much effort into upfront homework, assuming it to be a waste of money and time. In contrast, research reveals that upfront homework is significantly correlated with a positive impact on and profitability of companies' NPD efforts (Cooper 1995 & 1999). Upfront homework requires more time, money and quality work, but the benefit of solid upfront work is well supported by research and has been shown to contribute to new product success, resulting in a better NPD process, reduced time-to-market and increased financial performance (Cooper 1995, 1998, 1999). As small companies and start-ups often rely on the roll-out of only one product at a time, the importance of applying this principle cannot be stressed enough.

Seek differentiated superior products

This key principle might seem to be more market related. However, the NPD process and strategy determines which product concepts are generated and accepted for further development. As part of this, the search for differentiated superior products should be incorporated as a key criterion during product screening. This requires stringent gates in the stage-gate review process, but this top success factor will ensure a well-differentiated product with unique customer benefits and superior value for the user (Cooper 1995 & 1999). This then provides a competitive advantage to the company's products, although the customers are motivated by seeking their own benefits. A differentiated superior product has been shown to be a major driver of

NPD success (Cooper 1994) and the NPD process should therefore strive to incorporate this factor.

Planning and resourcing the market launch early in development

The launch of the new product is its entry to the market. Research shows that firms considered as new product winners commit twice as many resources to the product launch as those who fail in their NPD effort (Cooper 1999). In the generic model for product development in small firms, the launch is included as part of the NPD process (Peters et al. 1999). As a great deal of knowledge is generated during the design and development process, this should be exploited to maximise the impact of the launch. The launch should be thoroughly planned and resourced as it is regarded as a critical success factor for NPD, but is one which many firms disregard (Cooper 1999).

Incorporate tough gates in the stage-gate process

The stage-gate process should play a definite role in filtering out less-promising projects. Cooper notes that there is a significant correlation between the new products' profits and tough go/no-go decision points (Cooper 1995). Cooper also states that this is generally the weakest aspect of all process factors, and this leads to unsuitable projects being accepted and scarce resources being wasted. Once a project has been started, the chances of it being stopped are marginal. To counter this problem, the firm has to make use of stringent gates and corresponding tough criteria to evaluate the new projects that have been identified. In addition, ideas should be screened, and a pre-development business analysis and pre-commercialisation analysis completed (Cooper 1999). For many start-up companies, only one product with possible variations is at stake. However, throughout this study the need to commercialise products has been emphasized. Bearing this in mind and realising the resource investment required, it should be obvious that a really lucrative product is required if the lifecycle expenditure in new product development is to be adequately covered. This product income must be substantial, as it will also need to fund projects that do not yield income or those that will be cancelled prior to launch.

Build in an international orientation into new products

For small business start-ups aiming to fulfil a need in a domestic market it might initially be hard to imagine prospects beyond local boundaries. Globalisation is however a common phenomenon now and with the exception of high standards in some first world countries, trading on international markets is becoming easier. An international focus conceptualises a global product or variants of the same product for

global users and markets. Developing such products requires a thorough understanding of global users and markets. In turn, this requires international member representation on cross-functional teams to gain the necessary market and user input for design and development. It is also important that the design of the product takes international standards and requirements into account and not only domestic ones. To realise an international orientation, more upfront homework and greater commitment to the initial development phases is required. Once again, it is more difficult and costly to make the product compliant if later modifications have to be made (See Figure 22 Product lifecycle cost and ease of change curve). In summary, the possibility of exporting a product should be kept in mind, as this may provide an advantage, even though the initial NPD process was not aimed at developing products for international markets.

Acquiring the necessary process knowledge and skills

A common problem in NPD is that companies do not have the necessary knowledge, skills and experience to successfully develop new products. Another problem is that firms underestimate what is needed to execute each task within the process, thus the reason why this study also investigated a generic PD process. Through this a basic understanding of the activities executed within each phase of development could be determined. Since small firms are more bounded by limited resources, underestimating resource requirements, increases the severity of the situation. However, making use of frameworks, generic process models of NPD, training, consultancies, incubators, etc., can improve this situation. Other helpful methods suggested by Cooper include the exploitation of cross-functional teams, grooming of project leaders, overall team training and finally, defining expected standards of performance. Books are also available on how to perform NPD in small firms. In this regard, taking the extra step in planning the overall approach might provide the necessary edge to succeed.

Executing the process thoroughly as required

In small companies, the need for getting the product to the market even faster may exceed that of larger companies that have other sustainable sources of income. The sooner the product is finalised, the sooner expenditure can be reduced and income generated. However, cutting corners in NPD is not a good practice and does not contribute to long-term success. It is important to understand and recognise the need for reducing development time, but not at the expense of quality of execution. A well-executed process will result in a great product and this determines a great deal of the success.

Deployment of the optimal process

Research, including Cooper, states that the impact of having an NPD process has no impact on performance (Cooper 1995, 1998 & 1999). The key to making the difference lies in the use of best practices and whether critical success factors are incorporated in the process. The extent to which this holds for small firms is uncertain. However, the fact that companies follow or do not follow certain approaches has definite merit based on the results of practical experience. Based on the overall research included in this study, it would appear that definite benefits could be obtained by incorporating certain key principles.

5.4 Framework summary

A characteristic of the framework is that it highlights not only a list of best practice principles but it is composed of seven major aspects. In addition to the list of key principles, it also indicates which principles or activities are required to realise each aspect separately. For example, to deploy the Phase Reviews, those principles listed for Phase Reviews provide the basics to realise this aspect.

Highlighting the main aspect together with its accommodating key principles is beneficial as this enables the user to understand what the main aspect comprises and how it can be implemented separately.

The content of the framework makes it challenging to link the essence to a process. In other words, it is difficult to display the content in a way that represents a visual structured NPD process. The framework does not focus much on the process logic but rather the execution of the process; hence presenting a list of principles in a process form was difficult to achieve.

The graphic accompanying the framework helps to simplify the content and structure and highlights the relation between the seven major aspects that constitute the framework.

The framework appears to be quite extensive, but one should keep in mind that the initial aim was to develop a stand-alone solution that could be used without additional information. Hence, it incorporates all the necessary information in a concise way, explaining the applicability of each principle.

6. Framework Validation

This chapter describes how the framework developed and presented in the previous chapter was validated. This marks the last focus area of this study; *silo four*, as depicted by Figure 1 in Section 1.6 (Document layout).

The framework is mainly based on research of the literature that investigated best practices from industry. A large component of this research was obtained from industry feedback based on surveys and formal interviews with individuals representing this field of study. Since NPD literature is limited in the small business environment, the main source of information is companies with well-established NPD processes. Inevitably, these are larger companies, as smaller companies tend not to follow formalised processes.

There was some uncertainty as to whether it would be valid to adopt NPD practices from larger firms in the small business environment. In other words, would the adaptation of the NPD process be valid for small companies and start-up businesses? It was thus considered necessary to evaluate the validity of the framework within the small business environment.

It would have been appropriate to take a considerable sample size and test the framework in small businesses that have been confronted with NPD challenges. In this way, the model could have been validated and refined to develop a revised version based on industry feedback. However, due to the limited scope of the research project, it was not possible to conduct such an extensive study.

An alternative approach was followed, one which was expected to yield similar and representative results. In order to reduce the cost, a very small sample size was used but the participants were carefully selected based on their expertise and experience. In addition to a survey, structured interviews were also held with some of the participants in order to gain first-hand, personal feedback on the framework.

6.1 Questionnaire

Because of time constraints, the questionnaire was sent to the participants prior to thorough finalisation of the framework. Hence, amendments were made afterwards, although these were not significant to affect the general outcome of the survey. However, these amendments could have been of benefit to the participants if they had received them along with the questionnaire, since they would have gained insight and a better understanding of the framework and what was expected from them. Hence, no graphical content accompanied the questionnaire.

The questionnaire that was sent out proposed the same structure and content of the framework as shown in Appendix E (Tabulated Framework Summary) except for the

supplementary graphics. The “Significance” column was also omitted, which was used for comparing the feedback from the survey to the work and conclusions of the author. This was obviously omitted to prevent participants from being influenced or biased when asked to indicate the relevance of each principle based on their experience.

A column was added where participants could indicate the relevance of each key principle based on their knowledge and experience. The following scale was used to indicate “Relevance”:

- High
- Low
- Uncertain.

The scale above is very basic and it would have been better to use a five-point scale that would facilitate the ranking of the key principles based on the feedback. However, it was thought wise to keep the questionnaire as simple as possible, as the time it would take to complete the questionnaire needed to be reduced. (The framework itself is quite a lot to work through in a short period of time.)

The questionnaire was sent by email or delivered by hand to each participant. In some cases, no prior contact had been made with the participants and so they did not have any background information on the study. In these cases, a short background of the research was also sent by email, and included the aim of the framework and what was expected from the feedback. This posed some challenges, as it was difficult to communicate the necessary background in such a way. However, this did not appear to affect the feedback results.

One-on-one interviews provided insight into the practical aspects of new product development in small companies. As the author has only limited practical experience, these personal interviews delivered important information that contributed to the usefulness of the study.

6.2 Participants

This section gives a biographical sketch of each of the members who took part in the evaluation of the framework. Some participants only filled out the questionnaire while others were interviewed as well. The participants were asked to provide information on the following aspects of their personal background:

- Field of study/Qualifications
- Start-up or small business exposure
- Main employment areas
- Significant positions held.

