An organization structure and business process for product and platform development at Vitatron

van Hasselt, R.L.A.

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Vitatron

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Final report of master thesis

Rogier van Hasselt
Eindhoven University of Technology
Faculty of Technology Management

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Vitatron

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Master thesis

Eindhoven University of Technology
Faculty of Technology Management
Industrial Engineering and Management Science

Student:	R.L.A. van Hasselt
ID-number:	427150
Primary Supervisor:	Prof. dr. ir. J.I.M. Halman Department of organization science
Secondary Supervisor:	dr. ir. H.H. Van Mal Department of quality of products and processes
Graduation Company:	Vitatron Medical BV Kanaalweg 24 6951 KL Dieren Telephone: +31 (0)313 431 200 Fax: +31 (0)313 420 652 www.vitatron.com
Company Supervisor:	ir. D. van Waes Project Management

Abstract

The objective of this research project is to develop an organization structure and business process for derivative product development based on a product platform at Vitatron. It also describes an approach for managing and organizing a next generation product platform. Tools are provided to balance the development portfolio and a technology roadmap is constructed and will be used as a tool to contribute to the definition of the product platform strategy of Vitatron.

Management summary

Vitatron

Vitatron is one of the leading companies in the development, production and selling of pacemaker systems Vitatron sells and distributes pacemaker systems in more than 30 countries all over the world and has its headquarters in Dieren. Approximately 400 people work for Vitatron. Since 1986 Vitatron is an independent subsidiary of Medtronic, Inc, which has its headquarters in Minneapolis. More than 25,000 people are working for Medtronic, Inc.
Vitatron is the fastest growing pacemaker producer in the world and it wants to extend its market share by introducing innovative pacemakers. For the development of product and platforms Vitatron has developed a Stage Gate process that consists of a Business Analysis phase, a Commitment phase, a Development phase, an Evaluation phase and a Market release phase.

Assignment

For developing new products for innovative companies the product platform approach has become a key concept. A product platform has been defined as a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be derived [Meyer & Lehnerd 26] Using a product platform approach a company can develop a set of differentiated products by sharing common technologies. This approach has an impact on the development process and organization structure of a company. In general terms, the potential benefits of the platform approach are. reduced development and manufacturing costs; reduced development time; reduced systemic complexity, improved flexibility and improved ability to update products [Muffatto 12]
Vitatron started a product platform project, called DA$^+$ in 1998 Vitatron will produce a next generation of pacemakers based on this product platform Because of the complexity of the development project several development phases have been delayed, which will ultimately result in a delayed market release of the first product series based on product platform DA$^+$. Vitatron has moved from single product development many years ago towards product platform development today, but the organization structure still does facilitate good product and platform development. Based on what is mentioned above the following **problem definition** has been formulated:

What is a good organization structure and business process for product and platform development at Vitatron?

In the near future Vitatron will develop derivative series of pacemakers based on the actual product platform and within several years Vitatron will start the development of a next generation product platform. Considering these two aspects and the problems in the current product platform development the following **research project objectives** have been defined.

- *Develop an organization structure and business process for derivative product development based on the existing product platform DA$^+$.*
- *Determine preconditions and develop an organization structure and business process for the development of a next generation product platform.*

Research model
The organization has been analyzed through desk research and interviews with key persons involved in the product platform development project. The norm of the evaluation study consists of the following two elements: 1) Current scientific literature has been studied and reviewed and 2) The product development process of Vitatron has been studied. According to a conceptual model, product and platform development have been analyzed and evaluated. Based on the results of this study and relevant literature on successful product and platform development an organization structure and business process for derivative and for next generation platform

development have been developed This proposition has partly been implemented and an implementation plan has been made for what still has to be done Conclusions and recommendations have been formulated

Analysis and evaluation of product and platform development at Vitatron

Positioning product and platform development
As a start the product and platform development projects at Vitatron have been positioned. Therefore a technology consumer matrix has been composed This matrix is a graphic representation of the strategic importance of development projects in the market. It relates newness to the customer to technology newness. The composed matrix gives direction and clarity to the overall effort and helps to lay the foundation for outstanding performance The theory of the consumer technology matrix categorizes the following project types: Breakthrough, Platform, Derivative, and Brand support. Each type of project has a different role and provides a different competitive contribution.
The conclusions related to the development portfolio and the composition of the technology matrix are summarized:

- There are not many development projects in the development portfolio of Vitatron. About 80% of the resources are dedicated to the platform development project DA$^+$.
- The development projects are not new to the market
- There is no balance in the development portfolio between long term and short term development projects, and between high risk and low risk development projects.

Portfolio management is not integrated in the development organization of Vitatron. All development projects are managed separately, there is no aggregate project plan, and there is no overall ownership of all development projects.

Analysis of the strategy of product platform DA$^+$
Through interviews, meetings, and desk research the strategy of product platform DA$^+$ has been analyzed. All derivative products will be based on one product platform and this product platform is extensible for future upgrades For the development of the product platform new functionalities, new technologies, new development processes and new people have been used. Within Vitatron product development and platform development are integrated The results of the analysis are summarized:

- The top-down strategy of producing one platform to satisfy the top market segments first and then downscale it to satisfy all lower market segments is a high-risk strategy, because many new technologies and functionalities will be developed at once.
- The strategy of developing a new product platform with new technologies, new functionalities, development processes and new people is a high-risk strategy, because almost everything is new and uncertain to the organization
- The integration of product and product platform development is a high-risk strategy. All derivative products will depend on one product platform and it will take a long time before Vitatron will go to market with the first new derivative series. The development time of one derivative series is shorter than the development rime of a product platform
- Vitatron did not do the pre-development work well:
  - There was no roll-out plan of derivative products of the product platform.
  - There was no market segmentation plan of derivative product of the product platform
  - There was no sharp project definition that satisfied the customer needs.

Evaluation of product platform development DA$^+$
According to a conceptual model the project development project DA$^+$ has been evaluated. This conceptual model involves the environment of an innovation project in an evaluation and it analyzes the internal processes. This model analyzes the formulation of objectives; the specification of quality, time, and costs, the organization structure and business process, and the realization of the objectives.

The evaluation of product platform DA+ showed many gaps with the literature about successful product and platform development. The development process deviated from the product development procedure at some elementary points. The evaluation also showed that many aspects of the organization structure and business process of product and platform development could be improved.

Proposition of an organization structure and business process for product and platform development

Introduction of portfolio management.
The evaluation study showed that portfolio management was not integrated in the development organization of Vitatron
Portfolio management is a dynamic decision process whereby a business's list of new products (and R&D projects) is constantly updated and revised; new projects are evaluated, selected and prioritized; existing projects may be accelerated, killed or de-prioritized, and resources are allocated and re-allocated to the active projects. Effective portfolio management will improve a company's business, it will ensure that development projects are in line with the strategy and will maximize profit [Cooper & Kleinschmidt 3].
For the development of product platforms and derivative products Vitatron has a stage gate process (VPM 446), but that is only partly a solution for portfolio management. A portfolio meeting should be initiated to review all projects together, to prioritize development projects and to check the balance of the development portfolio. The portfolio meetings will form input for the Stage Gate meetings.
The evaluation study also showed that there was lack of overall ownership of all development projects, which resulted in a scattered planning and scattered management of development projects. According to Cooper & Kleinschmidt [3] and Wheelwright and Clark [30] all development projects should be considered, planned and managed together. An effective way of organizing this is to create a new function, the portfolio manager. This person is responsible for considering, planning and managing all development projects, within the product platform approach. All project managers will report to this person. The portfolio manager will initiate and lead portfolio meetings and he will control the projects on a multi-project level.

To create balance in the development portfolio.
Balance in the development portfolio should be created using the technology/consumer matrix and by separate product development and platform development.
The consumer technology matrix should be used to map the strategic significance of individual projects. By mapping all projects Vitatron can see the competitive strength of the entire innovation portfolio. The matrix illustrates how the portfolio is addressing the business strategy. This tool has proven to be a successful approach to balancing between the short-term derivative products and long term product platform products
Product platforms should be pre-developed while derivative products are still produced on the "old" product platform. Therefore a next generation product platform team should start earlier than it used to start and will enable a simultaneous development of derivative products and platforms. This reduces risk and enables a continuous stream of new products.

Managing and organizing the product platform strategy
To gain insight in the strategy of derivative products a market segmentation plan and a technology roadmap have been composed.

A market segmentation plan
A market segmentation plan for the derivative products based on the product platform has been composed. This plan identifies major market segments and the price/performance tiers within them

Technology roadmap
A technology roadmap has been developed as a derivative of the strategy of Vitatron. It contributes to the integration of business and technology and the technology strategy definition The roadmap creates a balance between the market pull and the technology push and it is a good communication tool between all functional groups in an organization. This roadmap should be updated twice a year in the PRC meeting

Steps for development of a new product platform strategy
In the near future the roadmap should be used as a tool to contribute to the definition of the strategy. Therefore an optional roadmap with all relevant technologies, functionalities, and possible products should be developed. It will show alternative technology or functionality developments over time, thereby clarifying the options that are available.
The market segmentation plan should be updated and should be input for the development of a new product platform. It is important to look forward in time, incorporating emerging market segments as well as existing ones into the grid. This plan should be updated, while the development project continues.
A Power Tower for Vitatron has been developed. This is a decision tool for designing, developing, and revitalizing a product platform. It integrates Vitatron's market segments, it defines the product platform's subsystems and their interfaces integrated by Vitatron's core competencies.

Managing and organizing derivative product development based on DA$^+$
The development of derivative products must be organized and managed efficiently. Therefore a new structure of organizing and an improved business process for derivative product development have been developed

Three people will do the BA Phase
The Business Analysis phase should be done by a multi-disciplined team that leads the entire project. In this way the customer view and the technical view are integrated respectively by the product planner and the system engineer In this composition technical opportunities and constraints are taken into account in a preliminary phase

Functional composition of the system team
In the Commitment phase the project manager will be the overall leader, but the system leader will lead the transition of specified customer requirements into system requirements. This will be done by system engineers. The most effective composition of defining the system requirements is a cross-functional composition with representatives of all functional groups. These representatives must be system engineers that know everything about the technical development of their functional group This team is co-located during this phase to improve communication and collaboration

Design teams around a functionality
The organization theory [Oosterman 23] suggests that design teams should be formed around product's building blocks The product architecture for derivative products has been determined Therefore research within Vitatron suggests that design teams should be formed around a functionality. This improves the focus of a team on their part of the project and it improves cross-functional collaboration and communication These teams should be co-located and led by a heavyweight project manager. Heavyweight project managers are senior managers with primary influence over the people working on the development effort and supervise their work directly through key functional people on the core teams [Wheelwright & Clark 30]. This way of organizing design teams speeds up the process and will ensure better commitment to the project.

Separation of technology projects, functionality projects and product development projects
Technology teams within the research department will do all future technology and feature projects. These teams will do the feasibility of the concepts and will develop algorithms for new features or components Only when these concepts are viable, well understood, and well

described these concepts can become part of the project plan of a development project in the BA-Phase. This will speed up the development process and the separation of technology, functionality development and product development, which will make product development less complicated, because of reduction of interdependence of the different development projects.

Risk diagnosis
An important aspect of the BA-Phase is making a good risk diagnosis. At this phase uncertainty has to be managed, taking into account the potential risks. In this phase management still has the ability to substantially influence the course of events and make a considerable impact on the eventual outcome.
Risk diagnosis is the responsibility of the project manager. Each potential risk should be evaluated on its likelihood, its controllability and its relative importance to project performance. A workshop with a cross-functional perspective could be an effective tool. Value-cost tradeoffs and potential risks of different features or components should be important factors in the decision process on the content of derivative development projects or product platform projects.

Managing and organizing next generation product development
New functions of the product platform should be determined as has been described in the section about formulating the strategy for a next generation product platform. These functions should be mapped on the building blocks. Design teams led by a heavyweight project manager should be formed around the product platform's building blocks. This is an effective way of organizing new product platform development [Oosterman 23], because it improves focus on and commitment to the development project of the team members. It also reduces coordination effort and interfaces with other development teams. As a result it will reduce costs and time.
The organization structure of the product platform development team will be the same as for the development of derivative products. The only difference is that design teams will now be formed around product's building blocks instead of new functionalities. This will reduce coordination effort again.

Implementation

This research project provides an approach and tools for organizing and managing product and platform development at Vitatron. Some parts of the development of an organization structure and business process have already been implemented. For the parts that have not been implemented yet, an implementation plan has been proposed. This plan dedicates people to the different parts of the proposed solution and explains what should be done.

Conclusions & recommendations

The conclusion can be drawn that the goal of this research project has been achieved and that the research question as formulated in the problem statement has been answered.
The recommendations focus mainly on extra points of attention in implementing the proposed approach for product and platform development at Vitatron.

Preface

This report is the final assignment to gain my degree in Industrial Engineering & Management Science at the Eindhoven University of Technology. This report is an overview of a research project conducted from September 2001 until May 2002 within the development & project management department of Vitatron in Dieren regarding managing and organizing product platform development. The report covers the result of eight months of working, discussing, presenting, and writing

Due to the novelty and my interest for product innovation, the research project was an excellent opportunity for me to obtain a better view on this topic and how a company deals and should deal with it. The literature discussed places the topic of product platform development in a broader perspective. All employees interviewed gave me a clear picture about the current state of product and product platform development within Vitatron. Moreover, they provided valuable input for the creation of my research.

I would like to thank everyone who worked with me in Vitatron, especially my company coach Dick van Waes for his work as a supervisor, for guiding me into the Vitatron organization, and for his input into my research project. Without him my research project would not have been so successful. I would also like to thank Gert-Jan Paau for keeping me company during my research project and for answering all my questions.