The biographical sketch of each participant is provided below in no specific order. The people involved were chosen based on their specific background in NPD and the small business environment.

Participant A

Field of study/Qualifications:	Electronic Engineering (B.Eng, M.Eng)
Start-up or small business exposure:	Founder, director & shareholder of start-up companies
Main employment areas:	Engineering, Consultancy
Significant positions held:	Company director and manager

Participant B

Field of study/Qualifications:	Master in Business Leadership
Start-up or small business exposure:	Founder, director of start-up company
Main employment areas:	IT & Communication
Significant positions held:	Senior Project Manager, Managing Director

Participant C

Field of study/Qualifications:	Electronic Engineering (PhD)
Start-up or small business exposure:	Founder of small business – 10 years old, 8 engineers
Main employment areas:	Engineer, Research and Lecturing
Significant positions held:	Manager

Participant D

Field of study/Qualifications:	Geographical Information Systems (MSc)
Start-up or small business exposure:	Successful establishment of start-up company
Main employment areas:	Project management, Business development, Sales, Technical information systems design
Significant positions held:	Director, Co-owner/shareholder

Participant E

Field of study/Qualifications:	Electronic Engineering (B. Eng), Medical Physiology (MSc)
Start-up or small business exposure:	Started a business from concept to full-scale international commercialisation
Main employment areas:	Innovative product development. Commercialisation of innovative technologies. Development of medical devices including ISO, CE and FDA certification.
Significant positions held:	R&D Director, Managing director of a start-up

Participant F

Field of study/Qualifications:	Industrial Engineering (PhD)
Start-up or small business exposure:	Employment at a small start-up consultancy business. Involvement in a consultancy project for starting a new independent business unit.
Main employment areas:	Research, Innovation Management, Business Engineering, Consultancy
Significant positions held:	Research manager at consultancy firm

Participant G

Field of study/Qualifications:	Bachelor in Agricultural Business Administration
Start-up or small business exposure:	Founder and developer of small and start-up business – 20 years.
Main employment areas:	Agriculture, Property development, Business development, Business management, Product development and commercialisation.
Significant positions held:	Managing director, co-director and owner of various companies

Participant H

Field of study/Qualifications:	Industrial Engineering (MSc), Commerce
Start-up or small business exposure:	Director of a closed corporation
Main employment areas:	Academic/Lecturing
Significant positions held:	Senior Lecturer, Director

The biographical sketches of the various participants cover a significantly broad field but it should be evident that there is no lack of exposure in the small business environment. Basically, all participants were directly involved in the development of a new product, either from a technical perspective or a managing perspective. Hence, the reason they were selected in addition to their experience in business development.

The selected participants are seen as knowledgeable and experienced, thus able to provide valuable feedback on the developed framework. Hence, the sample chosen was expected to provide useful feedback for validating the NPD framework.

6.3 Questionnaire feedback evaluation

In total, eight questionnaires were completed and used in the final results. There were too few responses to analyse statistically, however a logical interpretation of the results was done. Even though there were only a few questionnaires, summaries are shown in percentages for easy interpretation.

The results of the feedback are summarised and presented in Appendix F - Questionnaire Feedback. Specific feedback of each participant was retained in the final results. Hence, the feedback of each participant can be compared to his background to see whether this had any influence on the responses.

Figure 26 provides a summary of the questionnaire results for each of the main aspects in the framework. The reader should note that this is not the basis for the discussion that follows. The author made use of all the information obtained through the interviews as well as that shown in Appendix F, to conclude the questionnaire analysis. Figure 26 only highlights some basic aspects which will be mentioned in the discussion.

The figure indicates the overall average for each of the seven main aspects. Hence, the average of participants who indicated relevance to be either high or low is shown by the solid line curve at the top. In addition, the overall framework average is also shown as a dotted-line curve. This helps to understand how relevant each aspect is to the rest of the framework.

It is quite clear that the Review Board, Multi-disciplinary Team and Phase Review aspects were considered less relevant compared with the other aspects. On the other hand, Voice of the Customer was considered significantly more relevant.

In order to highlight the reliability in these results, a curve at the bottom of the figure has been added to indicate the proportion of participants who indicated the relevance to be uncertain. (Relevance could be indicated as uncertain, low or high.) Hence, the curve indicates what aspects have underlying uncertainty, even though the relevance is indicated as being high. This can be seen particularly when looking at the aspects of the Review Board and Multi-disciplinary Team, especially for the latter. A greater proportion of participants were uncertain about their choice when they had to indicate the relevance of these two aspects. In effect, the higher the uncertainty, the lower the confidence in the results – although relevance still is relatively high.

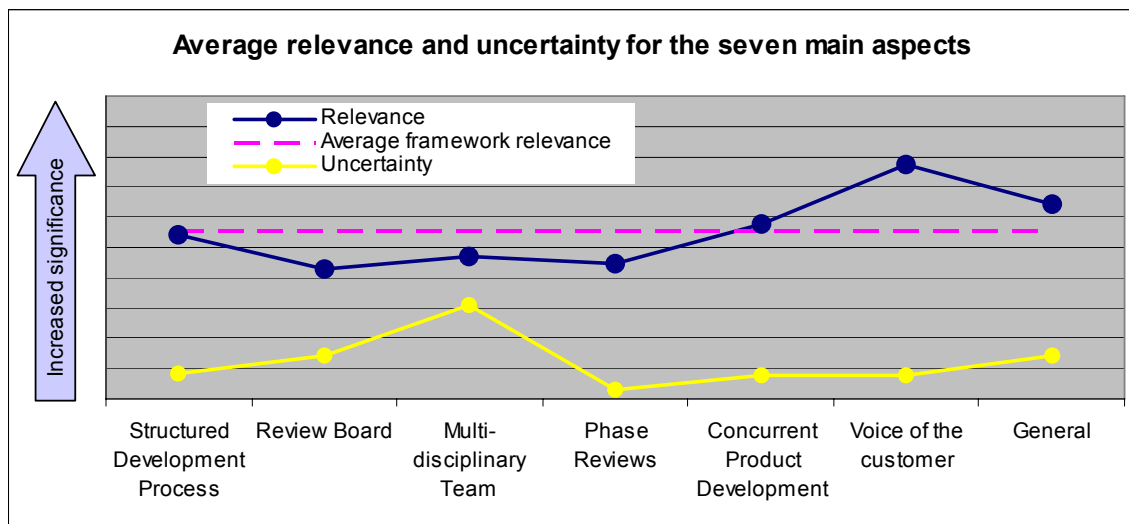


Figure 26 Questionnaire feedback on seven main aspects

Feedback on each of the seven aspects in the framework will be discussed in the sections that follow.

6.3.1 Structured Development Process

Feedback on the Structured Development Process yielded positive results. Firstly, all participants indicated the use of a *Development plan* as relevant, together with the inclusion of an *NPD schedule* to estimate development time. This is indicative of the need for small businesses to thoroughly plan their NPD approach and activities before execution.

Only two key principles of this aspect were considered less relevant. These are the *Collaboration and cross-functional interaction plan* and *Concurrent documentation*. The latter was included because, based on theoretical evidence, the author thought it

would be beneficial. The *Cross-functional interaction plan* was based on the logic of using Multi-disciplinary Teams; however there appears to be some overall uncertainty about Multi-disciplinary Teams. This is explained as in Section 6.3.3 (Multi-disciplinary Team).

Overall, the feedback indicates the Structured Development Process is highly relevant. The fact that less than 10% indicated that they were uncertain about this shows that participants understood the aspect as a whole and also the key principles that describe it. Hence, the feedback supports the use of this aspect and that it is considered highly relevant for small businesses.

6.3.2 Review Board

Feedback on the Review Board yielded positive results. Although participants were more uncertain about this than their responses to the Structured Development Process, no unexpected results were received. *Continuous product approval* was marked as considerably relevant. Inevitably, this means that small businesses need to focus on the design and development of the product and be definite in determining the course of development.

The feedback indicates that participants found the content explaining each principle useful. However, they were a bit undecided about the relevance of the setting of project priorities. The reason for this is not clear, although it could be that product developments, specifically in start-up companies, take on greater priority compared to other business activities.

The Review Board as a whole was considered valid by the participants and highly relevant. This percentage is slightly less than the average for the framework and that of the Structured Development Process.

6.3.3 Multi-disciplinary Team

Good feedback was received for the use of a Multi-disciplinary Team approach. However, this feedback does reveal some uncertainty. Participants indicated that the key principles here were either highly relevant or that they were uncertain about its relevance. From the interviews, it was apparent that participants struggled to conceive how the use of teams would work in a small company. The feedback indicates the underlying concepts are however still valid, despite this uncertainty.

Responses for the two key principles, *Dedicated team members* and *Virtual teams* showed a lot of variation and can thus not be considered to be highly relevant. However, the author also indicated that these were not critical, but merely beneficial factors. Hence, this feedback again validates the conformity of the research done by the author with feedback from practice.

It should be noted that most of the variation in this instance is explained by only two responses. Both participants were uncertain about the relevance of the Multi-disciplinary Team. Participant C noted in the interview and biographical sketch his lack of experience in this regard. It should thus be noted that an uncertain indication is not necessarily negative, but merely implies that the NPD experience of the specific participant could be limited and hence the participant could not comment on the specific aspect. Only indications of low relevance signal ambiguity in the framework.