At the university I like to thank my university coaches J.I.M. Halman and H.H. van Mal for their extensive comments and discussions which we had on content and process related issues.

I also like to thank my family and friends for their support, especially Joop, Kirsten, Koenraad, and Sanne for reviewing and commenting on my work

Rogier van Hasselt
Dieren, May 2002

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Introduction

For developing new products the product platform approach has become a key concept in the innovation process. This approach can have an impact on the way in which both product development and the management and organization of innovation is conceived.

This report is about managing and organizing product and platform development at Vitatron. It is divided in 7 chapters and has 16 Appendices to support the research.

The first chapter provides insight in the organization of Vitatron. The organization, products, supply chain and innovation process will be described.

In the second chapter the origin of the research project is set out, which leads to the to project's objectives. The scope and the research model of this research project are discussed.

What a product platform approach is and how it should be organized and managed will be discussed in chapter 3. This chapter explains the theoretical background and gives a review on the literature about managing and organizing product platform development.

In chapter 4, product and platform development at Vitatron will be positioned, analyzed and evaluated. An analysis will be made of the strategy of the actual product development project at Vitatron.

In chapter 5 a proposition of an organization structure and business process for product and platform development at Vitatron will be discussed. Tools for managing the development portfolio and for developing a product platform strategy will be provided.

Chapter 6 discusses the implementation of the new approach of managing and organizing product and platform development at Vitatron and provides an implementation plan.

Finally conclusions and recommendations will be provided in chapter 7. Furthermore this chapter provides an external validation of the design and suggestions for further research.

Abbreviations can be found in the section abbreviations.

This report is interesting for those who are directly or sideways concerned with this research project within Vitatron Medical or within the Eindhoven University of Technology. Furthermore, this report can be interesting for those who want to get a better insight in managing and organizing product and platform development.

1. Introduction Vitatron Medical BV

This chapter provides an introduction to Vitatron Medical BV and Medtronic, Inc. First, an introduction of Vitatron BV and an introduction of Medtronic, Inc. are provided. The following paragraph describes pacemaker systems, Vitatron products, and Vitatron development projects. Then the position of Vitatron in the supply chain is explained and the market of pacemakers is discussed. The next paragraph provides the Mission and Vision of Vitatron. Then the organization structure of Vitatron will be described. Finally the product creation process of Vitatron will be described.

1.1 Introduction Vitatron Medical BV and Medtronic, Inc.

Vitatron is one of the leading companies in the development, production and selling of pacemakers and pacemaker systems. Vitatron was founded in 1956 in Dieren, in the Netherlands. In 1962 the first Vitatron pacemaker was implanted and in 1981 Vitatron was the first company that introduced an implanted pacemaker that was software engineered. Since then, many innovations in the products and systems of Vitatron have been developed in order to optimize treatment possibilities for physicians and quality of life for patients under their care. Besides the strive towards meeting individual patient needs and continuous technological developments, Vitatron has earned the trust of physicians and cardiologists by its unprecedented quality performance. The company is closely related to the medical science in the development of pacemakers. Worldwide, more than 600,000 patients have been able to begin a new life thanks to a Vitatron pacemaker.
Vitatron sells and distributes products and systems in more than thirty countries all over the world. In total approximately 400 people work for Vitatron.

Since 1986 Vitatron is an independent subsidiary of Medtronic, Inc. Vitatron cooperates with Medtronic in the development, production and selling of pacemakers.
Medtronic, Inc. is an American company with its headquarters in Minneapolis and a listing at the New-York Stock Exchange. Medtronic is the world's leading medical technology company, providing lifelong solutions for people with a chronic disease. It has more than 25,000 employees and offers products, therapies and services that enhance or extend the lives of millions of people. Each year, 2.5 million patients benefit from Medtronic's technology, used to treat conditions such as heart disease, neurological disorders, and vascular illnesses.
In the fiscal year 2000/2001 (fiscal year starts in May and ends in April) the net sales were more than $ 5 billion with a profit of more than $ 1 billion.

1.2 Vitatron's products and development projects

A pacing system restores one of the most essential rhythms of life, the rhythm of the human heart. The two parts of the pacing system inside the body, the pacemaker and the pacing lead, work together to perform two main functions. pacing and sensing. For a doctor or nurse to communicate with the pacemaker the third part of the system, the programmer, is used.

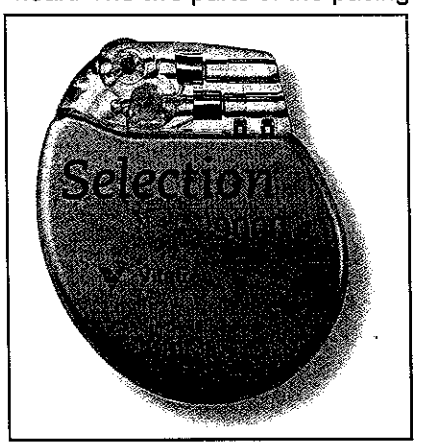


Figure 1.1: A pacemaker

A pacemaker has electronics that determines when to deliver a tiny amount of electrical energy called a pace or pacing pulse. Within the titanium outer case of the pacemaker are the battery and electronic circuitry. Pacing is when a pacemaker sends tiny electrical signals to the heart through a pacing lead. Each tiny electrical signal is called a pacing pulse (pacing impulse, pace) and it is this pacing pulse that starts a heartbeat. The pacemaker paces (sends a pacing pulse to) the heart when the heart's own rhythm is interrupted, irregular, or too slow. A pacemaker may also sense (monitor) the

heart's natural electrical activity If a pacemaker senses a natural heartbeat, it will not deliver a pacing pulse to the heart.
A pacing lead is an insulated wire that is connected to a pacemaker Leads are extremely flexible in order to withstand the twisting and bending caused by body movement and movement by the heart itself. A pacing lead carries a tiny electrical pulse from the pacemaker to the heart and it relays information about the heart's electrical activity back to the device.
Presently, pacemakers are smaller, lighter, and more streamlined than ever before. This is a result of using miniature electronic circuits and sleek, lightweight metals. Pacemakers are versatile and can be adjusted in the follow-up clinic or physician's office to make the therapy unique to your needs.

The current product portfolio consists of brady pacemakers, leads programmers and a new cardiac stimulator which prevents AF (Atrial Fibration). Some products of the collection are the Clarity, the Diamond 3 and the Selection. Vitatron pacemakers are functionally very advanced and well perceived by the market. Two essential features, beat to beat mode switching and dual sensor rate response, promoting the combination of a fast sensor (Activity) and a psychological sensor (QT), are still more competitive than any other device in the market.
The differentiation between Medtronic and Vitatron pacemakers is accomplished by differences in "corporate" identity (brand image) and on technology/features.

The biggest development project of Vitatron at this moment is DA$^+$ DA$^+$ is a platform development project and will generate a new streamline of Vitatron pacemakers. It will replace the current generation of pacemakers. A major part of the organization of Vitatron has been working on this project for several years. Some other small development projects are Slate and Vision, both new software products for the programmer Discover 3 is a new tool for the doctor. HF (Heart Failure) is a new bi-ventricular device, based on a current pacemaker and prevents heart failure.

1.3 Vitatron's position in the supply chain and the market for pacemakers

The position of Vitatron in the supply chain is illustrated in figure 1.2.
Vitatron and Medtronic, Inc. have their own research department, but Vitatron depends on Medtronic for some parts Vitatron and Medtronic, Inc. cooperate in development, but have their own independent development process. Vitatron and Medtronic joined the production of pacemakers in SMO (Swiss Manufacturing Organization) in Switzerland, ADM (Arizona Device Manufacturing), and MMC (Medtronic Microelectronics Center) in the United States. Vitatron and Medtronic have their own sales organizations and sell the pacing systems to hospitals.
The buyers in the hospitals can be a purchase combination, the hospital administration, and the cardiologists. The insurance companies in the different countries actually pay for the pacemakers. The cardiologists are the customers and implant the pacemakers into the patients.

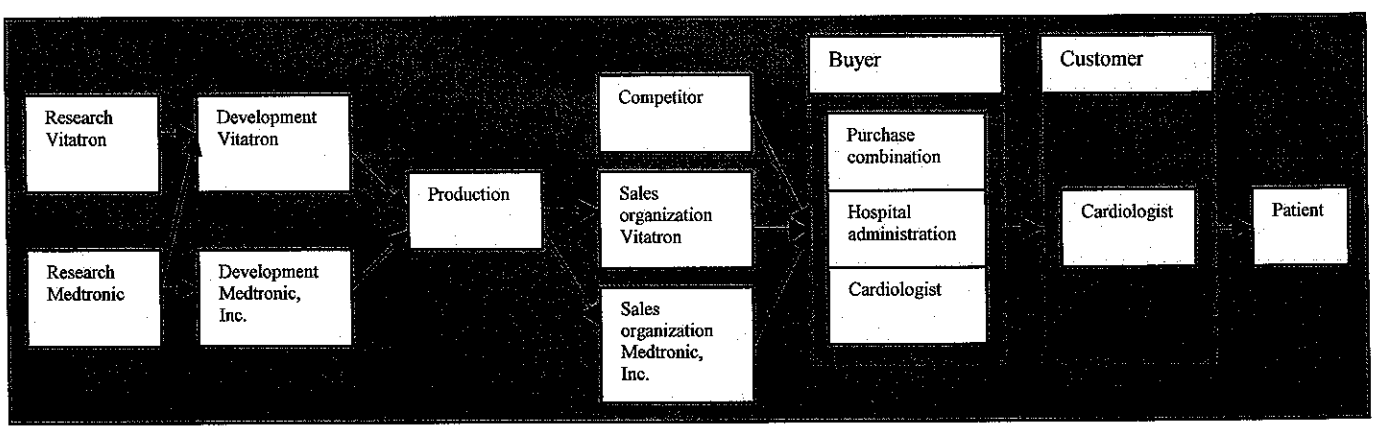


Figure 1.2: Position of Vitatron in the supply chain

Medtronic, Inc. and Vitatron together form the biggest manufacturer of pacemakers in the world with a worldwide market share of more than 50%. There are five big players in the world market. The most important competitors are Guidant, St. Jude, and Biotronik. The market is still growing and a lot of research is done to find other applications for pacemakers. Vitatron is at this moment the fastest growing brady pacemaker manufacturer in the world.
Vitatron and Medtronic have a dual brand strategy. Here both companies strive for cooperation to get a maximal market share in individual accounts by "known thy customer". In a multinational study it was shown that in accounts where both Vitatron and Medtronic, Inc. were present, both brands grew faster than in those accounts where only one of them was present. This dual brand strategy has had a significant impact on the growth of the Vitatron Brand and Medtronic, Inc. as well.

1.4 Mission and Vision of Vitatron

Vitatron has defined its **mission** as follows:
To contribute to human welfare by application of biomedical engineering in the research, design, manufacture, and sale of instruments or appliances that alleviate pain, restore health, and extend life

Vitatron has defined its **vision** as follows.
Worldwide, more than 600,000 patients have been able to begin a new life thanks to a Vitatron pacemaker. A life that once again has become carefree, active, and purposeful. Human physiology is the starting point in the development of our therapies, in which pacemakers are tailored to meet individual patient needs, instead of patients having to adapt themselves to standard therapies. The Vitatron dual sensor rate response, which combines the physiological QT interval sensor with a fast responding activity sensor, is the crown on our commitment to mimicking the healthy heart. By means of this unique sensor the pacemaker is capable to adjust the cardiac rhythm to the patients' metabolic needs, and, unlike any other sensor, it reacts to any kind of stress and even emotion, such as anxiety and love.
In the near future the next generation of fully digital pacemakers will be available, which can be monitored from a remote location. Vitatron encourages these technological advancements because they guarantee faster and better care and the potential to lower societal healthcare costs.

1.5 The Organization

The organization structure of Vitatron can be defined as a functional structure. All activities in the organization are grouped in a department based on a common function [Daft, R.L. 1998]. These departments are. Development & Project Management, Strategic Logistics & Facility, Global Marketing, Clinicals & Education, Research, Strategy & Business Development, HRM, Quality Assurance & Regulatory Affairs, Finance and Information Systems.
This research project has been conducted within the department of Development & Project Management. Currently, the main element of the development organization of Vitatron is the product platform development team. This is a cross-functional project team led by a program manager.
See appendix I for the organization structure of Vitatron on 01-09-2001. Vitatron is rethinking its organization structure and it will be redesigned in the beginning of 2002.
Vitatron is part of the Arrhythmia Management department of Medtronic, Inc. This is shown graphically in Appendix II.

1.6 The Product Creation Process

In figure 1 3 the **start-up process** of development projects within Vitatron is shown. The idea for a new development project could come from several project independent inputs such as: Vitatron product strategy, new technology, existing features and concepts, market, customer, competitor and product performance reporting After the idea has been sent to the PPC (Product & Planning Council), the PPC does a screening on the ideas. The PPC and the VOC (Vitatron Operating Committee) can give an order to an appointed project manager to prepare a project outline including the scope and aim of the project, an estimate of the required resources, and a plan for the Business Analysis Phase During the kick-off meeting the project will be presented to the PPC and the VOC In this meeting the product plan will be presented. Also will be decided whether or not the project is allowed to enter the Business Analysis phase

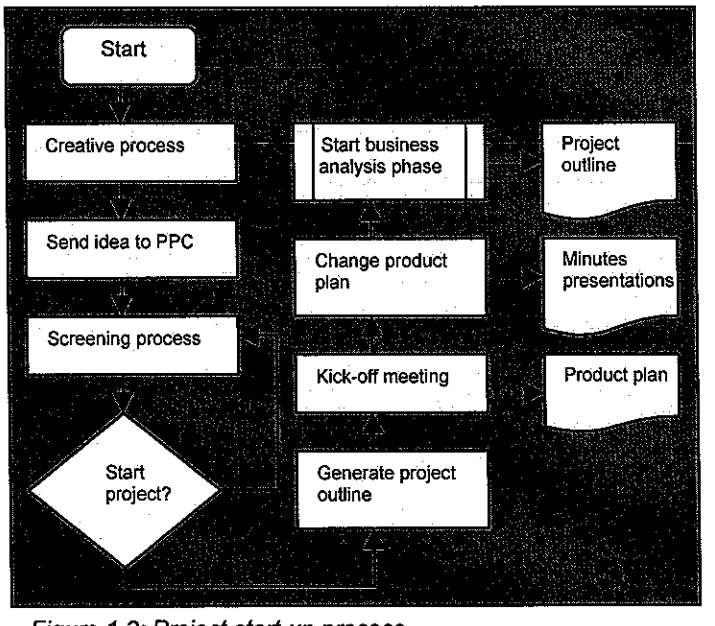


Figure 1.3: Project start-up process

Products and product platforms are being developed according to a procedure called VMPN 446. This procedure will be discussed, because the platform development project DA$^+$, that will be evaluated in chapter 4, has been developed according to this procedure All future derivative products and next generation product platforms are intended to be developed according to this procedure. VPMN 446 is a standard procedure and has been developed during the initial phases of the platform development project DA$^+$ This procedure is applicable to all product or platform development projects that have been approved in the PPC meeting. Figure 1.4 illustrates a model of the development life cycle. In this model a decomposition process is followed by an integration process. A product development project is divided into four project phases: **Business Analysis**, **Commitment Phase**, **Development phase**, and **Evaluation Phase** These project phases and the project phase reviews are included in Figure 1 4. This is a Stage Gate model. In a review meeting it will be decided whether or not a development project can enter the next stage/phase or not.
Project phase reviews will be done by members of the VOC and the PPC for the purpose of assessing whether the objectives of the project phase have been fulfilled. A decision will be made if a development product can enter the next development phase

Business Analysis Phase (B1)
In the PPC Meeting a project manager will be assigned. In the business analysis phase the project manager will initiate feasibility studies, make a marketing plan, forecast profitability and formulate regulatory and clinical strategies. Based on the project inputs, the customer requirements for the product /platform can be established This is phase B1 in figure 1.4.
The primary outcome is to establish the required goals for reliability, customer focus, profitability and market expectations The Business Analysis Phase output is reviewed during the Business Phase Review (BPR) meeting

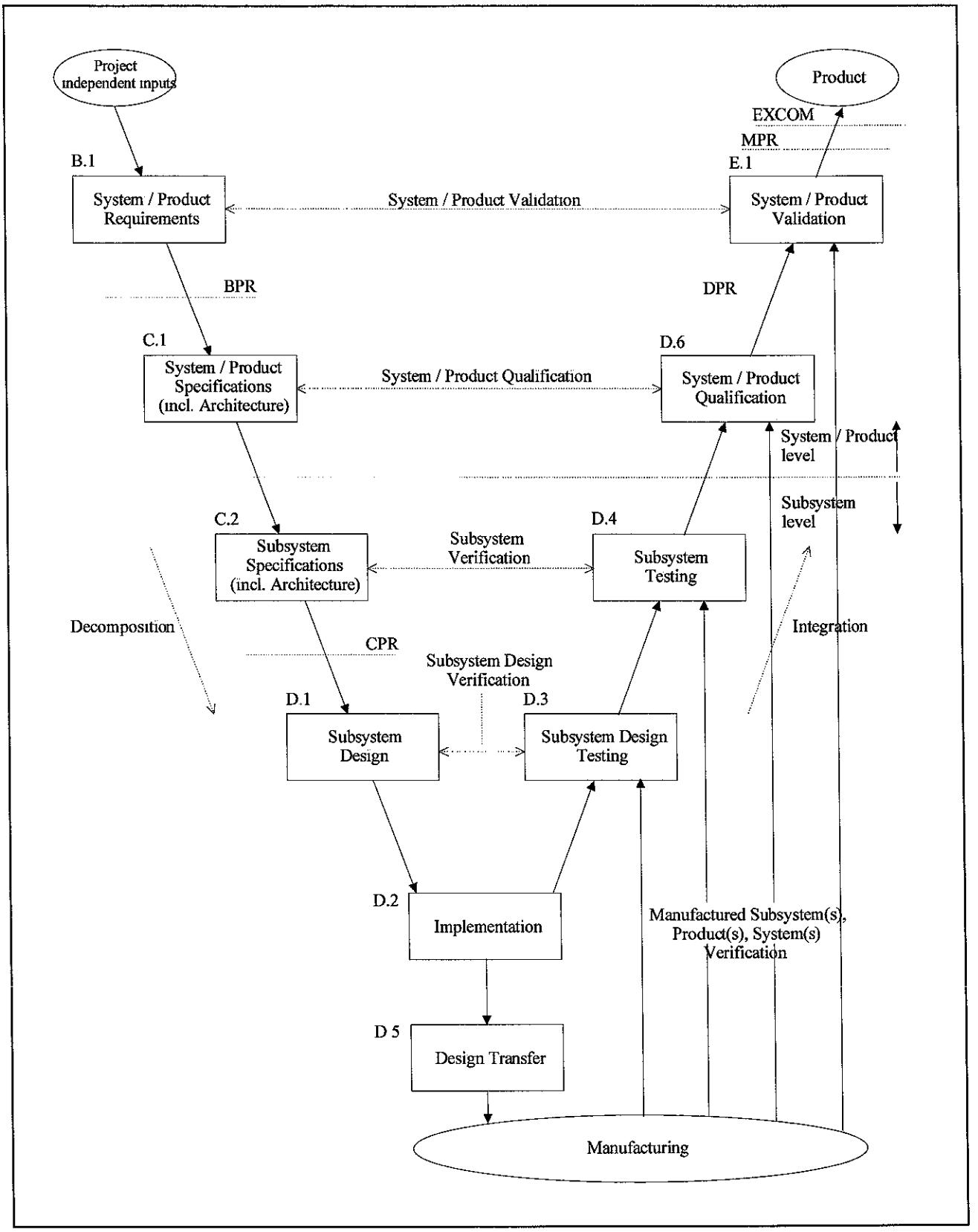


Figure 1.4. Product development procedure VPM 446

Commitment Phase (C1 and C2)

In the BPR meeting a project team will be assigned and the Commitment Phase (C1 en C2 in figure 1.4) will be started. This phase consists of the analysis of the impact on resources. In C1 the System Requirements Specification (SyRS) will be made based on the product/platform description of phase B1. The SyRS determines all the requirements the system has to fulfill and will form the input for the design teams. Phase C2 requires the Competence Centers (CC's, see appendix V) to analyze the new product or platforms on present risk, opportunities, cost estimates, and impact on other projects. The subsystem specifications will be made in this phase. The primary outcome is management commitment to provide resources to the project. The Commitment Phase output is reviewed during the Commitment Phase Review.

Development phase (D1-D6)

The Development Phase (D1-D6 in figure 1.4) completes all project activities necessary to design, document, test, build, and obtain appropriate regulatory agency approval to conduct clinical studies. In phase D1 the subsystems will be designed. The subsystem implementation (D2) is to obtain subsystem design items that are built according to the specifications. In phase D3 the subsystem design will be tested. In phase D4 the subsystem will be tested. Then the design needs to be transferred to the manufacturing organization (D5) and finally the subsystems will be integrated into the system/product and will be qualified in phase D6. These phases will be done by the project team divided into several design teams.
The primary outcomes are documented proof of manufacturability, reliability, clinical readiness, and management approval to start clinical evaluations. The Development Phase is reviewed during the Development Phase Review.

Evaluation phase (E1)

In the Evaluation Phase (E1) the clinical evaluation of the product will be completed and all regulatory approvals necessary to manufacture and market the product in line with the forecasted outcomes will be obtained.
At the conclusion of the integration process a design validation is carried out to determine whether or not the system or product works as intended.
Primary outcome is management approval for a limited and/or full market release. The Evaluation Phase Output is reviewed during the Market Release Phase.

Market release

After Regulatory Approval for Market Release and the approval from EXCOM (Executive Committee of Medtronic, Inc.) the product can be released and a project review has to be made.

Figure 1.4 gives a rather simplified view of product development. In practice there are feedback paths between each phase of the development process and previous phases. Another reason is that a lot of activities are being done in parallel. This means that in practice overlap of design phases is allowed.

This chapter gained insight in the environment of the research project. The problem statement, the research objectives and the research model of this research project will be described in chapter 2.

2. The assignment

A successful research project needs a good research model. In this chapter the model used during this project is shown. In the first paragraph the current platform development will be described. The second paragraph will define the problem statement and the research objective. The next paragraph will discuss the scope of the research project. The fourth paragraph will describe the research model along with the research steps and actions. This chapter ends with a model representing the order and cohesion of the report.

2.1. Current platform development at Vitatron

The product platform concept has become a key concept in the innovation process. This approach can have a radical impact on the way in which both product development and the entire innovative process is conceived. It also affects the development process and has an important impact on the firm's organization structure. By using a platform approach a company can develop a set of differentiated products sharing common technologies. In general terms, the potential benefits of the platform approach are: reduced development and manufacturing costs; reduced development time, reduced systematic complexity; improved ability to update products.
A **product platform** has been defined as a set of subsystems and interfaces that form a common structure from which a stream of related products can be efficiently developed and produced [Meyer & Lehnerd 26]
Vitatron started a platform development project, called DA$^+$. This platform will produce a next generation of pacemakers. The platform development project started in 1998 as a cooperation between Vitatron and Medtronic, Inc. This project was called the Alpha project and was based on APP (Advanced Pacing Platform), a platform project set up by Medtronic, Inc in 1995. At the end of 1999 Medtronic quitted the Alpha project in favour of another broader product platform CRM (Cardiac Rhythm Management). Vitatron adopted the components of the Alpha project which they could use and started their own platform development project DA$^+$.
Vitatron is planning to release the first pacemakers based on this platform in February 2003. This first product series will be called the C_0 -series. Other types of pacemakers will follow within a year.

2.2 Problem definition and objectives

The development of the platform DA$^+$ faced many problems. Because of the complexity of this development project several development phases have been delayed, which will ultimately result in a delayed market release of the first product series of pacemakers based on this platform. Due to this delay some new functionalities have been eliminated from the platform and will be added later.
Vitatron has moved from single product development many years ago towards platform development today, but the organization structure still does not facilitate good product and platform development. This statement is acknowledged by the entire organization.
Based on what is mentioned above and many discussions within Vitatron and outside Vitatron the following problem definition has been formulated.

Problem definition
What is a good organization structure and business process for platform and product development at Vitatron?

The coming years Vitatron will produce several product series based on the platform DA$^+$.
Analysis of the problem statement in the orientation phase has learned that it is useful to focus on two aspects. One aspect is the development of new products based on the actual platform. The other aspect is focusing more on the future. Vitatron is interested how a next generation platform should be developed. The current platform development project will be finished in February 2003. The present problems with the development of the platform provide a good opportunity to rethink the platform development process for the future.

This leads to the following objectives for the research project.

Objectives

- Develop an organization structure and business process for product development based on the existing platform DA$^+$.
- Determine preconditions and develop an organization structure and business process for the next generation platform development at Vitatron.

These two objectives are the guiding principles for the research project.

2.3 The Scope

In consultation with the university tutor and the company tutor the scope of this project has been limited to the following.

- The phases before the kick-off (see figure 1 3) are the most relevant ones, considering important decisions that have to be made on the content of a project. The phases after the kick-off until the evaluation phase (see figure 1 4) are relevant considering the management and organization of a development project. Given the above, this research project will focus on the development phases until the evaluation phase.
- This research project will primarily focus on the process-related aspects of new product and platform development. As a consequence the content related aspects such as the designing process itself will get less emphasis.
- This assignment is restricted to the development of IPG (Implantable Pulse Generators) related items only. The development of leads and programmers is beyond the scope of this project.

2.4 Research model

The research model guides the research project activities and shows the logical steps during the project to fulfil the objective [Verschuuren & Doorewaard 29]. The model is shown in figure 2.1

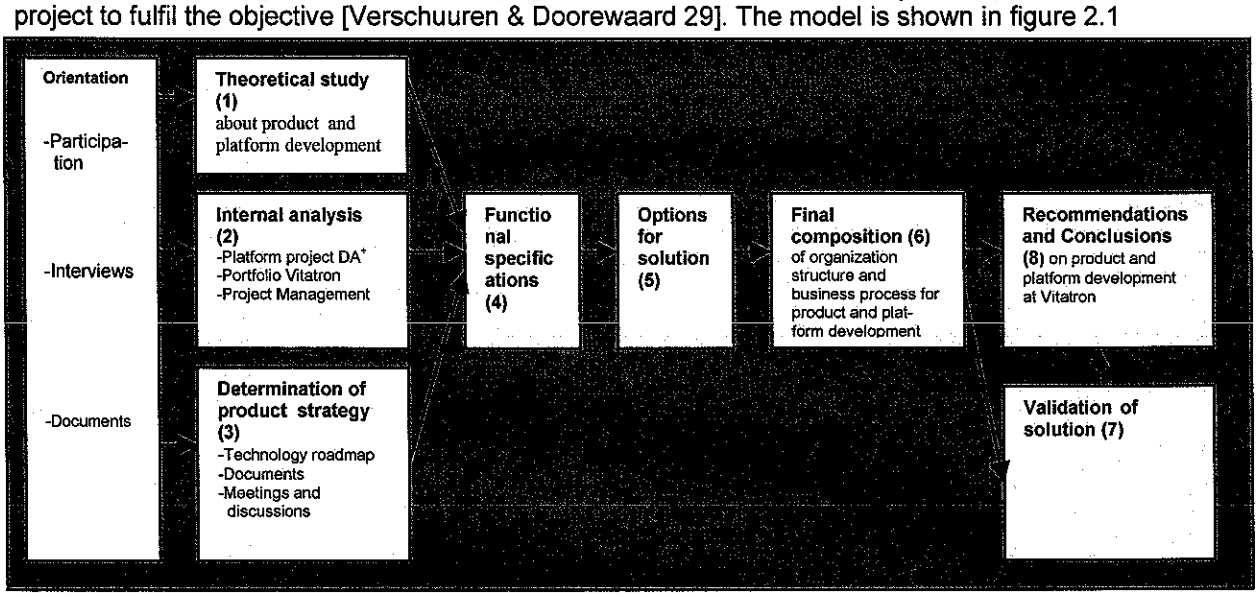


Figure 2 1. Research model

The mentioned steps of the research model, shown in figure 2.1, need some explanation.