6.3.4 Phase Reviews

The concept of Phase Reviews was perceived better than initially expected and the results of the survey validated the framework in this regard. In strong support of this aspect was the fact that there was little indication of uncertainty. This implies that the overall aspect and key principles were well described and could be applied to the small business environment. Also, the overall relevance of the Phase Review aspect compares well with the rest of the framework.

It was expected that members from small businesses would find it difficult to understand and relate the use of Phase Reviews to their environment. However, this was not the case as many principles were considered to be significant and the results showed very little uncertainty.

Strategic input from management was not as relevant. Participants noted that in small businesses management forms part of the development anyway. Hence, it is not necessary to have this as a separate principle in the framework, as strategic input prevails anyway.

The other two principles about which participants were not sure were *Assess product lifecycle impact on company* and *Lean, scalable and adaptable stage-gate process*. However, as the literature research considered both aspects to be very important, it is assumed that the framework did not provide enough clarity in describing these. This is particularly true of the lean stage-gate process, which heavily emphasises the maintenance of the process - something that is hard to come by in a small company. In contrast, it was concluded that participants did not grasp the aim of the principle, as it potentially offers assistance to small businesses in this regard.

6.3.5 Concurrent product development

The key principles of CPD were shown to be highly relevant to the respondents. Hence, this validates the applicability of the CPD approach in small businesses. The high relevance percentage for CPD is higher than that of the overall framework average.

A major principle that is inevitable in the deployment of CPD is *Higher investment up-front*. This is the only principle where the majority of participants considered it not very

relevant. It was noted that small businesses tend to delay investments as long as possible. Opposed to traditional NPD practices, CPD is an industry-wide best practice that requires a higher form of investment early in development. The benefits of CPD are hard to realise without this commitment. The variability in feedback indicates that participants do not realise this. Since this principle is well proven and has been successfully applied, it is assumed that participants might not be familiar with the CPD approach. In addition, the framework structure might lack the ability to sketch a thorough picture of this approach.

The principle, *Teams take on responsibility*, also created some uncertainty. However, this was expected as indicated by the author's theoretical judgement.

Overall, Concurrent product development was considered highly relevant. The fact that less than 10% indicated uncertainty shows that participants understood the aspect as a whole and also the key principles involved. Hence, feedback here supports the use of this main aspect and indicated it to be highly relevant for small businesses.

6.3.6 Voice of the Customer

Substantial positive feedback confirmed the relevance of a customer-focused approach. This aspect had the highest relevance indication of all aspects, which supports the research findings.

The only principle not overwhelmingly accepted here was the use of *Market research tools and methodologies*. One obvious reason for this is because the detailed list of available tools was not included in the framework summary. Hence, participants had to provide feedback based on limited information.

Once again, the feedback confirms the soundness of adding *Voice of the Customer* as a separate aspect in the framework. Small businesses need to have this focus in order to improve their chances of succeeding in NPD.

6.3.7 General

The focus of this part of the framework was to introduce General key aspects not covered in the rest of the framework. In summary, the overall relevance percentage compared with the rest of the framework is high. This indicates these General aspects are considered to contribute to NPD success in small businesses.

Participants indicated some uncertainty in the principle of *Build in an international orientation into new products*. However, no respondent indicated this as irrelevant, which validates the usefulness of the principle. However, its applicability to small companies might be uncertain. The framework took this into account, as the principle

was put forward as being beneficial and not critical, based on earlier findings by the author.

Planning and resourcing the market launch early in development was also indicated as a valid principle, although with uncertainty. This might be due to small companies' being risk-averse, especially when it comes to investment early on in development. The impact of a product launch might be less in smaller companies as opposed to larger ones. Hence, entrepreneurs might tend to reduce investment in this area of development. However, many participants still indicated this as highly relevant for a small business.

The last principle - the *Deployment of the optimal process* - is considered important, based on practical experience from various industry sectors as indicated by the author. In order to provide feedback on this principle, more extensive experience may have been required than what is used in this survey. Once again, the indications of uncertainty do not necessarily mean there is ambiguity in the framework content, but rather highlight the pitfalls of such a small survey sample.

6.4 General feedback and comments

This section discusses feedback obtained through the additional comments made by the participants in both the questionnaires and the interviews and includes comments on the overall usefulness of the framework, things one should take into account, possible amendments to the current structure and so forth.

A definite omission was a graphical summary to complement the framework. Due to the number of key principles listed in the framework, it was difficult to get an overall picture of the framework. An illustration would have helped the participants to better understand how the main aspects in the framework are linked and which can be viewed as separate principles. Such a diagram was added only after the survey was started (See Figure 14 Layout of NPD framework for small businesses). Although only adding this later was not ideal, it was unavoidable. Including this earlier may have given the participants a better understanding of the framework structure.

The initial literature used to develop the framework was based mainly on larger companies. This means that much of the terminology used in the framework creates the impression that it is not applicable to the small business environment. Many participants made this assertion even though they agreed with the underlying principles. Hence, this is interpreted as a positive result as the content of framework is still considered to be relevant. Using less-common terms certainly makes it more difficult for the user to relate the content of the framework to a small business environment.

Due to the number of key principles listed in the framework, the framework seems to be overwhelming. It could thus be necessary to differentiate between principles that are more or less important. However, the framework's aim and content make this challenging. A hierarchical structure could also prove useful for making the framework more user-friendly. One should keep in mind that the content of the framework aims to provide a stand-alone solution, so to speak, fully describing each of the seven main aspects. Hence, detail is required.

The role and involvement of top-management was met with some uncertainty. In small businesses, management are often involved in the actual development of the product and participants noted this. In effect, management is inevitably involved in the project, thus this principle is not only valid but also is inherent to the small business setting.

Feedback indicated most of the principles are important for improving the NPD process and could benefit a small business. However, the way it is adapted for small businesses is important. The challenge lies in balancing structure with flexibility and freedom – one does not want to burden businesses with unnecessary administration structure and control. It was suggested that it would be very beneficial to give guidelines to small businesses on how to implement and apply these principles effectively and efficiently.

It was also suggested that one could also indicate which principles were applicable to the various stages of the product development lifecycle. As an example, the fuzzy front-end phases require less structure than the development and implementation phases. Hence, knowing what principles are more important at each stage could be beneficial.

Positive feedback highlighted that the framework is a good summary on how to execute NPD. The model was perceived to be quite extensive, providing much-needed guidance in product development for small businesses.

It was highlighted that the setting larger firms use to develop products incorporate smaller functional units and that these operate quite autonomously from the rest of the business. This is compatible with the small business focus of the framework, which also concentrates on small business entities.

It is noteworthy to mention how many participants highlighted and emphasised the importance of specific principles, which increases the validity of the framework. This also immediately enabled participants to relate the content of the framework to their own experience.

6.5 Recommendations and impact on current framework

In order to do a more thorough investigation of the validity of the framework, further work is needed. Although feedback provided useful information for validating the framework, the current survey might not be sufficient to prove its wider applicability.

Further research would be useful in strengthening this validation and to improve the current framework.

By changing the terminology used in the framework its effectiveness could be increased. Terms need to be changed to reflect the circumstances of the small business environment more accurately and not those found in larger firms.

If the framework's principles were prioritised according to their importance, it might be possible to reduce its size. The framework could then be split in two or better structured in a hierarchical form to increase its user-friendliness. However, in order to achieve this it may be necessary to reduce the generic property of the framework. In other words, by making it more tailored for specific business environments, some principles will no longer apply and could be dropped. In this way the framework size could be reduced, but would then be less widely applicable.

The framework comprises seven major aspects, each with its corresponding key principles. Principles can thus not be dropped without first establishing which principles are basic to each major aspect. For instance, although some principles of the Phase Reviews aspect may seem less relevant, these may still be critical to the description of Phase Review in practice. This is actually a key property of the framework as it describes the key principles required to realise each main aspect. Thus, to alter any of these will be to change its key property. Hence, this explains why some principles inevitably overlap (See Concurrent Product Development aspect in framework).

In support of the validity of the research used to develop the framework, it is necessary to mention the following: Where the survey showed that principles were considered less relevant or of uncertain relevance, the author had arrived at the same conclusions based on previous research. This leads to two remarks. Firstly, it confirms the author's basic understanding of NPD practices and their application in the small business environment, and secondly, the research methodology used in this study, would appear to have led to valid results.

7. *Conclusions and Recommendations*

The initial literature study indicated the importance of managing the NPD process. It was noted that a poorly managed process could be detrimental to overall product success. Research of the literature included possible solutions for managing the process by using control mechanisms. These mechanisms would be effective for countering undesirable behaviours in the process that could negatively affect the final product.

The study emphasises that product development needs to progress through certain phases in order to be successful. These phases represent the lifecycle of a product. Based on a generic product development model, the phases of NPD were discussed, highlighting the requirements of the process, particularly as this relates to product development in smaller companies.

The capability of companies executing NPD was also investigated. Since larger companies generally follow a more formal process, these companies tend to focus less on execution capability, since they already have an established process. However, larger companies do consider technology and resource requirements for their development projects.

The study also investigated the emphasis placed on NPD in small businesses. The results indicated that various sources focus more on pre- and post-design and development phases. Thus, compared to general business management activities, the process of NPD receives less attention.

The literature study provided a good basis from which to develop the framework. This good basis was evident from the feedback received during the framework validation, as this compared well with the theoretical research of the study. Moreover, it was concluded that there is merit in benchmarking large company practices and then adapting these to benefit the small business environment.

The framework validation is based on a small survey sample of selectively chosen members. Members were chosen based on their NPD experience and exposure to the small business environment. The overall results obtained from the survey, comprising a few interviews and questionnaires, yielded results that confirmed research done earlier on the literature. Hence, it can be concluded that the framework is valid and relevant to the small business environment. Furthermore, there was little criticism about the general validity of the framework in the feedback. Where respondents were uncertain about the relevance of certain aspects, a good explanation could be provided for this. Since the participants were carefully selected, the feedback obtained was of remarkable benefit. Additional comments and feedback were also obtained. In addition, the validity of the feedback given may be regarded as fairly significant for such a small sample size. The

personal way in which the interviews and questionnaires were handled also contributed greatly to the overall success of the survey.

Further research could be useful for further validation and for improving the current framework, as the scope of this initial study was limited. A larger survey should include statistical analysis and amendments could then be made to the framework on that basis. The interviews and accompanying survey only provided basic validation for the framework.

The timing of the survey was not ideal. Hence, the feedback was produced in quite a short period of time. More in-depth interviews would have been preferred. The literature discussion describing the small business environment provided a limited understanding of practical considerations. Incorporating more practical considerations would provide a finishing touch to the framework.

The fact that the framework was developed for use without additional accompanying information did not create serious concerns. Instances where participants were uncertain about the content of certain principles did occur. However, this was not significant compared with the other feedback. It can be concluded that the framework is a thorough summary that includes the necessary detail and that it can be used without additional accompanying explanations.

The framework should enable small and start-up businesses to improve their NPD approach and this should be expected to lead to increased success in the execution of the process, resulting in a better product offering.

With regard to the initial aim of the study, it can be concluded that objectives were met and the expected outcomes realised. The research also did enable the author to develop a greater understanding of product development practices in order to try and master this field of study.

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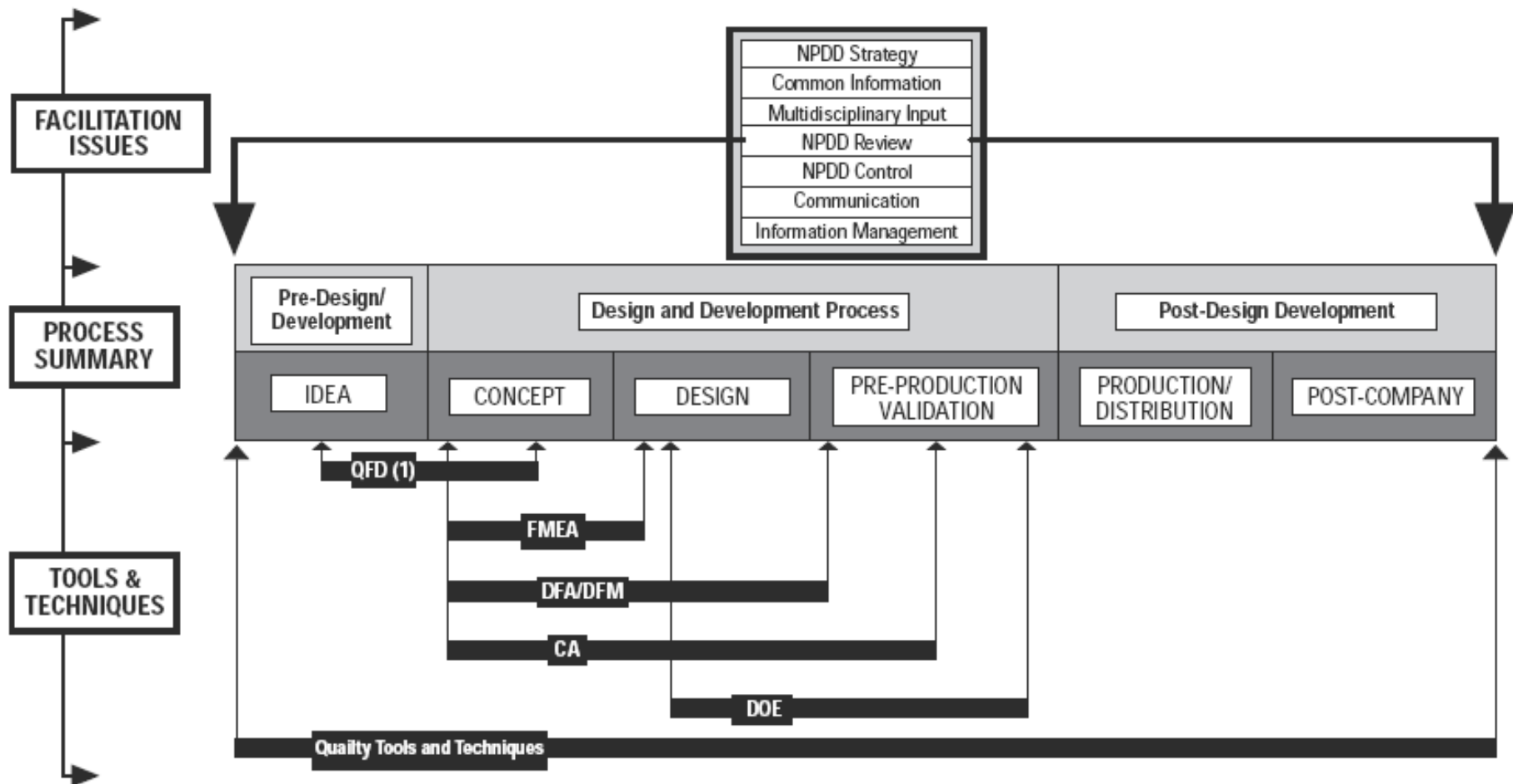
A

<i>Appendix A</i>	<i>Product Development Facilitation Issues</i>
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Issue	Common information	Communication	Information management
Description	Availability and accessibility of knowledge within the company so that personnel have the information they need to enable them to complete their job in the most effective manner.	An essential requirement of the NPDD process, with information exchange across all functional, departmental and hierarchical boundaries.	Reinforces communication interactions and exists to make sure that information is delivered in an optimum format at required points in time to relevant personnel, be they internal or external to the company.
Checklist summary	<ul style="list-style-type: none"> ▪ previous NPDD history ▪ business plans and financial projections ▪ working practices ▪ product portfolios including the post-company performance ▪ customers, markets and competitors ▪ suppliers ▪ skills and expertise available ▪ technology available and associated capabilities ▪ quality and traceability procedures ▪ quality control and assurance procedures ▪ training (e.g. courses, programmes, and resources available) 	<ul style="list-style-type: none"> ▪ paper, electronic, verbal ▪ informal/formal ▪ internal/external ▪ cross-functional, interdepartmental, vertical, horizontal ▪ procedures (see information management) ▪ working practices 	<ul style="list-style-type: none"> ▪ information routes, destinations, format and medium ▪ information feedback mechanisms ▪ timelines ▪ information priority including previous information in relation to current activities ▪ information source and date/time of release ▪ authorising information sources and procedures and responses ▪ aiding informal information exchange ▪ engineering change control (configuration management)

B

<i>Appendix B</i>	<i>NPD Process: Generic SME Model & Supporting Framework</i>
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Process summary	Pre-design/development	Design and development process			Post-design/development	
Generic phases	Idea	Concept	Design	Preproduction validation	Production/distribution	Post-company
Generic phase activities	Sourcing Collation Prioritisation Idea introduction	Conceptualisation Feasibility studies Peripherals	Design (incl. industrial/peripheral) Proto-typing Tooling Testing	Trial production Batch testing Beta/gamma testing Launch planning	Assembly Manufacture Launch Sales Delivery	Performance Sales Disposal
Phase review	Initial review	Preliminary design review	Detailed design review	Final design review	Product review	Product performance review
Review criteria	Requirements Impact on company Initial project definition	Idea realisations Evaluation-market Technical Business Concept definition	Design schemes Evaluation Design activities review Design definition	Batch analysis Reliability/reproducibility Project review Product definition	Production schemes Sales/marketing literature Aftercare support schemes	Market/customer response Legislation New technologies Competition Sales/orders
Phase definition/control	Project definition	Concept definition	Design definition	Product definition	Product	End-customer
Control criteria	Time constraints Resourcing Project (team) personnel Project priority	Initial specifications Detailed project plan Time constraints Resource allocations	Specifications/drawings Prototypes/models Conformability Reliability	Production methods Packaging/peripherals Product specifications	Product specifications Peripherals/packaging Delivery/storage Guarantees Product support	Product use Product disposal Requirements from replacement!