Orientation (Input)
This phase consists of the introduction in the company. The organization, development processes, development projects, and management will be studied. This phase results in formulating the project's objective. The information is gained through the following methods of data collection [Kempen & Keizer 4]: participation, interviews, and documents.

Theoretical study (1)
A literature study will be done to investigate new product development and the discussion about product platforms in general. It will focus on the organization structure and business process of product development based on product platforms. This study is also focused on the development of a next generation platform.

Internal analysis (2)
The internal analysis consists of many parts:

- According to a conceptual model the current platform development project DA$^+$ will be analyzed. This analysis is mainly based on documents of the development process, interviews with members of the core team of DA$^+$, and participation in weekly meetings of the core team.
- A project map of Vitatron development projects will be made to gain additional insight in the present product portfolio of Vitatron
- The current project management structure will be analyzed, by interviewing project managers

Determination of product strategy of Vitatron (3)
The product strategy of Vitatron will be determined to gain insight into future product portfolio and development projects of Vitatron. A technology roadmap will be made to link strategy to necessary technologies. All this is based on the following.

- Strategic plans
- Management meetings about the future product portfolio of Vitatron
- Interviews with the general director, the director of strategy and new business development, development director, and the company tutor.
- Interviews with project managers

Functional specifications for a solution (4)
From the internal analysis, literature, and the strategic vision, the functional specifications for the final solution of a new organization structure and business process for product and platform development will be defined.

Options for solution (5)
The functional specifications give rise to the design of a new organization structure and business process for product and platform development at Vitatron. There is not one solution for an organization structure and business process for product and platform development. Therefore several options will be considered and evaluated on their advantages and disadvantages.

Composition of organization structure and business process for product and platform development (6)
One option will be chosen during a discussion with the stakeholders. This design will be further developed into more detail

Validation of solution (7)
The composition of an organization structure and business process will be tested if it answers the research questions and if there is enough support within Vitatron for implementation.

Recommendations on product and platform development at Vitatron (8)
The research project will be concluded with a set of recommendations and conclusions, based on the final proposition of an organization structure and business process for product and platform Further implementation of the design will be started afterwards.

2.5 Structure of the report

The previous chapter provided insight in the organization of Vitatron and Medtronic, Inc. This chapter describes the assignment and the research model. The third chapter adds some theoretical backgroud on the organization and management of product platforms. The fourth chapter will analyze and evaluate the current product & platform development. Chapter 5 comprises an organization structure and business process for product and platform development at Vitatron. The conclusions and recommendations derived from this research project for successful implementation of an organization structure and business process are set out in Chapter 6. The structure of the report is visualized in figure 2.2.

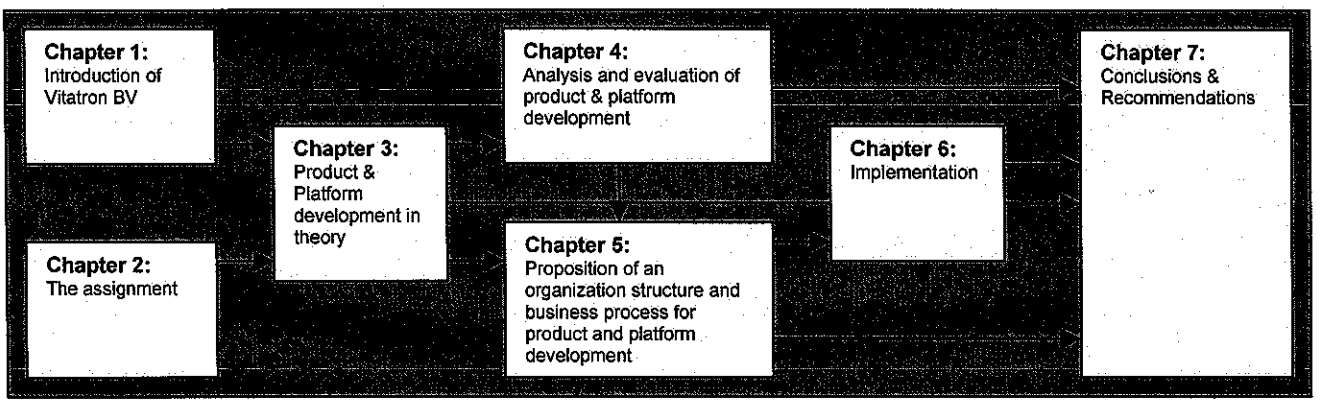


Figure 2.2: The structure of the report

In order to manage and organize product platforms successfully, insight has to be gained into different aspects of product platform development. In the next chapter different opinions and best practices of an organization structure and business process for product platform development will be discussed

3. Product and platform development in theory

This chapter gives a literature review on product and platform development. First, it discusses a successful product development process and then it gives insight into the development of a product platform. Then the review will focus on managing and organizing a product platform.

3.1 A successful product development process

A Stage gate system can help to drive new products to the market, quickly and successfully The Stage gate process is simply a template or roadmap for driving new product projects from idea through to launch and beyond [Cooper 2] It breaks the product innovation process into stages, typically five or six, with each stage comprising a set of parallel, cross functional activities Between the stages are gates: these gates open or close the door for projects to move to the next stage. A typical stage gate process is shown in figure 3 1

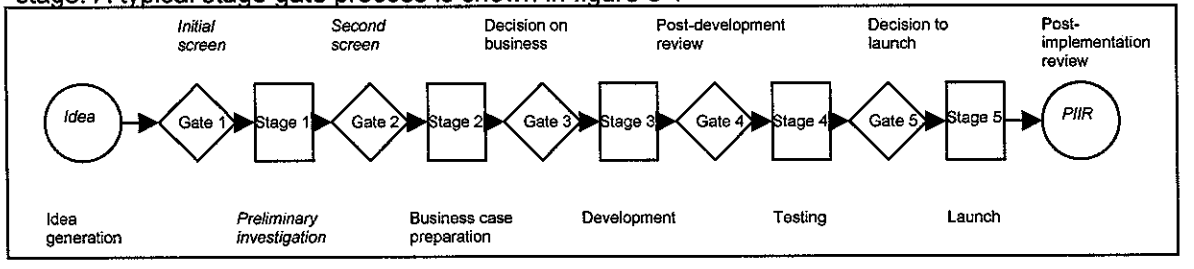


Figure 3.1. A 5-stage gate process [Cooper 2]

Each stage specifies the required actions, including the details on how to do each task as well as various best practices. The gates make the process work: they specify the deliverables or the desired results on each stage, and hence expectations for project teams and leaders are crystal clear. Stage Gate systems improve the efficiency of the NPD (New Product Development) process, because they improve teamwork, discover faults in the development process more quickly and they integrate best practices and critical success factors in the process.
Common denominators of successful product development have been identified by Cooper [2].

- **A unique, superior product**

Superior and differentiated products are the number one driver of success and product profitability.

- **A strong market orientation-market driven, customer focused**

A thorough understanding of customers' needs and wants, the competitive situation and the nature of the market is an essential component of new product success. Not only does a strong customer focus improve success rates and profitability, but it also leads to reduced cycle time.

- **Pre-development work, the homework**

Countless studies reveal that the steps precedinging the actual design and development of the products make the difference between winning and losing Successful firms spend considerably more time on these vital up-front activities, such as: initial screening, preliminary market assessment, preliminary technology assessment, detailed market research, business and financial analysis as part of the business case preparation.

- **Sharp and early product definition**

How well the project is defined prior to entering the development stage is a critical success factor Companies should undertake excellent product and project definition before the door is opened to a full development program.

- **A true cross-functional team effort**

Product development projects must be organized using a cross-functional team with members from R&D, engineering, marketing, operations, and finance. It should feature a team, where team

members are not just representatives of their respective functions The team members should be in constant contact, a strong project leader should lead the project, and the project should have top management commitment.

3.2 Defining a product platform, product family and product architecture

By sharing components and production processes across a platform of products, companies can develop differentiated products efficiently, increase the flexibility and responsiveness of their manufacturing processes, and take market share away from competitors that develop only one product at a time. This approach affects the way in which both product development and the entire innovative process, including relationships with suppliers and customers is conceived [Clark & Fujimoto 1]. It affects the development process and also has an important impact on a company's organization structure.
First, it is essential to gain organizational consensus on the definition of platforms within a business of a company. Meyer & Lehnerd [26] define a **platform** as:
A set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced. Derivative products range from cost-reduced versions of existing products to add-ons or enhancements for an existing production process [Wheelwright & Clark 21].
A **product family** is defined as a set of products that share common technology and address a related set of market applications. A product family typically addresses a market segment, while derivative products target niches within that segment [Meyer & Utterbeck 11]
Another concept that is related to the product platform and the product family is product architecture. Ulrich [19] defined **product architecture** as:
The scheme by which the function of the product is allocated to physical components" or "the arrangement of functional elements, the mapping from functional elements to physical components; the specification of interfaces among interactive physical components.

3.3 Managing a product platform

As pointed out by Meyer and Lehnerd [26] new platform development must be pursued on a continuing basis, embracing technological changes as they occur and making each new generation of a proposed line more exciting and value-rich than its predecessors. Effective design and development of product platforms allows a company to deliver distinctive products to the market while conserving development and production resources, but also involves managing a basic trade-off between distinctiveness and commonality. On the one hand, there are market benefits to offering several very distinctive versions of a product; on the other hand, there are design and manufacturing benefits to maximizing the extent to which these different products share components.
Meyer & Lehnerd [26] proposed a general framework for the evolution of a product family, shown in figure 3.2. The figure represents a single product family starting with the initial development of a product platform, followed by successive major enhancements to the core product and process technology of that platform, with derivative product development within each generation.

An entirely new platform emerges only when its basic architecture changes. Subsystems and interfaces from prior generations may be carried forward into the new design but are joined by entirely new subsystems and interfaces. This can be seen in figure 3 3.

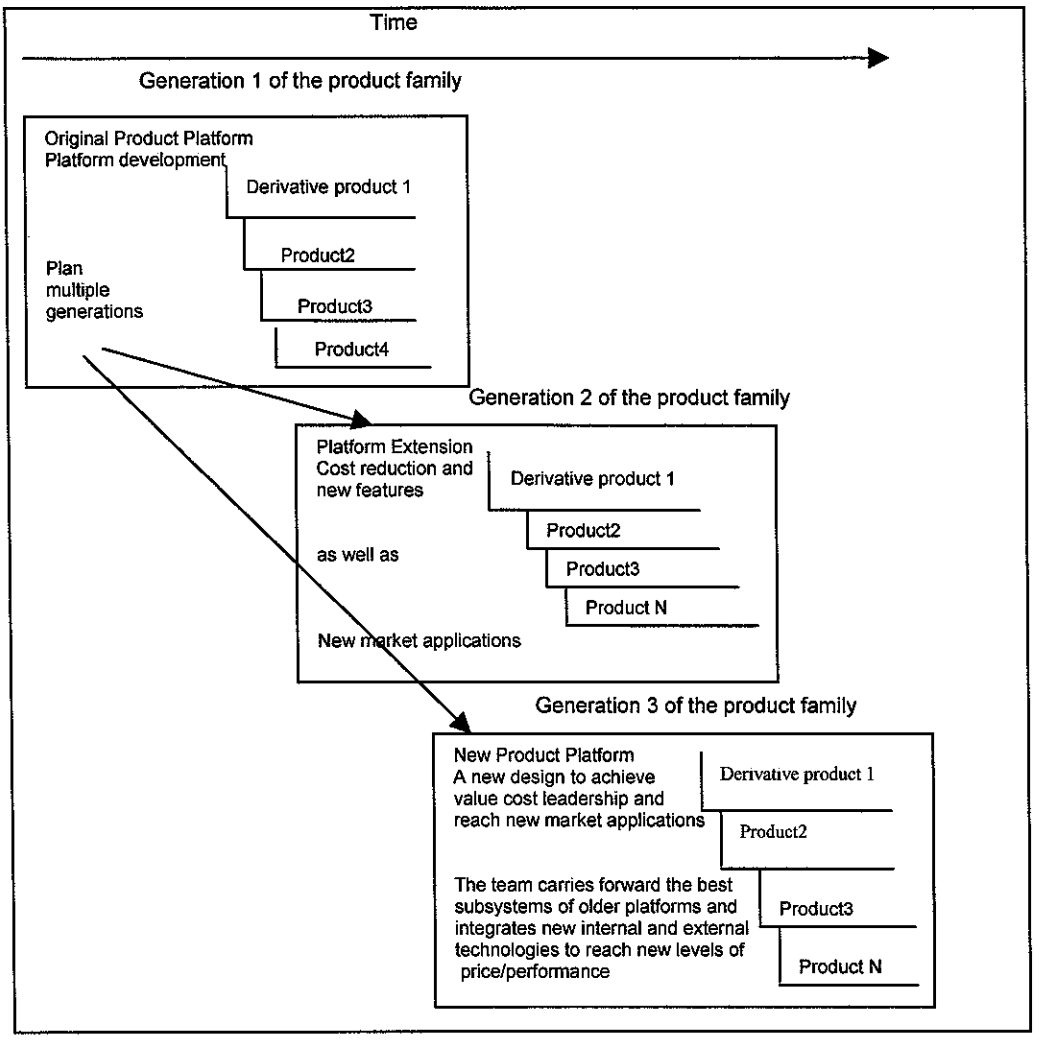


Figure 3.2: Product family evolution, platform renewal and new product creation [Meyer & Lehnerd 26]