C

*Appendix C Small Businesses
and NPD*

Main focus area	Explanation	Specific topics	Reference					
			1	2	3	4	5	6
Planning a new business	Before starting a new business, an entrepreneur needs to evaluate his/her personal competencies with regard to overall requirements of the business. Age, experience, interests, personal life, motivation and goals are all things that need to be assessed. Small businesses may yield much more personal gain and self-fulfilment. Decisions need to be taken about current employment and future opportunities must be weighed against starting a business. Any business is heavily dependent on supporting structures, e.g. partners, knowledge resources and social networks.	Personal abilities Personal fulfilment Career benefit when your doing own thing Resources and support	x	x	x	x	x	x
Setting up or acquiring a business	Different options can be evaluated each with various benefits. It is often easier to buy out an existing business that includes human resources, infrastructure and all other facets of the current business. Franchising is also a common way of starting a business. Starting a business from scratch has a much higher risk and normally includes an extended period of little or no income until it is fully established and running. Different options exist regarding the type of the business e.g. close corporations, corporations, partnerships and sole proprietorship.	Start a new business Acquire a business Franchising Business type	x	x	x	x	x	x
Identifying the opportunity	Small businesses can be developed around services or product offerings to the customer. The identification of the right opportunity is needed before a business can be started. Doing the necessary research will highlight ideas that vary in potential and what is required to establish it. By doing the necessary feasibility studies, each opportunity may be evaluated in depth, which will enhance the validity of the idea. Hereafter, the most suitable and lucrative opportunity that will fit the given constraints of	Research Feasibility studies Opportunity selection	x				x	x

Main focus area	Explanation	Specific topics	Reference						
			1	2	3	4	5	6	
	the stakeholder needs to be selected.								
Funding	Funding a new business can be a significant barrier and pose financial risk. Determining the amount of funding is dependent on many factors including the type of business, goals, premises needed as well as potential income and value of business. The most suitable source for funding needs to be identified together with the resulting obligations. Many opportunities exist, e.g. banks, venture capital, personal or individual investment, angel investors or government. The firm needs to realise the risk involved in taking up investment and the impact it will have on the company. The company needs to ensure that the business will be able to use necessary exit strategies before acquiring any funding, like selling the business or company shares.	Fund estimate Source Risk and obligations Exit strategies	x	x	x			x	x
Finding the premises	Basically, all businesses need a facility to house the business, whether it is a large factory or home-based business. The type of business will determine the facility and equipment needed to run the business. Normally the option of buying, renting or building new premises accompanies this decision.	Location Physical facilities Equipment Build/Rent/Buy	x	x	x	x	x		
Workforce	Businesses rely on human input to function properly and meet specific goals. The right people need to be recruited and selected based on criteria determined by the firm's needs. Training forms an integral part of recruiting people as this equips the employee to adjust to the environment and to become competent in meeting the requirements of the job. Compensation is determined based on the skills, experience and performance of the employee. Incentives provide good motivation for employees to contribute to the firm's wellness. Contracts bind the firm and employees to certain regulations that will	Recruiting and selecting employees Training Compensation Incentives Contracts and legal aspects	x	x	x	x	x		

Main focus area	Explanation	Specific topics	Reference						
			1	2	3	4	5	6	
	benefit and protect both parties. Management is needed to steer an organisation's workforce to enable them to work together and achieve the goals of the company.	Management							
Business Plan	A business plan aids planning of the business and help determines where you want to go, how you are going to get there and how you will know when you have arrived. Knowing what your goals are is quite important in business. Short term, long term and strategic planning that determine tactical integration of long- and short-term plans form part of the process. Templates to help determine the contents of a good business plan are generally readily available. This process forces one to carefully analyse the opportunity, and this will improve one's decision-making capability. The business plan is a blueprint for the business's success and may be used to convince potential stakeholders to buy into the business. Lastly, it is a dynamic document that is used and updated on a continuous basis in order to remain effective.	Short term planning Long term planning Strategic planning Blueprint to business Stakeholder buy-in Document revision	x	x				x	x
Marketing	Marketing is about building a relationship with customers, one that determines their needs and find the best ways to fulfil them. Marketing also determines the best means of communication with the customer. Marketing forms an advocate for the customer within the company itself. In this way, better products can be developed to fit customer needs and maximise profits. Since marketing is in touch with the market, different pricing strategies and advertising techniques can be identified to attract more customers. A good understanding of the competitiveness of the market is crucial. Building solid networks can provide many opportunities and alternatives to the firm's benefit.	Budget Customer needs Pricing strategies Competitors Networking Advertising and promotion Profiting		x	x	x	x	x	x

Main focus area	Explanation	Specific topics	Reference					
			1	2	3	4	5	6
Advertising and promotion	With regard to marketing, advertising and promotion focus on the means and physical methods of communicating with the customer. This can be realised through sales people, the media, events, agents and the many other proven practices. This interaction establishes an image for the company and creates an awareness of the company's brands. Advertising and promotion activities can be costly; hence they are normally tied to a budget.	Budget Advertising practices and methods Corporate image and branding	x		x		x	
Customer focus	The customer is the source of income for the business. Hence authors emphasise this aspect of business. The key to achieving a customer focus is doing the necessary market research, understanding the customer and getting the customer involved as closely as possible in all customer-related aspects of the business. A customer focus ensures that the company retains its customers and that value created for them on a long-term basis. As a result companies also need to develop product related services. Good aftersales-support contributes positively to the image of the firm. Handling inquiries and problems help to build a relationship with the customer, which benefits the firm in the long term.	Market research Customer involvement Retaining customers Lifetime value Extended services Aftersales support	x		x	x	x	
Financial management	The financial status of the firm is indicative of the overall well being of the firm. Hence, assessing its performance and keeping up to date with the financial position of the firm is imperative. Key to financial administration is the managing of the firm's assets. Assets include inventory, debt and credit, in effect all aspects that influence the cash flow of the business. Budgeting also is a typical practice used to plan and steer spending of finances. Business involves risks, which can be managed. These risks are	Performance assessment Assets Budgeting Risk and insurance	x		x	x	x	

Main focus area	Explanation	Specific topics	Reference						
			1	2	3	4	5	6	
	inherent on the side of the company, the customer and company stakeholders or investors. Insurance is a form of mitigating risk and reducing the potential severity of risks.								
Tax and regulatory	Any firm is bound by law to pay taxes on the profit earned. The firm needs to register as a business entity and hereby also gains certain lawful rights, protection and trading benefits provided by government. Health and safety regulations form an integral part of any business environment. It is a business's lawful obligation to look after the well being of its employees and to ensure their long-term health, especially in manufacturing facilities and similar environments. Protecting the ideas of the company ensures the firm is legally entitled to the value and knowledge it creates. Any intellectual property generated increases the value of the firm. Protecting this information is important in order to secure the competitive advantage gained through this.	Tax Health and safety Intellectual property Patenting Trademark registration	x		x				x

Key to References:

Book	Coverage count for 12 main focus areas	Coverage count for 6 most covered focus areas
1. Small business: An entrepreneur's plan	11	5
2. Be a winner: Run your own business and make lots of money	7	6
3. The small business handbook: a comprehensive guide to starting and running your own business	10	6
4. The ultimate small business guide: a resource for startups and growing businesses	7	5
5. Small business management: An entrepreneurial Emphasis	12	6
6. The Portable MBA in Entrepreneurship	7	4

D

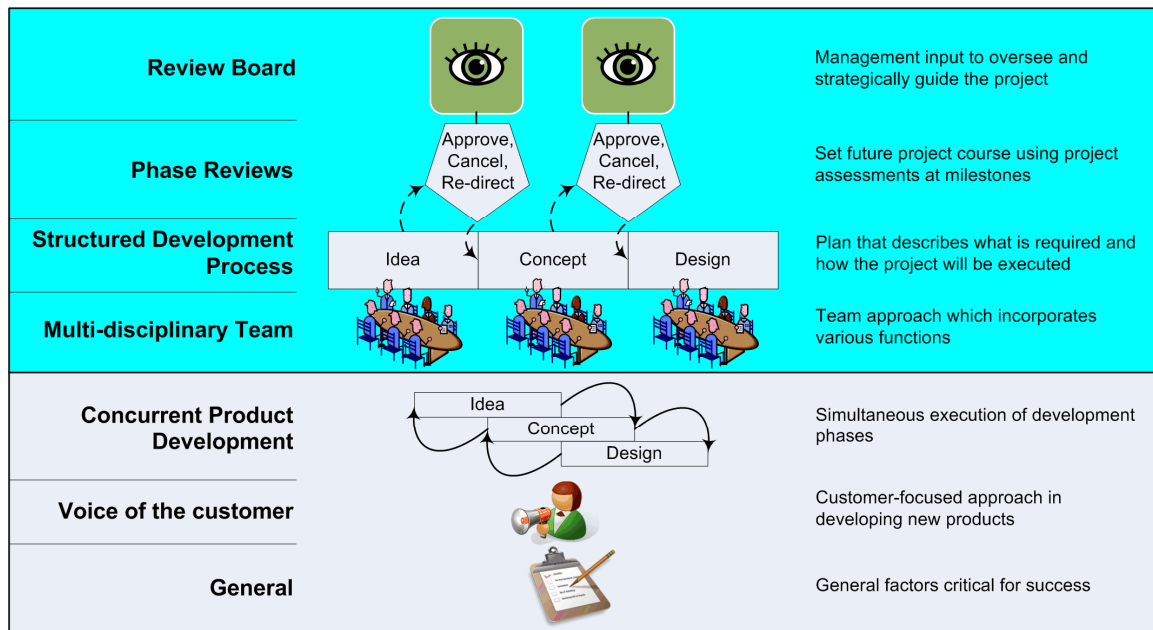
*Appendix D Four Fields
Mapping -
Example*

Example of a four fields map for a small “mini loader” (Duhovnik et al. 2004).


Stage No	DESCRIPTION OF PRODUCT DEVELOPMENT STAGE	Planned activities within the stage:	Department: Development and planning dept.		Design dept.	Technology dept.		Supply dept.		Production		Marketing and sales dept.		Financial dept.	Quality dept.	Informat. unit	Delivery	Shaping	No. of members
			Employees: Development	Product	Design	Prod. proc. plan	Logistics	Supply	Cooperation	Operative prepare	Manufacturing	Marketing	Sales						
1	Definition of goals	Goals of the product development process																	3
2	Feasibility study	Term plan																	8
		Financial plan																	3
		Pre-calculation																	6
		Goals of market																	3
3	Development	First draft and structure of the product																	4
		First draft of components																	5
		Product planning and its control processes																	2
4	Design	Design of components																	4
		Drawings of parts																	5
		Bills of material																	6
5	Process planning	Material requirements																	5
		Technology routings																	3
		Control procedures																	5
		Preparations																	3
		Documentation of orders																	2
		Overview of available stock																	3
		Creation of orders																	4
		Order and supply of material																	5
Acceptance and storing																	5		
6	Manufacturing and assembly	Launch of production																	4
		Preparation of material																	4
		Manufacturing of appliances																	4
		Manufacturing of parts and components																	5
		Assembly																	3
		Check																	3
		Test and control																	2
7	Marketing and sales	Offer and contract																	8
		Preparation of the product																	4
		Final control																	5
		Supply																	4


E

Appendix E Tabulated Framework Summary




Structured Development Process		Idea	Concept	Design	Plan that describes what is required and how the project will be executed
Key principle	Significance	Basic aspects	Explanation		Significance explained
Shared development plan - primary tasks and key milestones	Critical	Major component of Structured Development Process. All NPD participants adhere to common agreed plan. Forces thorough project planning.	Well-defined plan that determines the execution of the process. It indicates development phases, milestones and subsequent steps. The plan allocates responsibilities to project participants. It aids project coordination and coherent project execution.		Inform entrepreneurs of the overall scope of a NPD project and what it entails. It aids project participation of external members.
Collaboration and cross-functional interaction plan	Critical	Forces cross-functional collaboration. Identifies knowledge and skills needed.	A plan based on the project plan that indicates who will be involved and how human interaction will take place.		Compensates for knowledge and skill resource constraints in small businesses.
NPD Schedule	Critical	A method to estimate development time. Takes into account all activities of NPD process.	The schedule is based on the development plan. The schedule depends on the resources the company has available regarding knowledge, skills, workforce, money and time.		Enables newcomers to determine how long it will take to commercialise a new product. It assists in determining the resources to complete and support the project.
Estimate resource requirements	Critical	Determines upfront development resources. Investigates product lifecycle. Indicates NPD impact on overall company.	The project plan is used to identify the resources required. By using generic NPD models and related resources, the whole lifecycle and its impact can be assessed. Thus requirements ensuring success is considered.		The long term requirements and impact of a new product indicates the true effort to develop and sustain a product. Small businesses need to account for development and post-launch requirements.
Entry and exit criteria at milestones	Critical	Set intermediate targets and evaluation criteria. Fundamentals to review and manage development.	Each milestone should include deliverables and the criteria to be met before permitting the project to the next phase.		Prevents scope-creep. Ensures development activities are finalised according to plan including the necessary quality and performance evaluation.
Concurrent documentation	Beneficial	Enables repeatability of the process. It aids process improvement and external project participation. Captures, transfers and manages NPD knowledge.	Documentation of NPD process, which includes lessons learned, knowledge gained, previous project histories, documents and templates. Using and populating the project plan with these is a good starting base.		This activity benefits small businesses and start-ups that are likely to innovate again in future.

Review Board		 Management input to oversee and strategically guide the project		
Key principle	Significance	Basic aspects	Explanation	Significance explained
Senior management involvement	Critical	Provides necessary strategic input. Interface between management and development projects. Aligns company goals and NPD goals. Sets project boundaries.	Management's role is realised through the Review Board. The Board consists of senior directives, the CEO and major stakeholders. Well-informed members such as heads of departments or core project members also participate this sitting. The Review Board interacts with the project through Phase Review meetings.	Balance is required regarding management's input and that of members working on the project. The Review Board assists involvement best as it stimulates management participation but prevents too much involvement which strains progress. Management involvement is critical in guiding the project.
Initiate, approve and prioritise new product development projects	Critical	The Review Board initiates and evaluates NPD projects and optimises the portfolio.	The Review Board takes responsibility for initiating new projects. Also, new projects are evaluated, approved and given priority among other business activities.	Management has a high level and strategic perspective on the NPD process. Therefore, the responsibility to instigate and optimise the NPD portfolio partially resides within the Review Board.
Continuous product approval - Go/No-go decisions	Critical	At milestones evaluate and approve new developments.	New and ongoing projects should be evaluated and approved throughout development. However, further development should be prevented if projects do not meet intermediate assessment expectations at milestones.	Project information evolves and integrity increases towards the end of development. Should this indicate reduced potential, a project should be cancelled in order to cut expenditure on non-lucrative projects.
Allocation of development resources	Critical	Optimises allocation of resources to NPD projects. This requires management's perspective of the business.	The Review Board is responsible for allocating resources to NPD projects. Sufficient resources are needed to execute developments successfully.	High level and strategic knowledge is needed from the Review Board to optimise the use of resources across company projects. Inadequate resourcing can prolong development time and/or be at the cost of the product's success.
Set project priorities	Critical	Prioritises NPD projects among other business activities.	The Review Board should provide guidance in order to prioritise business projects and core activities. This priority should be communicated to the rest of the company to prevent conflict and optimise the business activities.	NPD is not the only business activity or process underway. The priority the NPD project has among other activities, which are required to sustain the business, needs to be clarified and communicated.
Project oversight	Beneficial	Review Board members should concentrate on supervisory related activities.	For management to be well informed, dedicated time needs to be set aside for supervisory related activities. Phase Reviews assist in obtaining direct project feedback.	Since the Review Board is not involved on operational level, they possess the ability to observe the behaviour and progress of the project using a bird's eye view. This is necessary to manage the NPD process.
Determine levels and roles of responsibility	Critical	Determine management's control, management's involvement and roles of responsibility.	The amount of control the Review Board exercises and the extent to which they are involved in the project needs to be balanced. The roles members take up during the project should be clearly differentiated in order to account for all responsibilities where dual roles exist.	If roles and responsibilities are not identified and allocated, the risk of neglecting responsibilities is increased. For small companies where the same person takes on multiple roles, this pitfall should be countered.

Multi-disciplinary Team		 Team approach which incorporates various functions		
Key principle	Significance	Basic aspects	Explanation	Significance explained
Multi-disciplinary input	Critical	Various disciplines collaborate. Team approach followed. Increased perspective and knowledge on project.	Incorporate members from various disciplines to take part in NPD process. These members constitute a development team. Collaborative interaction should span the lifecycle of the NPD project, i.e. from idea to launch and post-launch phases as well.	Limited knowledge and NPD experience require small businesses to incorporate all available internal and external skills to participate in the project. This broader perspective provides input to succeed in NPD. If neglected, many aspects of NPD would be left untouched, only to surface at critical stages later on in the project.
Early-on involvement	Critical	Realise Multi-disciplinary input as early as possible. This enables lifecycle approach from the start.	The benefit of Multi-disciplinary input should be exploited as early in the development process as possible. Hereby various lifecycle aspects are taken into account from the start.	Effective NPD takes into account the later stages of the lifecycle during the initial stages of development. Collaborative input during initial stages leads to significant benefits later on.
Continuous collaboration and interaction	Critical	Establish effective means of communication. Keep everyone informed.	Collaborative interaction on a continuous basis enhances the effectiveness of the Multi-disciplinary approach. Interaction, whether formal or informal, should be provoked at all times.	Continuous collaboration enables fast and efficient exchange of information. This approach limits formal communication methods and processes which benefit small companies that are limited by time and money constraints.
Supply-chain integration	Beneficial	A small firm's success is dependent on the supply chain. Supply chain input creates benefit for the firm, supply chain and product. Long-term relations required.	Gain company benefits through integration and use of external knowledge. External members can enhance knowledge and skills that are lacking in the company. Thus a team approach is realised which increases NPD success.	Limited internal capability of small companies forces them to rely on their supply chain. Small firms can benefit greatly from knowledge contained in members of the supply chain, up- and downstream. The supply chain provides input that will optimise success when executing their responsibilities.
Product or process champion	Beneficial	Skilled person with good NPD knowledge. Leads and motivates project members. Owner who drives process whilst backed by management. Training.	The process champion takes on responsibility to drive the development by envisioning the final product offering. This person should either be well acquainted with the process or be trained to become competent to fulfil his role.	A product champion is the entrepreneur who buys fully into the project and essentially owns it. Without this leader and motivator, who constantly seek solutions to problems, succeeding with NPD becomes difficult.
Fast, flexible and dynamic teams	Beneficial	Ability to change team composition. Flexible teams being able to adapt quickly to the requirements of the project.	NPD benefits from flexible project participation and an adaptive team approach. The process requires employment of different members at different times. Member roles and responsibilities may change over time. Informing and training the team to understand the NPD process is necessary.	The successful outcome of NPD depends on the input of various functions and team members. In order to realise the potential of the product, the company needs to be adaptable to meet the requirements of the process.