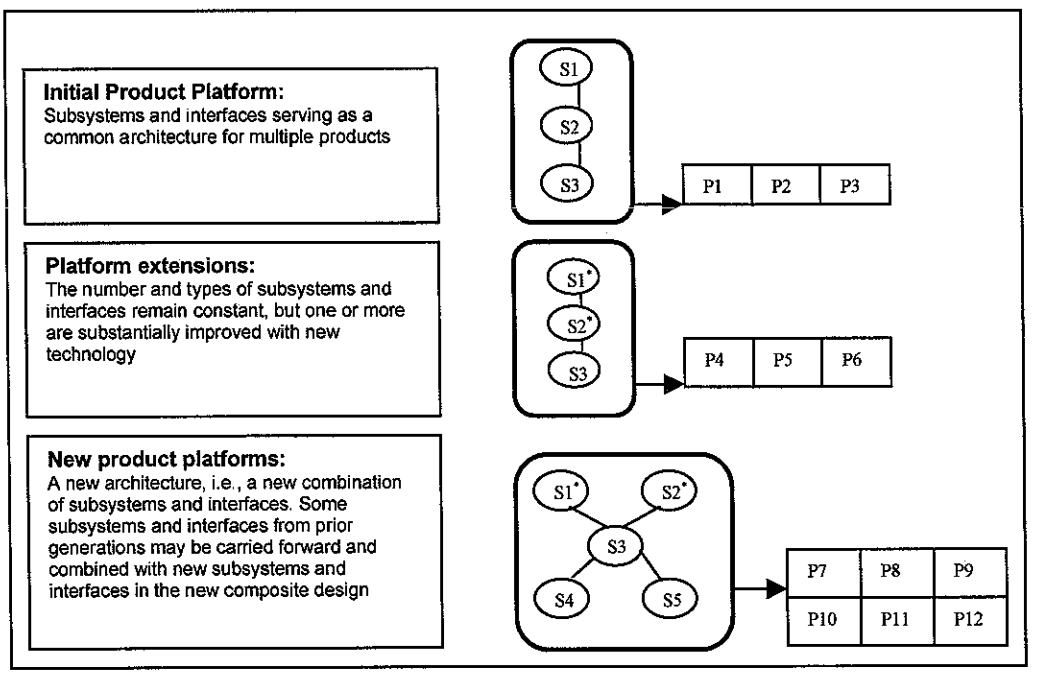


Figure 3.3: Defining changes to product platforms [Meyer & Lehnerd 26]

According to Meyer and Lehnerd [26] effectively managing the evolution of a product family requires that management considers in collective fashion three essential elements of the enterprise. (1) the market applications of technology, i.e., derivative products made for various customer groups, (2) the company's product platforms, and (3) the common technical and organizational building blocks that are the basis of product platforms. These elements fit in a conceptual framework, which is called the "Power tower". The building blocks are categorized in four areas.

1. Insights into the minds and needs of customers and the processes of customer and competitive research that uncover and validate those insights
2. Product technologies in components, materials, subsystems interfaces, and development tools
3 Manufacturing processes and technologies that make it possible for the product to meet competitive requirements for cost, volume, and quality.
4. Organizational capabilities, which include infrastructures for distribution and customer support, as well as information systems for control and market feedback.

Principles of platform management
The following principles of platform management are defined [Meyer & Mugge 10]

- **Platform renewal must be continuous**

To achieve sustained success in new product development, a company must continuously renew its platform architectures and its manufacturing processes by integrating advances in the core product and process technologies

- **Interfaces can be strategic**

Clearly defined interfaces between subsystems of products ,and between products , provide product designers with the degrees of freedom needed for the rapid and cost efficient creation of derivative products.

- **Clever architects design their platforms to enable recurring revenue**

The platform must be designed so that it can be upgraded by integrating new modules easily and that it can be upgraded with new applications. These possibilities provide revenue.

- **Manufacturing should not be forgotten as a key enabler**

It is important to use standardization in sub-systems and interfaces to drive production and deployments costs down

- **Growth comes from attacking new markets, leveraging existing competencies into new platform architectures for new product or service lines**

It is important to create platforms that leverage technologies and competencies into new markets. Platform technologies with different applications can be used for other markets.

According to Meyer [9] companies can use a simple grid to segment their markets Here, major market segments are arrayed horizontally, each representing the major customer groups served by the firm's products The vertical axis of the market segmentation grid represents different tiers of price and performance. Now it is possible to consider platform strategies:

- **Strategy 1**. Niche specific platforms with little sharing of subsystems and manufacturing processes. Each market niche is served by a different platform architecture. The result is a myriad of product families with few shared subsystems or manufacturing technologies and higher costs.
- **Strategy 2**. Horizontal leverage of key platform subsystems and manufacturing processes. A product platform is leveraged from one market niche to one other within a given price performance. The benefit is that a company introduces streams of new products across a series of related customer groups without having to reinvent the wheel for each group. The

standardization of key subsystems across a product family can improve product performance and reduce costs.

- **Strategy 3**: Vertical scaling of key platform systems. The company seeks to address a range of price-performance tiers within a market segment with common product platforms. The benefit is that the firm is able to leverage its knowledge of any particular market segment and to do so through product development that will be less costly than if an entirely new platform had to be developed for each tier price performance. The risk is that a weak common platform or weak common subsystems undermine competitiveness of the entire product line. A special type is the "beachhead strategy (shown in figure 3.4)". Here the company develops a low-cost but effective platform and the processes for making it efficiently, for one particular segment of low-end users. From that initial market foothold, engineers then scale up the performance characteristics of the platform and add other features designed to appeal to the needs of other segments. Extensions are made to make the platform ideal for other segments.

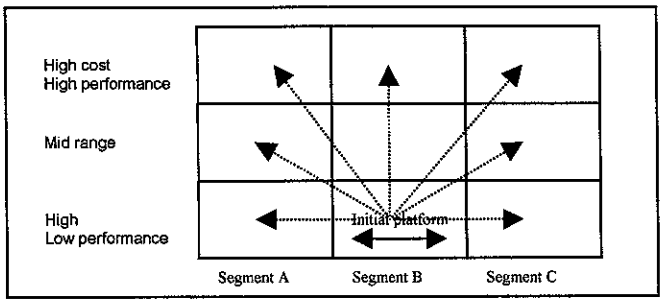


Figure 3.4: Beachhead strategy [Meyer 7]

3.4 Organizing a product platform

In the organization theory an organization is assumed to be a collection of social entities that process and exchange information and together achieve the overall business goal or goals. The work within an organization can be divided into tasks. Tasks interact and coordination of those tasks is important for a successful organization. An effective manner to coordinate a project is to assign tasks to a design team. Organization theory advises to structure tasks into groups of tasks as independent as possible in order to minimize overall coordination effort and increase speed [Oosterman 23].

Product development processes and problem solving structures associated with them correspond to a large degree to the structure of the product to be designed [Wheelwright & Clark 30]. Product architecture has been defined as the functional arrangement of the sub-systems (building blocks) of a product [Ulrich 19] Oosterman [23] argues that effective organizations in competitive environments group their design tasks around a product's building blocks. Effective design projects strive to allocate the conception of each building block to an organizational unit solving all interactions within the block. This is depicted in figure 3 5. Moreover, several authors have claimed effectiveness for organizational structures that mirror the product architecture [Henderson & Clark 2, Sanchez 15]. The interactions between design teams have to be efficiently managed. This is defined as system-level coordination

Modular product design requires a state of technological knowledge about components and their interactions that is adequate to fully specify how components will perform and interact in a product design As a consequence, modular product architectures must be based on technologies about which a firm has developed a high level of understanding at the time development begins. Thus the development of new technologies must be decoupled from and precede the development of new modular products. These activities should be organized as autonomous self-managing development teams [Sanchez & Mahony 16].

Interactions between components (building blocks) need to be standardized and fully specified in the beginning of development [Sanchez & Mahony 16]. A modular product architecture is a system of loosely-coupled component designs that is created by standardizing component interface specifications and by specifying component interfaces to allow substitution. The development activities of these components should be undertaken by self-managing groups. These can function autonomously and concurrently [Sanchez 15].

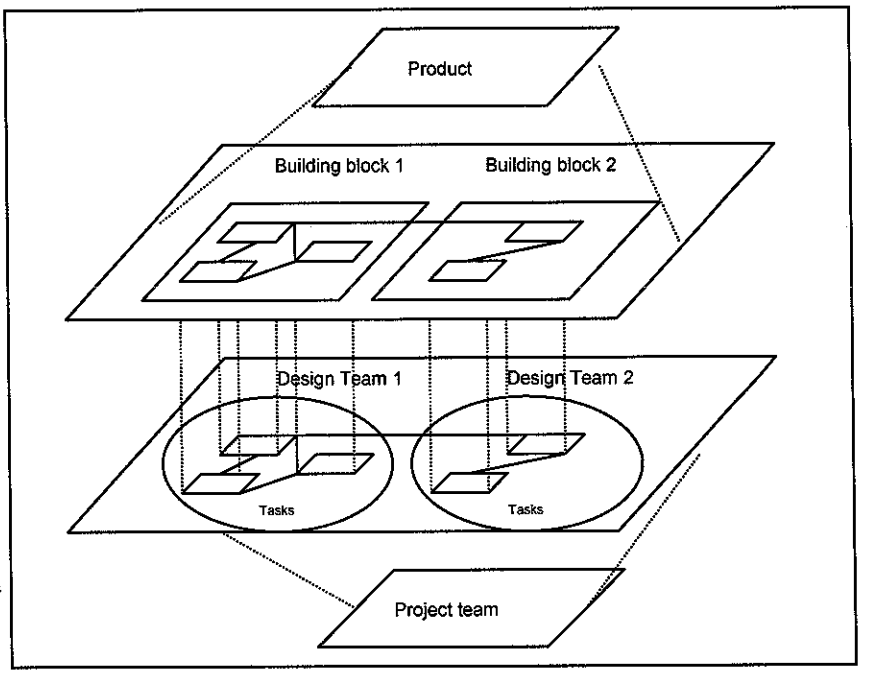


Figure 3.5: Reflecting product architecture within the organization [Oosterman 23]

In organizational terms a platform strategy has an impact on the product development process and on the organization structure adopted Experience indicates that successful innovation through teams has three ingredients. ownership, empowerment, and constancy [Meyer & Lehnerd 26]. Ownership is control, a charter to make the decisions required by the task. Empowerment provides teams with the time and resources necessary to do the job. Constancy means that ownership and empowerment are granted for the full term of a project, from conceptualization until such time as the concept has either succeeded or failed in the market.

Provide ownership at every level

Within product families, ownership must be provided to teams developing each product platform and its respective derivative products. From an organizational perspective, that means the corporation should "look" like the things it seeks to make.

A platform based organization resembles a "Spiders's" web, which is shown in figure 3.6.

In this figure, platform teams are networked to derivative product teams and to one another. As new platforms are brought online, derivative product teams are formed. Naturally, each team must have a clear charter that, among other things, assigns boundaries to its work and prevents conflicts with other teams In this way a team is clearly focused.

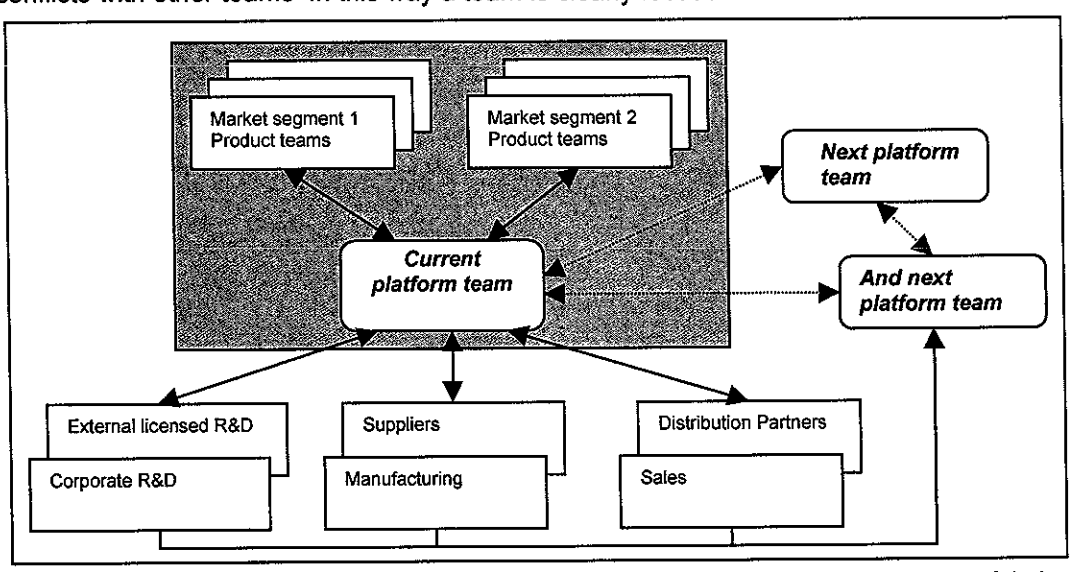


Figure 3.6. Spider's web organization for product family development and renewal [Meyer & Lehnerd 26]

Staffing platform development teams
Platform and derivative product teams should be small and cross-functional, limited to dedicated individuals who collectively represent a range of functional skills and interests The first team member should be a leader and he should work with top management to identify and recruit the remaining players, balancing the team with other key people from key functions: product design, manufacturing, and marketing development.

Co-location is important
The principles of co-locating teams, exposing them to a variety of information, and providing a persistent display of that information are important to business as well. Just bringing team members together into one physical place has shown to improve communication and information sharing. Team co-location also fosters bonding between individual member's commitment.

Organizing and leading project teams
Effective product and process development requires both that all of the organizational groups involved develop and bring to bear the appropriate specialized capabilities, and that the efforts of all these groups be appropriately integrated [Wheelwright & Clark 21]. The focus of this paragraph is on the range of organizational options for directing development projects and their associated options for project leadership It begins by outlining four types of project organization structures and their primary differences. Wheelwright & Clark [30] defined four levels of development teams:

- Functional: The work is completed in the function and coordinated by functional managers
- Lightweight: A coordinator works through liaison representatives but has little influence over the work.
- Heavyweight: A strong leader exerts direct, integrating influence across all functions.
- Autonomous: A heavyweight team is removed from the function and dedicated to single project and is co-located

Research has shown [Wheelwright & Clark 30] that the heavyweight team structure may be highly effective for platform or next generation development, but the approach of heavyweight teams can be an overkill for those projects so small that only a few engineers need to work on the project. Then a lightweight or functional structure is preferable because it is relatively easy to subdivide tasks and to pass a project from one function to another. In Appendix III a further explanation of these development teams is shown

3.5 Conclusion

It becomes clear that the product platform development concept affects the organization structure and business process of product development within a company. Considering the problem definition of this research project "What is a good organization structure and business process for product and platform development at Vitatron" this literature research gained insight into how "best in class" companies manage and organize their product platforms:

- Major markets must be segmented
- Core competencies and a platform strategy must be defined.
- A product platform must be designed taking the platform strategy and core competencies into account, whereby interfaces between the building blocks are important.
- A roll-out plan of derivative products of the platform must be made and a product platform should be managed as evolving entities.
- A product platform must be continuously renewed and should be pre-developed
- Design teams must be composed around a product's building blocks
- A cross-functional co-located heavyweight team structure can be very effective to develop big derivative products or product platforms, but can be an overkill for small derivative projects

In this chapter theory was explored about the organization structure and business process for the development of product platforms. This will be used to evaluate product and platform development at Vitatron in chapter 4 and it forms input for the design criteria in chapter 5.

4. Analysis and evaluation of product and platform development at Vitatron

In this chapter product and platform development at Vitatron will be analyzed and evaluated. First the product and platform development projects of Vitatron will be positioned. Then in paragraph 4.2 the product platform strategy will be analyzed and the objectives of the product platform development project DA+ will be discussed. Paragraph 4.3 will evaluate the product platform development project DA+ and provides conclusions. The composition of the paragraphs of chapter 4 is summarized in figure 4.1.

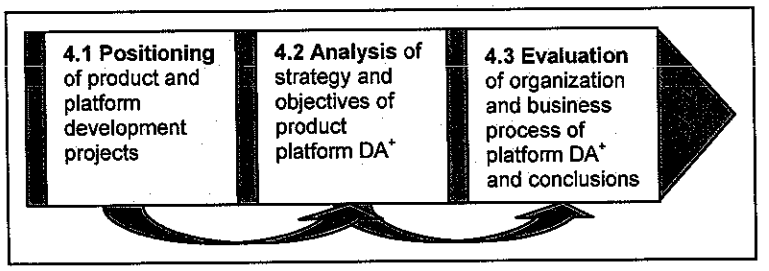


Figure 4.1: Composition of chapter 4

4.1 Positioning of product and platform development at Vitatron

This paragraph describes the positioning of product and platform development at Vitatron. First a consumer/technology matrix of current development projects will be presented to analyze the current development project portfolio. Then the most important research projects and product platform development projects within Vitatron will be discussed. Finally conclusions about the development projects portfolio and about portfolio management will be provided.

The consumer/ technology matrix of Vitatron

Creating a project map gives direction and clarity to the overall development effort and helps to lay the foundation for outstanding project performance. An initial step to realize that is to make a project map [Wheelwright & Clark 30]. This will be done in this paragraph.

It is important to define projects in categories [Wheelwright & Clark 21]. Each type of project has a different role and provides a different competitive contribution. Each type of project also requires different levels and mixes of resources, and typically generates different results. It links to business strategy, gets capacity requirements clearly defined and provides implications on thinking about future projects. It helps with building development capability. In figure 4.2 the consumer/ technology matrix theory developed by Unilever is used to define the development projects at Vitatron. This theory categorizes the following project types.

Breakthrough:	First to the market with new core product exploiting radical technology and/or unique market concept. Scope for sustainable category dominance but with associated high risk.
Platform:	Superior product concept or attributes relative to available products in the market. Should yield significant share gain with potential for sustainable category strength. Constitutes base for future derivatives and/or line extensions. Meyer and Lehnerd [26] describe a platform as a set of subsystems and interfaces that form a common structure from which a stream of related products can be efficiently produced [Meyer & Lehnerd 26].
Derivative:	Extension of Platform product. Offers distinctive claims, features, and market positioning relative to competition.
Brand support:	Usually "cosmetic" changes maintaining contemporary market image.

The consumer/ technology matrix is a graphic representation of the strategic importance of the projects in the markets. The following development projects are mapped. An explanation of the typologies of the matrix and its interpretation can be found in Appendix IV.

1. **DA+**: DA+ is a platform development project. It constitutes a basis for future derivative products. Existing functionalities have been implemented in the product platform using totally new technologies. New functionalities have also been added to the platform. These new

functionalities are not new to the market, but are improvements of existing functionalities. The first derivative series will be the C_0-series

2. **Slate**: This project transfers PROVIT software for the new Medtronic/Vitatron Slate programmer. Slate is programmer software that already exists, but now has to run on a new programmer. The application has not changed, but the programmer has. This is a minor change in technology. The application is not new to the customer. This project is defined as brand support.
3. **Discover 3**: Discover 3 is a tool for doctors that provides the following new features: Trend analysis and Editor "Mydiscover". Discover 3 is a tool that is new to the market, but the used technologies are well known by the company. This project is defined as brand support.
4 **HF**: HF is a new bi-ventricular product based on the HF (Heart Failure) therapy. HF is for Vitatron a new product, but existing technologies and processes are used to develop it. It is an addition to a product family and is new to the market. This project is a derivative project of the previous platform Dema.

As discussed in chapter 3 a product platform is a set of subsystems from which a stream of derivative products can efficiently be produced. Vitatron planned a number of derivative products to be created from the platform. A platform approach to product development reduces manufacturing costs, improves flexibility, and provides significant economies in the procurement of components and materials because so many of these are shared between individual products [Meyer 10]. Vitatron planned to produce the following derivative products:

5. C_0-series. Mid model (February 2003)
6. C_1-series. Mid model (May 2003)
7. R-series: Basic model (September 2003)
8. T_0-series: Top model (September 2003)
9. T_1-series Top model (September 2004)

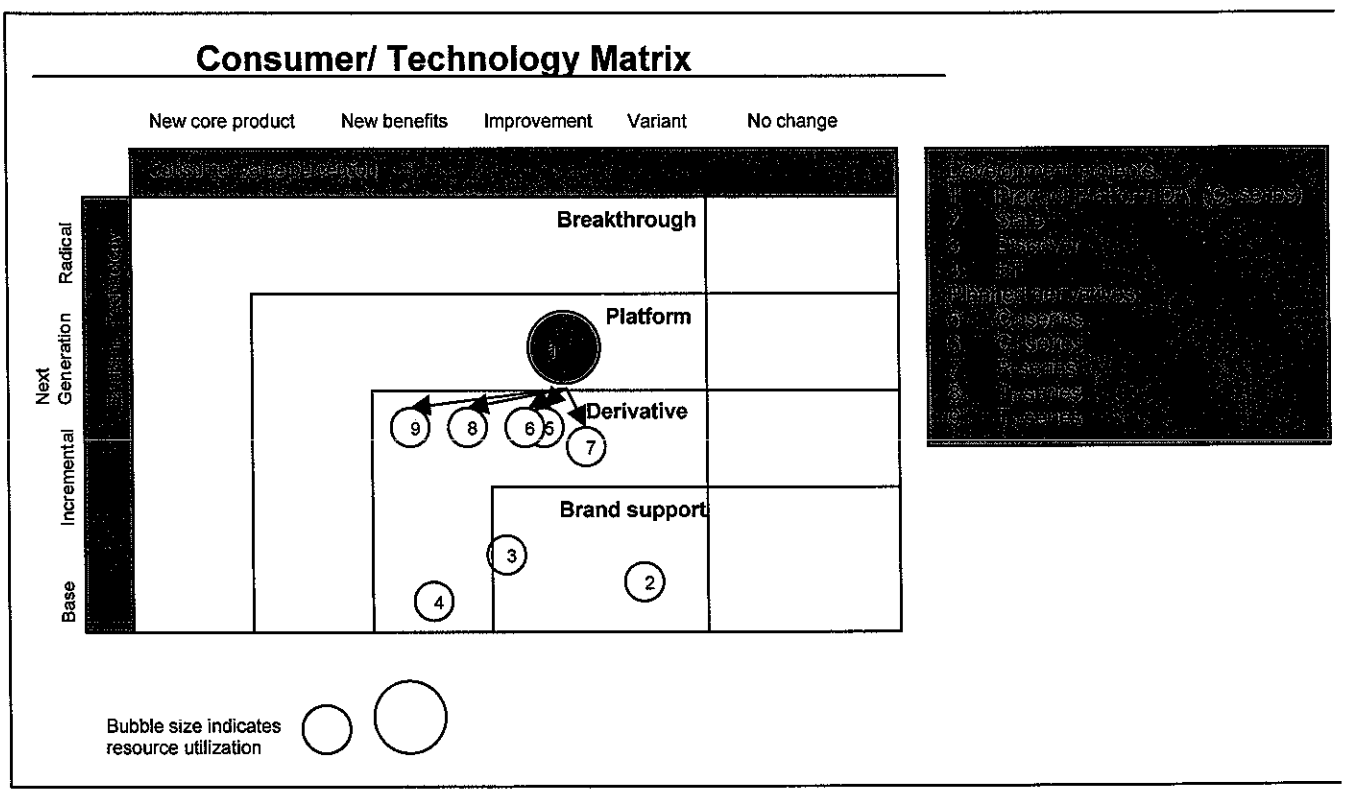


Figure 4.2. The consumer technology matrix of Vitatron

Research projects
This year (FY 02) there are five main research projects in the research department:

- ATP AF (Anti Tachy Pacing Atrial Fibillation), a therapy that stops Atrial Fibrillation
- Autosensing: A tool for automatic adjusting of power and sensing tools.
- Capture control: A diagnostic feature that monitors ventricular thresholds between follow-up visits and, when necessary, automatically adjusts output voltage and pulse width.
- Diagnostics observations: Diagnostic observations is a programmer feature that automatically analyzes all diagnostic pacemaker data and notifies the physician on notable events.
- FFRW: FFRW is a sensing method to discriminate Far Field R-Wave from atrial events based on DSP.

These features are ready to be developed and will be added in the next derivative series.

Product platform development within Vitatron
A definition of a platform that represents best all the definitions that are used by the employees of Vitatron defines a platform as a technological basis for new pacemakers, which consist mainly of standardized hardware components. The definition of Meyer that describes a product platform as a set of subsystems and interfaces that form a common structure from which a stream of related products can be efficiently produced [Meyer & Lehnerd 26]. This definition contains more than only hardware, namely, people, processes, and markets
The first platform introduced by Vitatron was the DDD-3 platform The Collection series was based on this platform. DDD3 was developed in the beginning of 1990. This development project was driven by a small organization and about 35 people worked on this platform. Two platform extensions were produced based on this platform: the Diva and the Dema The Diva was introduced in 1996. The Collection II product series was based on this platform. Dema was introduced in 1998. Derivative products based on this platform are the Selection and the Clarity. Presently about 200 people are working on the second product platform DA^+
Several derivative product series based on this platform and several platform extensions will be developed in the near future. All derivative products are based on one platform. For this reason the development of the product platform DA^+ is extremely important to Vitatron. All platforms and platform extensions are summarized in figure 4.3.

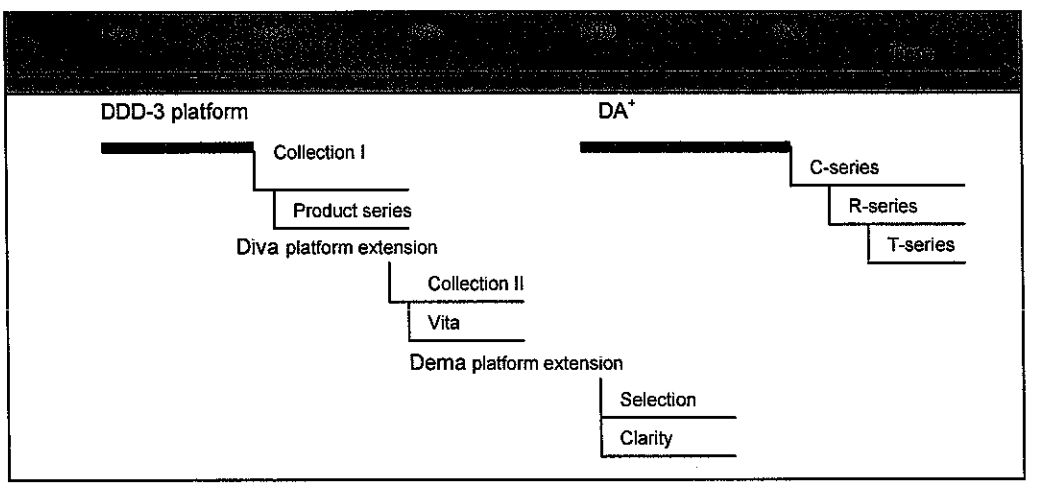


Figure 4.3: History of platform development at Vitatron

Conclusions related to the development project portfolio
The conclusions related to the development project portfolio are summarized below:

- **Not many development projects**
  Due to the size and importance of product platform DA^+ (DA^+ requires more than 80% of the development capacity) there are presently not many projects in the development phase at

Vitatron. This implicates a risk for Vitatron, because there is no focus on other new development projects that could be very important for Vitatron.