<p>Dedicated team members</p>	<p>Uncertain</p>	<p>Employees dedicated to the NPD project without other major responsibilities. Alternatively a matrix structure is preferred.</p>	<p>Fulltime NPD members are most beneficial. Otherwise, small firms benefit most by using a matrix structure to compose project participation. Hence employees still fulfil major responsibilities within functional departments in addition to part-time participation in the NPD process. Functional heads form the core team.</p>	<p>Non-dedicated participation may be implemented at the cost of decision-making capability and constructive human relations. It also poses challenges in communication.</p>
<p>Virtual teams</p>	<p>Beneficial</p>	<p>Off-site part-time and external project participation.</p>	<p>The internet and similar information technology solutions enable project participation when members are geographically distributed. Virtual collaboration also enables cost effective supply chain integration.</p>	<p>Virtual teams and collaboration enhance external project participation and part-time members who are not dedicated to the project. This may provide alternative low-cost solutions. This increases flexibility for small firms and effective teams can be realised.</p>

Phase Reviews		 Set future project course using project assessments at milestones		
Key principle	Significance	Basic aspects	Explanation	Significance explained
Decision-making process for new products and enhancements	Beneficial	NPD process: Decision-making capability through Phase Reviews.	Phase Reviews provide a clear and consistent process for making major decisions on new products and product enhancements.	A clear and consistent approach supports and benefits the realisation of successful innovation.
Establish review criteria	Critical	Determine review criteria for each phase of development.	Review criteria are used to evaluate the project based on aspects most relevant to the company. These criteria should be identified for each phase review. The criteria are used to assess the performance, quality and prospects of products. Usage and relevance of criteria differ among phases.	Review criteria are required to evaluate and set standards with which the product needs to comply in order to gain development support. Without review criteria the project cannot be assessed. The criteria also set guidelines within which the project should progress.
Drives other NPD activities	Critical	Phase Reviews force critical milestones and completion of phase deliverables.	Phase Reviews set the pace for development by determining milestones and phase deliverables. These are assessed during the review in order to approve project progress.	NPD execution involves a significant period of time. Intermediate milestones and project reviews keep the project on track and make it more manageable.
Project review points	Critical	Phase Reviews provide review points to evaluate the overall project. Monitor progress and performance.	Phase reviews provide checkpoints with which to assess the project progress and product performance. Management obtains the opportunity to oversee the project and evaluate the quality, performance and features of the development to date.	Review points keep management up to date with the project without being involved on a day-to-day basis. This provides the information necessary to control the project and make management decisions on a company-wide basis.
Strategic input from management	Critical	Phase reviews create management involvement to guide projects strategically. Link NPD with strategy.	Phase reviews are the mechanism that the Review Board uses as an interface to take part in the NPD process. Hence the strategic component that management provides is realised only through phase review meetings. The Review Board provides strategic insight to specific projects and overall NPD.	Phase review meetings are required to obtain the strategic guidance and input from management and key stakeholders. An NPD process is most valuable when contributing to overall company strategy.
Phase conclusion and planning	Critical	Finalise and prepare phase deliverables for review. Execute review. Plan upcoming phase.	This activity concludes phases and sets the scene for the upcoming phases. All deliverables are completed and prepared for evaluation at the review. After the review the next phase is planned which includes budget, deliverables, schedule and also resources allocated.	Phase conclusion ensures and approves the thorough finalisation of a milestone in development. Phase planning sets guidelines for the upcoming phase within which the project should progress. This enables employees to act more autonomously.
Set project course	Critical	Determine project future course: proceed, cancel or re-direct.	Input from management and the use of thorough review criteria help to determine future direction. Updated market research and information gathered during the last phase, provides insight to decide whether to proceed with the development, cancel the project or set new direction.	Product information quality is improved as development progresses. Using updated info to direct the product development is critical. Weak developments should be cancelled as early as possible in order to cut losses and stop further investment.
Empowerment of team members	Critical	Phase Reviews empower employees to execute a project plan.	Phase reviews empower employees who execute the development, by setting the guidelines that determine the project boundaries.	Autonomous execution by employees reduces management involvement and benefits development progress.

Establish pressing milestones	Critical	Establish pressing milestones that emphasise a sense of urgency.	By setting reasonable goals for the upcoming phase review, the development can be paced to increase productivity and efficiency. Phase Reviews emphasise more short-term goals.	Stretched goals that run over extensive periods increases risk and impede product success, especially for small business with limited NPD knowledge and skills.
Assess product lifecycle impact on company	Critical	Assess product lifecycle impact on the enterprise.	Each phase of the product development lifecycle impacts the current and future status of the company and vice versa. This impact should be assessed and plans made accordingly.	Through lifecycle contingency planning the impacts between NPD and the company could be managed advantageously.
Project assessment from a functional perspective	Critical	Holistic assessment of project from a functional perspective.	Reviews provide a point in development where the project can be assessed from various functional perspectives as required. This pertains to the challenge where one employee represents multiple business functions.	In firms with limited employees, not reviewing the project from time to time using various functional perspectives may lead to the overlooking of important issues.
Lean, scalable and adaptable stage-gate process	Beneficial	Easy to maintain lean NPD process. Scalable according to product complexity. Flexible to adapt to project requirements.	The NPD process should include the necessary activities and nothing more, be scalable to accommodate basic and extensive projects and at the same time be able to adapt to the internal and external business demands.	Planning and managing the NPD process prevents it from being overbearing. The NPD process can also be detrimental to NPD success.

Concurrent Product Development (CPD)		Simultaneous execution of development phases		
Key principle	Significance	Basic aspects	Explanation	Significance explained
Activities run in parallel	Critical	Concurrent execution of activities.	In CPD activities and phases of NPD are executed in parallel, even though information required from preceding activities is not fully finalised.	Concurrent product development is a key best practice used globally which enables rapid development of new products. The results are reduced costs and development time.
Updating and knowledge sharing among concurrent activities	Critical	Iterative integration of parallel activities. Diffuse new and updated information.	Activities in the NPD process depend on information generated in other activities. Integration and information exchange among these are required especially when activities are executed simultaneously.	To increase the likelihood of success, developments should make use of the latest information gained from other phase activities as the development progresses.
Stability in product specifications	Critical	Sharp, early, stable definition and specifications for the project and product.	The definition of the product and project should be finalised as early as possible. Hence, boundaries and outcomes for the project are determined which will stabilise directions.	The dynamics of Concurrent Product Development require early and stable product and project definitions. This prevents wasted effort and time. This is due to uncertainty in development actions concerning final outcome.
Teams take-on responsibility	Uncertain	Teams as a whole are held responsible instead of individuals.	The team approach shifts any liability for decisions taken during NPD to the team.	Individual blame may be less and company politics reduced as well. This aspect of a team approach may also increase general morale and motivation.
Technology related supportive tools	Beneficial	Modelling and simulation tools. Centralised source for NPD information. Collaboration tools.	Technology provides solutions to implement, test or simulate prototypes of the product beforehand. A company-wide network linked to a central source provides common and up-to-date information for all NPD participants. Collaboration tools using the internet support virtual teams.	The use of technology-related tools can reduce significantly development time and cost. This is in favour of small firms who are constrained by limited resources.
Higher investment upfront	Critical	Higher level of resource commitments during initial phases.	For the successful exploitation of Concurrent Product Development, greater resource commitments are required during initial stages of development in contrast to traditional developments.	The benefits of achieving rapid time-to-market outweigh the cost of having increased levels of resources commitments during initial development phases.
Cross-functional teams	Critical	Key aspect of Concurrent Product Development.	Refer to "Multi-disciplinary Team".	
Incorporating the Voice of the Customer	Critical	Key aspect of Concurrent Product Development.	Refer to "Voice of the Customer".	

Voice of the Customer		Customer-focused approach in developing new products		
Key principle	Significance	Basic aspects	Explanation	Significance explained
Strong market orientation - Market driven and customer focused	Critical	NPD is driven by the market and focused on the customer.	Competitive situation and market nature is investigated. Customer needs should be obtained and understood in full. A customer-centric culture together with feedback and satisfaction loops is required.	Performance in the market determines the product's success. Therefore, being knowledgeable about the market is crucial as well as knowing the customer at whom the product is aimed.
Quality Function Deployment (QFD)	Critical	Identify customer needs. Translate this into product design and process dimensions. Take into account competitor products.	QFD is a systematic process which deals with issues such as determining exactly what will satisfy the customer, how this weighs up to competition and how the process will guarantee to meet the demands of the customer.	QFD is a proven technique used worldwide with tremendous success. It requires little skill, can be used by small firms with ease and is a key aspect in developing new products.
Direct customer interaction	Critical	Direct customer interaction with the NPD process.	The more direct the interaction with customers the more beneficial. This includes direct contact with the customer and the relating social or physical environment in which the product is to be used.	Direct customer contact overcomes communication gaps and ensures nothing important to the customer gets lost through poor, indirect communication channels. It also improves customer understanding.
Customer focus in each phase of development	Beneficial	Specific points in each phase of development that considers customer input. Improves and validates development.	Customer input should be planned for each phase of development. Therefore, continuous feedback and input is obtained to improve and validate development progress with the user itself.	Incorporating customer input as an activity in the project plan will prevent customer focus from being omitted during each phase. This may be critical for small firms not having permanent representatives of the customer on the development team.
Market research tools and methodologies	Beneficial	Making use of standard tools and techniques to do market research.	Many proven tools and techniques exist which can be used to gain insight into the market and understand customer preferences.	Many of these are low-cost and easy-to-use principles that are well suited for small businesses. Making use of these proven tools may increase the efficiency and effectiveness with which market research is completed.