- **No balance between the short-term and the long term**
  In the consumer/technology matrix there is no balance between the short-term and the long-term. Currently there is one long-term product platform development project and only one short-term derivative development project. The interpretation of the consumer/technology matrix (Appendix IV) indicates that the development of a long term product platform development project and several short-term derivative projects simultaneously is preferable. Before the development of product platform DA$^+$ Vitatron only focused on the short term and started too late with the development of a new product platform.

- **Products not new to the market**
  The first derivative product series based on the product platform contains many new technologies, but will not be new to the market. The interpretation of the consumer/technology matrix indicates that technical benefits of the product platform are not supported by consumer communication.

Conclusions related to portfolio management
Research within Vitatron through desk research and interviews with many project and functional managers resulted in some conclusions about the management of the development project portfolio of Vitatron. The conclusions are summarized below:

- Management of the development project portfolio is not integrated in the development organization of Vitatron.
- The various development projects are managed separately and influence each other. There is no aggregate plan. This results in a scattered planning and difficulties in the overall planning and in the allocation of resources. Besides there is no tool to choose between development projects.
- There is no overall owner of all development projects together.

4.2 Analysis of the strategy of product platform DA$^+$

DA$^+$ is a product platform development project. DA$^+$ is based on the Advanced Pacing Platform Technology (APP) that was initiated by Medtronic, Inc. in 1995. In 1998 a cooperation between Medtronic and Vitatron was started to produce a combined product platform for brady pacemakers, called Alpha. In 1999 Medtronic, Inc. decided to develop another platform CRM (Cardiac Rhythm Management) and therefore cancelled DA$^+$ because of lack of capacity.
The DA$^+$ program objective is to develop a pacing platform capable to support the development of several product families of implantable pulse generators (pacemakers) and their software application on the programmer. The product platform DA$^+$ is capable of supporting the next mainline Brady-, and AF products and the IC chipset will be prepared for HF therapy.

The most important arguments for Vitatron to choose for the product platform strategy of DA$^+$ are listed below:

Future extensibility
DA$^+$ has future platform extensibility. That means that the platform can be upgraded easily with new technology components. The first derivative series will contain technologies that will not be used initially. These technologies will be used by functionalities in next derivative product series. DA$^+$ will introduce Digital Signal Processing (DSP). The first derivative series will contain the technologies of DSP, but will not use it. New features based on DSP will be added in the near future in next derivatives based on DA$^+$.

Scaling down the product platform
The platform strategy in 1998 was to produce a top model and then produce all other derivatives at once by scaling down the product platform. The next derivative series (C-series and R-series)

will be obtained by scaling down on a range from high cost and high performance to low cost and low performance. The next derivative series will share many technologies and functionalities with the T-series but these functionalities cannot be used or will be elimintated The product platform will support all future Brady, AF, and HF pacemakers.

Cooperation with Medtronic, Inc.
The intent in 1998 was to cooperate with Medtronic, Inc. in the development of an entire product platform. As Medtronic, Inc. canceled the Alpha project, Vitatron could transfer four electronic chips into product platform DA^+ and Vitatron had to develop one electronic chip by itself

Integration of technologies, functionalities, development processes and people
The intent was to develop a superior product platform with new technologies, new functionalities, new development processes, and partly new people.

Integration of product and platform development
Within Vitatron product and product platform development are integrated. All future derivative products will depend on the product platform During the development of the product platform no derivative products based on the previous platform will be developed

The need for segmenting markets in advance of developing a product platform has been discussed in chapter 3 Vitatron does not have a market segmentation plan of derivative products. A roll-out plan of derivative products has not been made in advance of the development of the product platform.
The importance of knowledge of the building blocks (core competencies) of a product platform has also been discussed in chapter 3 Vitatron did not analyze them well enough in advance, especially the building block of market intelligence.

The **initial specified objectives** of the development project DA^+ formulated in **May 1998** were:
- DA will contain all functionalities of Dema.
- Three derivative product series (T, C, R-series) based on DA^+ will be introduced in the market at once. The T-series will be introduced and the C-series and R-series will be downgrades from the T-series.
- New features of DA^+ will be: IECG, Faster telemetry, Automatic sensing, Capture control, Extended QT based therapy, DSP applications, and support of downloadable software.
- The market release of the derivative product series based on the platform will be in November 2001

The realization of these objectives will be analyzed in the evaluation study in the next paragraph.

Conclusions
- The top-down strategy of producing one top platform and then downscale it to all lower market segments is a high-risk strategy. If one subsystem in the product platform turns out to be weak it will have consequences for all future products. The strategy of producing a top model first with many new technologies and new functionalities will delay the introduction of the first derivative product.
- The strategy of developing a new product platform with new technologies, new functionalities, development processes and new people is a high-risk strategy.
- The integration of product and product platform development is a high-risk strategy. All derivative products will depend on one product platform and it will take a long time that Vitatron will go to the market with the first new derivative series.
- Vitatron did not do the pre-development work well:
  - There was no roll-out plan of derivative products of the product platform.
  - There was no market segmentation plan for derivative products based on the product platform.
  - There was no sharp project definition that satisfied customer needs

4.3 Evaluation of product platform development project DA+

The goal of this part of the research is to evaluate the product platform development project DA+ in a systematic way. Therefore a conceptual model will be used. The norm for this evaluation will be the results from the literature study in chapter 3 on an organization structure and business process for product and platform development and the general development process described in paragraph 1 6 This evaluation focuses on the organization structure and business process of the development project DA+. Later this will form the input for the design criteria for the new design. In paragraph 4.3.1 the methodology of this evaluation will be described. Paragraph 4.3.2 will describe the organization structure and the business process of the development of the product platform Paragraph 4.3.3 will provide the most important results of the evaluation of product platform DA+. Finally the conclusions of this evaluation will be provided in paragraph 4.3.4.

4.3.1 Methodology of the evaluation

Research has shown [Halman 22] that it is useful to involve the environment (entities such as: competitors, market, parent company) in an evaluation of an innovation project, because the environment could have a great influence on an innovation project. Research has also shown that the conceptual model shown in figure 4.4 could be very useful to evaluate an innovation project [Halman 22] This adapted conceptual model (figure 4.4) involves the environment of the development project (Medtronic, Inc, PPC, VOC, Markets, Regulatories, Competitors, and Customers) in the evaluation; it specifies time, quality, and costs of the development project; it focuses on organization structure and business process; and it discusses the realization of the initial objectives of the product platform DA+.
The information and insight in the development project has been gained through:

- Desk research: Many strategic project plans and management reviews have been investigated.
- Interviews: All members of the Core team and other people involved in some way in the project have been interviewed.
- Participation: The weekly Core team meeting has been attended during 8 months.

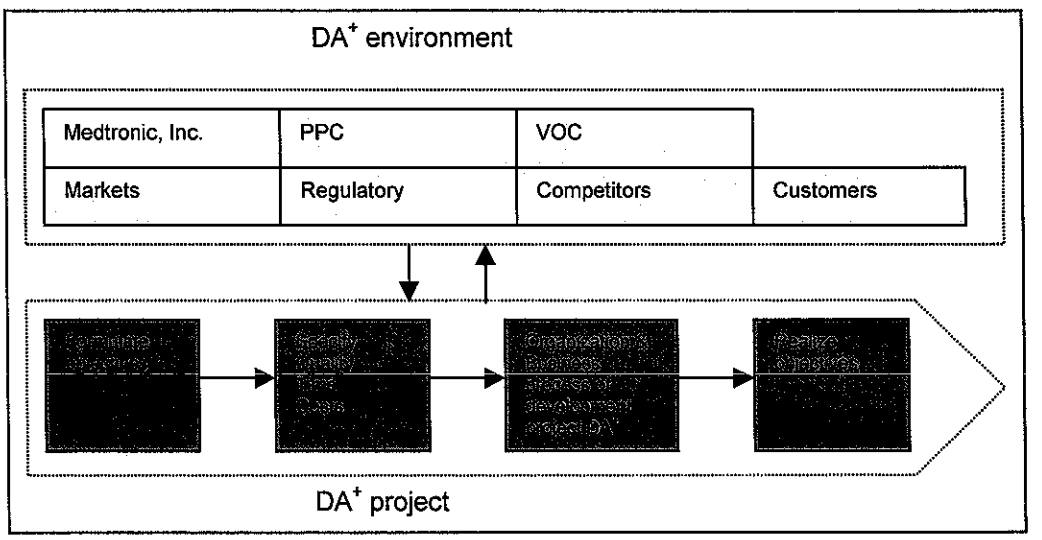


Figure 4.4. Conceptual model for the evaluation of product platform DA+

4.3.2 Description of management and organization of DA+

The project is led by a program director who has the overall leadership. A cross-functional project team, called the core team, was set up for this project. This team is lead by a program manager who reports to the program director. The program manager focuses on the daily operational management, planning, and forecasting The core team will exist until the last derivative series will have been developed. The DA+ core team is divided into ten sub-project teams to achieve an acceptable span of control These sub-project teams are described to gain insight in the development team of the product platform DA+. This description is summarized in Appendix V.

Each sub-project team is led by a sub-project manager who is responsible for the planning and process of the team's activities according to the applicable development protocols. In a sub-project team a technical lead is responsible for the technical content of the project. He reports to the functional CC (Competence Center)-manager. Co-location is not implemented, since team members are supposed to continue their respective activities within their functional area.
The core team meets every week. In this meeting the progress, planning and issues about the content of the project are discussed. Some sub-project teams have interface specification documents. In these documents the interfaces between project teams are determined. In this way the work of various design teams can be adapted to each other.
The support team supports the core team. The support team is not directly involved in the development of the platform, but is established to help with process and organizational issues.
The organization is basically a matrix structure with (sub)-project managers represented in the core team and functional managers who manage a functional department. The organization structure of the platform development project DA$^+$ is depicted in Appendix VI.

4.3.3 Results of the evaluation study

This paragraph describes the most important results of the evaluation study of the development project DA$^+$. An extended description of the evaluation study is depicted in Appendix VII. Like the conceptual model, the results of the study are categorized in. the environment of DA$^+$; the objectives of DA$^+$, specification of quality, time, and costs, management & organization of DA$^+$; and the realization of the objectives.

The environment of DA$^+$

This section analyzes the most important entities of the environment of DA$^+$ that have influenced the development project DA$^+$.

- Vitatron depends heavily on the research of Medtronic, Inc. Transferring components of the canceled Alpha project into the product platform DA$^+$ caused many problems.
- The role of the PPC in a development project is not clearly defined. The PPC does all review meetings and has a strong role in the start-up phase of a project, but there is no owner of the entire product creation process (described in paragraph 1.6).
- The two new features that the first derivative series will introduce are not new to the market. Many competitors already have those features. The first derivative series of the product platform may not be as successful and breakthrough as Vitatron hopes it would be.
- It took too long to introduce new products in the market. During the development of the product platform few derivative products have been introduced in the market. Currently the market is "screaming" for new products.
- There has not been a lack of a good scope on the entire project by the VOC. The VOC underestimated the effort and resources it would take to develop the platform with new technologies, processes and people all at once. There has not been a good scope on the entire project and its feasibility for Vitatron.

Formulation of objectives

The aim of the development project DA$^+$ was to develop a product platform from which several product families in the Brady, AF, and HF could be produced. The specified objectives have been described in paragraph 4.2.

Specification of quality, time, and costs

This section describes the most important findings of the analysis of quality, time, and cost of the development project DA$^+$.

Quality

The most important quality issues occurred in transferring components of the Alpha project into the DA$^+$ product platform and in transferring existing features into a new product platform

Especially CCHW (Competence Center Hardware) faced many issues in transferring QT technology into the product platform. Thereby the CC also faced sensitivity problems. These components could not meet the quality criteria that were set initially on time.

Time
There has been a continuous and unpredictable delay of the development process. The development project was underfunded with resources in the beginning of the project. This resulted in capacity problems later in the project. This can be concluded from the AOP (Annual Operating Plan) in Appendix VII. As a result of the delay the market release of the first derivative product series overruns more than a year and is now planned for February 2003.

Costs
Due to the continuous delay and the extra effort needed to develop the product platform DA$^+$ will cost finally more than 50% they planned in 1998. The project costs are shown in Appendix VII.

Organization structure and business process of DA$^+$
This section describes the most important results of the evaluation study considering the organization structure and business process of DA$^+$:

- **Development process**
  The new product development process procedure VPM 446 describes how a product or product platform should be developed. There has been a lack of control of the development procedure. Development phases have been done twice, the SyRS (System Requirements Specification) changed many times after the CPR(Commitment Phase Review) and the design teams were not in sync within the development process.
  Processes and products have been developed at the same time. They influenced each other and this is not the right way to develop development processes

- **Many changes in the SyRS and in the project input**
  Continuous changes in the SyRS and changes in the project input of the product platform DA$^+$ were due to lack of scope and lack of management understanding and support by the program manager and Vitatron management.