General		General factors critical for success		
Key principle	Significance	Basic aspects	Explanation	Significance explained
Commit to heavy upfront homework	Critical	Conduct solid, thorough and in-depth research before starting the development.	Heavy upfront homework is required before approving new ideas for further development. Although this requires more resources, the benefit it provides exceeds the costs in the long run.	The benefit of solid, upfront work is proven to contribute to new product success, a better NPD process, reduced time-to-market and increased financial performance. For small firms relying on product success, this is a key principle.
Seek differentiated, superior products	Critical	Strategy within a good NPD process. Tough gates in the stage-gate review process.	NPD process and strategy determines which product concepts are generated and accepted for further development. Part of realising this aspect lies in incorporating this as a key criterion during product screening.	This crucial success factor ensures a well-differentiated product with unique customer benefits and superior value for the user. Since customers seek their own benefit, this approach provides a competitive advantage for the company's products.
Plan and resource the market launch early in development	Critical	Early planning of launch. Commit thorough resources.	Knowledge generated during the design and development process should be used to maximise the impact of the launch. The launch is the product's entry to the market and hence requires thorough planning and resourcing.	Best practice firms commit twice as much resources to the product launch as those who fail in their NPD efforts. A good launch increases product success and provides first-hand market feedback.
Incorporate tough gates in the stage-gate process	Critical	Decisive Phase Reviews. Relevant review criteria. Pre-development feasibility studies.	The Phase Review process should be effective in filtering out less promising projects. More upfront homework highlights project shortfalls. Not cancelling weak projects inherently approves them. Stopping developments that have already been started does not often happen.	Weak Phase Reviews which do not incorporate tough gates lead to marginal projects being accepted and scarce resources being wasted. Successful projects need to subsidise money spent on poor projects.
Build in an international orientation into new products	Uncertain	Global product focus. Different markets and different users. International standards and regulations. Upfront homework.	Global products require that different users and markets are understood globally. The NPD process should account for this by involving global knowledge and skills. Increased upfront homework and commitment to initial development phases is needed.	Keeping in mind the possibility of exporting a product may be advantageous; even though the process does not have an explicit international focus. Upfront planning pays-off in the long term.
Acquiring the necessary process knowledge and skills	Critical	Obtain knowledge and skills to prepare and plan for the execution of NPD.	Obtain skills and make use of frameworks, generic NPD process models, training, consultancies, incubators and available resources to prepare, plan and execute the process.	Knowledge and skills are required to develop and commercialise products successfully. Companies underestimate the effort of NPD, which has decisive consequences. This could have been prevented through training and preparation.
Executing the process thoroughly as required	Critical	Do not skip phases and critical activities. Understand time-to-market relevance and how to reduce it.	Reducing time-to-market may yield many benefits although it should not be at the cost of product success. Companies should know when, where, how and why to reduce NPD time.	A well-executed process will result in a great product and this determines a great deal of the product success. Cutting corners in NPD is not a good practice and does not contribute to long-term success.
Deployment of the optimal process	Critical	Build in best practices into NPD process. Account for critical success factors.	The process as such does not impact NPD performance but rather the nature of the process. Incorporating best practices and taking into account critical success factors are necessary to make the process effective.	To benefit from the advantages of a NPD process, the company needs to incorporate best practices and adhere to critical success factors.

F

*Appendix F Questionnaire
Feedback*

Key principle	Participant								Theoretical significance	Relevance %		
	A	B	C	D	E	F	G	H		High	Low	Uncertain
Structured Development Process												
Shared development plan - primary tasks and key milestones	H	H	H	H	H	H	H	H	Critical	100	0	0
Collaboration and cross-functional interaction plan	H	L	H	L	H	H	L	U	Critical	50	38	13
NPD Schedule	H	H	H	H	H	H	U	H	Critical	88	0	13
Estimate resource requirements	L	H	H	L	H	H	H	H	Critical	75	25	0
Entry and exit criteria at milestones	H	H	H	L	H	H	U	H	Critical	75	13	13
Concurrent documentation	L	H	H	H	L	H	L	U	Beneficial	50	38	13
										73	19	8
Review Board												
Senior management involvement	H	U	H	H	L	H	H	L	Critical	63	25	13
Initiate, approve and prioritise new product development projects	L	U	H	L	H	H	H	L	Critical	50	38	13
Continuous product approval - Go/No-go decisions	H	U	H	H	H	H	H	H	Critical	88	0	13
Allocation of development resources	L	H	H	L	H	H	H	U	Critical	63	25	13
Set project priorities	L	U	H	H	H	H	H	U	Critical	63	13	25
Project oversight	L	U	H	H	L	H	H	H	Beneficial	63	25	13
Determine levels and roles of responsibility	H	U	H	H	L	H	H	L	Critical	63	25	13
										64	21	14
Multi-disciplinary Team												
Multi-disciplinary input	H	U	U	H	H	H	H	U	Critical	63	0	38
Early on involvement	H	U	U	H	H	H	H	U	Critical	63	0	38
Continuous collaboration and interaction	H	U	U	H	H	H	H	H	Critical	75	0	25
Supply-chain integration	H	U	U	H	H	H	H	U	Beneficial	63	0	38
Product or process champion	H	U	U	H	H	H	H	L	Beneficial	63	13	25
Fast, flexible and dynamic teams	H	U	U	H	H	H	H	H	Beneficial	75	0	25
Dedicated team members	L	U	U	H	H	L	H	L	Uncertain	38	38	25
Virtual teams	U	U	U	L	L	H	L	H	Beneficial	25	38	38
										58	11	31

Key principle	Participant								Theoretical significance	Relevance %		
	A	B	C	D	E	F	G	H		High	Low	Uncertain
Phase Reviews												
Decision-making process for new products and enhancements	L	L	H	H	H	H	H	H	Beneficial	75	25	0
Establish review criteria	H	L	H	L	H	H	H	H	Critical	75	25	0
Drives other NPD activities	H	L	H	H	H	H	H	H	Critical	88	13	0
Project review points	L	L	H	H	H	H	H	H	Critical	75	25	0
Strategic input from management	L	L	H	H	L	H	H	U	Critical	50	38	13
Phase conclusion and planning	H	L	H	H	H	H	H	H	Critical	88	13	0
Set project course	L	L	H	L	H	H	H	H	Critical	63	38	0
Empowerment of team members	H	L	H	H	H	H	H	H	Critical	88	13	0
Establish pressing milestones	H	L	H	L	H	H	H	H	Critical	75	25	0
Assess product lifecycle impact on company	L	L	H	U	H	H	H	L	Critical	50	38	13
Project assessment from a functional perspective	L	L	H	H	H	H	H	H	Critical	75	25	0
Lean, scalable and adaptable stage-gate process	H	L	U	H	H	H	L	L	Beneficial	50	38	13
										71	26	3
Concurrent Product Development												
Activities run in parallel	H	H	H	H	H	H	U	H	Critical	88	0	13
Updating and knowledge sharing among concurrent activities	H	H	H	H	H	H	H	H	Critical	100	0	0
Stability in product specifications	H	H	H	U	H	H	H	L	Critical	75	13	13
Teams take-on responsibility	L	L	H	H	H	H	U	L	Uncertain	50	38	13
Technology related supportive tools	L	L	H	H	H	H	H	U	Beneficial	63	25	13
Higher investment upfront	L	L	U	H	L	H	L	H	Critical	38	50	13
Cross-functional teams	H	L	H	H	H	H	H	H	Critical	88	13	0
Incorporating the Voice of the Customer	H	H	H	H	H	H	H	H	Critical	100	0	0
										75	17	8

Key principle	Participant								Theoretical significance	Relevance %		
	A	B	C	D	E	F	G	H		High	Low	Uncertain
Voice of the Customer												
Strong market orientation - Market driven and customer focused	H	H	H	H	H	H	H	H	Critical	100	0	0
Quality Function Deployment	L	H	H	H	H	H	H	H	Critical	88	13	0
Direct customer interaction	H	H	H	H	H	H	H	H	Critical	100	0	0
Customer focus in each phase of development	H	H	H	U	L	H	H	H	Beneficial	75	13	13
Market research tools and methodologies	H	H	U	L	H	H	H	U	Beneficial	63	13	25
										85	8	8
General												
Commit to heavy upfront homework	U	H	H	U	L	H	H	H	Critical	63	13	25
Seek differentiated superior products	H	H	H	H	H	H	H	H	Critical	100	0	0
Plan and resource the market launch early in development	L	H	H	L	L	H	H	H	Critical	63	38	0
Incorporate tough gates in the stage-gate process	L	U	H	H	H	H	H	H	Critical	75	13	13
Build in an international orientation into new products	H	H	U	H	H	H	U	U	Uncertain	63	0	38
Acquiring the necessary process knowledge and skills	H	H	H	H	H	H	H	H	Critical	100	0	0
Executing the process thoroughly as required	L	H	U	H	H	H	H	H	Critical	75	13	13
Deployment of the optimal process	L	H	H	U	H	H	H	U	Critical	63	13	25
										75	11	14
									Framework avg.	71	17	12