- **Technology and products have been developed simultaneously**
  Technology components were part of the product plan, while they were not completely feasible and well understood. The development of these technology components has delayed and has had consequences for the entire development project.

- **Lightweight project managers**
  The project managers of DA$^+$ have been determined as lightweight project managers. A description of this investigation is summarized in Appendix VIII. In practice the responsibility of a project manager is limited. The power still resides with the functional (CC) managers. The CC-manager is the one who manages the people and the work. The CC-manager has a higher position in the organization and he makes the important decisions. Important decisions about the development project are still made by the functional CC-managers. These decisions are not focused on what is best for the project, but on what is best for the functional department. This limits the project managers and the project progress
  Moreover the roles and responsibilities of project managers are not clearly defined. It depends partly interpretation of himself what his or her responsibilities are.

- **Unclear and unbalanced matrix structure**
  Some sub project managers have to report to the program director, others have to report to the functional CC-manager. Some people have a double role in the project. The organization of the development project has an unclear organization structure. This leads to the following conclusion:
  The organizational structure can be classified as an unbalanced weak matrix structure.

The people that are assigned to projects reside physically in their functional areas, but each functional department designates a liaison person to "represent" it on the DA+ core team meeting The functions are stable and long lasting The several design teams do not cooperate well The teams are not co-located and the teams do not all have interface specifications between each other. The teams only think within their own sub-function.

- **Ineffective composition of the system team**
  The composition of the system team consisted of too many people so that decisions about the content of the SyRS could not be made and the input changed many times. Finally only two people were left in the system team supported by system engineers from several departments. Research within Vitatron suggests that this is not an effective composition.

- **Absence of a well functioning risk management tool**
  A risk management tool is not used in the start-up phase and planning of a development project. This has resulted in an unforeseen delay as shown in Appendix VII

- **Absence of structural evaluation of development projects**
  Previous projects are not evaluated on a project basis. Knowledge of structures, processes and faults are not kept and not used for new development projects.

Realization of the objectives
The objectives of the product platform development project as specified in the previous paragraph could not be realized. Due to the continuous delay, Vitatron was forced to eliminate some functionalities and technologies from the product platform to speed up the development process. The objectives have changed during the project and have been redefined many times. The strategy in **May 2000** was to develop the product platform as quickly as possible and commercialize the product platform with limited functionality with respect to the initial plan:

- Only one product series will be introduced first. This will be the C-series and not the T-series as was originally planned. Then the product platform will be up-scaled and down-scaled into respectively the T-series and the R-series.
- The new functionalities will be IECG and faster telemetry only. The rest has been eliminated.
- The date of the first market release of the product will be February 2003, which is a delay of more than one year.

Problems occurred with the transfer of QT technology into product platform DA+. Vitatron decided in **September 2001** to eliminate QT sensing (a well-known feature of Vitatron products) from the product platform. This feature will be added in the next derivative product series.

Negative effect on other projects
The DA+ development project needs so much time and resources, that these resources can not be used for other development projects. For an innovative company like Vitatron it is important to go to the market with new applications continuously. The development of these new applications has been limited by the extra time and resources that were needed to develop product platform DA+.

4.3.4 Conclusions

The evaluation of product platform DA+ showed many gaps with the literature of successful product and platform development in chapter 3. The development process deviated from the product development procedure VPM 446 at some elementary points. The evaluation also showed that many aspects of the organization structure and business process of product and platform development could be improved. All mentioned aspects will be taken into account in the proposition of an organization structure and business process for product and platform development in the next chapter

This chapter positioned, analyzed and evaluated product and platform development at Vitatron. In the next chapter a proposition will be made of an improved organization structure and business process for product and platform development at Vitatron.

5. Proposition of organization structure and business process for product and platform development

This chapter describes a proposition of an organization structure and business process for product and platform development at Vitatron. First, paragraph 5.1 describes an approach of managing and organizing the development portfolio of Vitatron. Paragraph 5.2 describes the development of a product platform strategy of Vitatron Paragraph 5.3 describes an organization structure and business process for the development of derivative products based on product platform DA$^+$. Finally 5.4 will describe and approach for the development of a next generation product platform. The composition of the paragraphs of chapter 5 is visualized in figure 5.1.This chapter strives for an integration of portfolio management, product platform strategy, and managing and organizing product and product platform development at Vitatron.

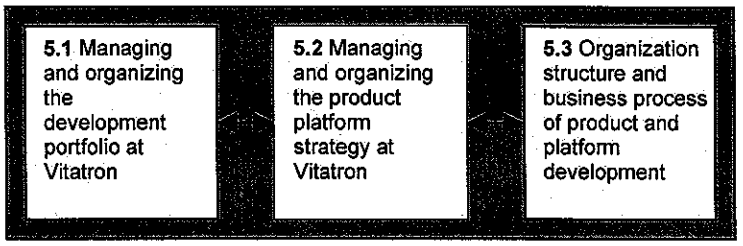


Figure 5.1: Composition of chapter 5

5.1 An approach for portfolio management for Vitatron

In this paragraph a proposition will be discussed for the integration of portfolio management in the development organization of Vitatron. It will discuss the introduction of portfolio meetings and a portfolio manager. It will also discuss how to manage the development projects on a multi-project level. Finally this paragraph provides insight in how to create more balance between the short-term and the long term in the development portfolio of Vitatron

5.1.1 Portfolio review meetings

The evaluation study of chapter 4 showed that showed that portfolio management was not integrated in the development organization of Vitatron.
Portfolio management is a dynamic decision process whereby a business's list of new products (and R&D projects) is constantly updated and revised, new projects are evaluated, selected and prioritized; existing projects may be accelerated, killed or de-prioritized; and resources are allocated and re-allocated to the active projects Portfolio management has the following goals [Cooper & Kleinschmidt 3].

- **Value Maximization**. within the product platform concept (product platform and all its derivative products) resources should be allocated so as to maximize the value of the development portfolio in terms of a stated business objective, such as profitability. A performance indicator that can be used is the NPV (Net Present Value) of the development portfolio.
- **Balance in the development portfolio**. to achieve a desired balance of projects in terms of a number of parameters, long term projects versus short-term ones; high risk versus sure bets; and across various markets, technologies, and projects types
- **Strategic direction**: to ensure that the final portfolio of development projects reflects the business strategy.

Vitatron has a product platform approach. For the development of product platforms and derivative products it has a stage gate process (VPM 446), but that is only partly a solution for portfolio management. A portfolio meeting should be initiated to review all projects together, to prioritize development projects and to check the balance of the development portfolio
Considering the changes in the development portfolio and the sequence of all development projects a quarterly portfolio review meeting is recommended.
Gating processes focuses on individual projects, and each project is evaluated on its own merits. At the phase review meetings a project is evaluated and scored before moving to the next stage Committing people and funds to the project are made at these gate/review meetings. Input for

these meetings comes from the portfolio meetings. The Stage Gate meeting is a Management Team meeting.
The portfolio meetings review all development projects together. These meetings check if the development portfolio is in balance, if it is in line with the strategy and development projects are prioritized. Gaps in the portfolio may be identified which need to be filled with new products. The portfolio meetings should be led by the portfolio manager, and should not be event driven, but periodically driven. Thus decisions being made in the portfolio meeting about priority setting and the strategy affect the stage-gate meetings. This is depicted in figure 5.2.
The PRC (Portfolio Review Council) will do these meetings. Tasks and responsibilities of the PRC will be discussed in paragraph 5.1.3

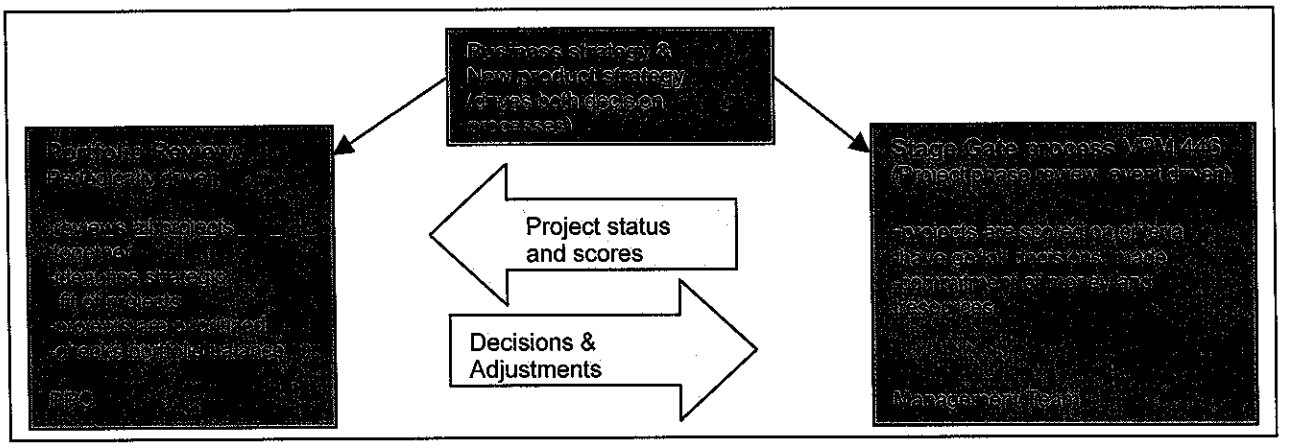


Figure 5.2. Relation between portfolio review and stage gate process [Cooper 3]

5.1.2 The portfolio manager

The evaluation study of chapter 4 showed that there was lack of overall ownership of the development projects, which resulted in a scattered planning and scattered management of development projects.
According to Cooper & Kleinschmidt [3] and Wheelwright and Clark [30] all development projects should be considered, planned and managed together. An effective way of organizing this is to create a new function, the portfolio manager. This person is responsible for considering, planning and managing all development projects, within the product platform approach. All project managers will report to this person. The portfolio manager will initiate portfolio meetings and he will control the projects on a multi-project level. This will be discussed in the next paragraph. All tasks are summarized in figure 5.3. The position of the portfolio manager in the new organization structure of Vitatron is depicted in Appendix XIII.

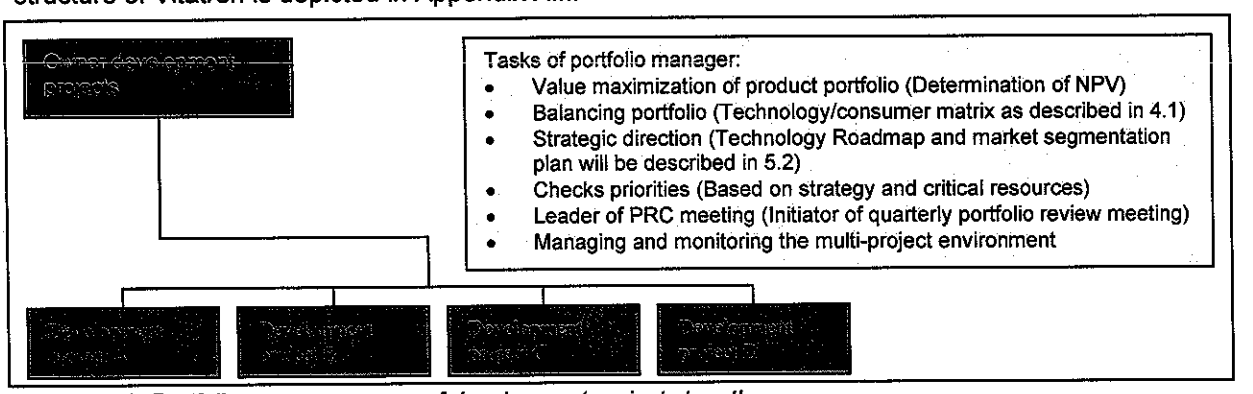


Figure 5.3: Portfolio manager: owner of development projects together

5.1.3 Managing and monitoring development projects on a multi-project level

All development projects will be managed and controlled by the portfolio manager with support of project managers and project planners and the PRC meetings. The PRC is a substitute for the PPC and manages the development portfolio. The PRC has an initiating and managing role. Decisions about the product strategy are still made by the Management Team supported by the PRC. The project managers manage individual projects.
The project planners will use the Concierto tool. This is web-based software for global project portfolio management, resource planning and scheduling, progress tracking, time reporting and cost control. This is an overall tool that incorporates all different project planning programs. The project planners should quantify skill-sets needed for each development project by phase. The CC-managers should quantify resources by skill sets. Weighting criteria and measures must be determined by the PRC. The development productivity is maximized by balancing development demand and development capacity through project prioritization based on the portfolio evaluation and strategy. These decisions should be bound by resource constraints. If there are gaps between the resource supplies and resources demands, priorities should be changed or new people should be hired.

5.1.4 To create balance between the short-term and the long-term in the development portfolio

The technology/consumer matrix (as described in paragraph 4.1) could be used to create balance in the development portfolio. Appendix IV describes how to manage the development portfolio by the consumer/ technology matrix and it describes how to interpret it.
An additional way to create balance in the development portfolio is the simultaneous development of product platforms and derivative products. Vitatron used to develop a product platform and derivative products sequentially. When a product platform was finished, the development of derivative products started. With the result that the development of the first derivative series took long and implicated a high risk, because the first derivative series was mainly based on new technologies. The development of a new product platform should start much earlier than it used to start. When a product platform development team starts, derivative products should be produced on the "old" product platform. This way of organizing product and product platform development may cause budget allocation problems. A trade-off must be made between the short-term development of derivative products and a long-term product platform development. To set aside resources for the development of a next generation platform much earlier will be best on the long-term. This reduces risk, enables a continuous stream of new derivative products, and creates balance in the development portfolio. This is depicted in figure 5.4. In this figure the input of several development teams to other development teams is shown. The impact of platforms teams on the organization structure will be described in paragraph 5.4.

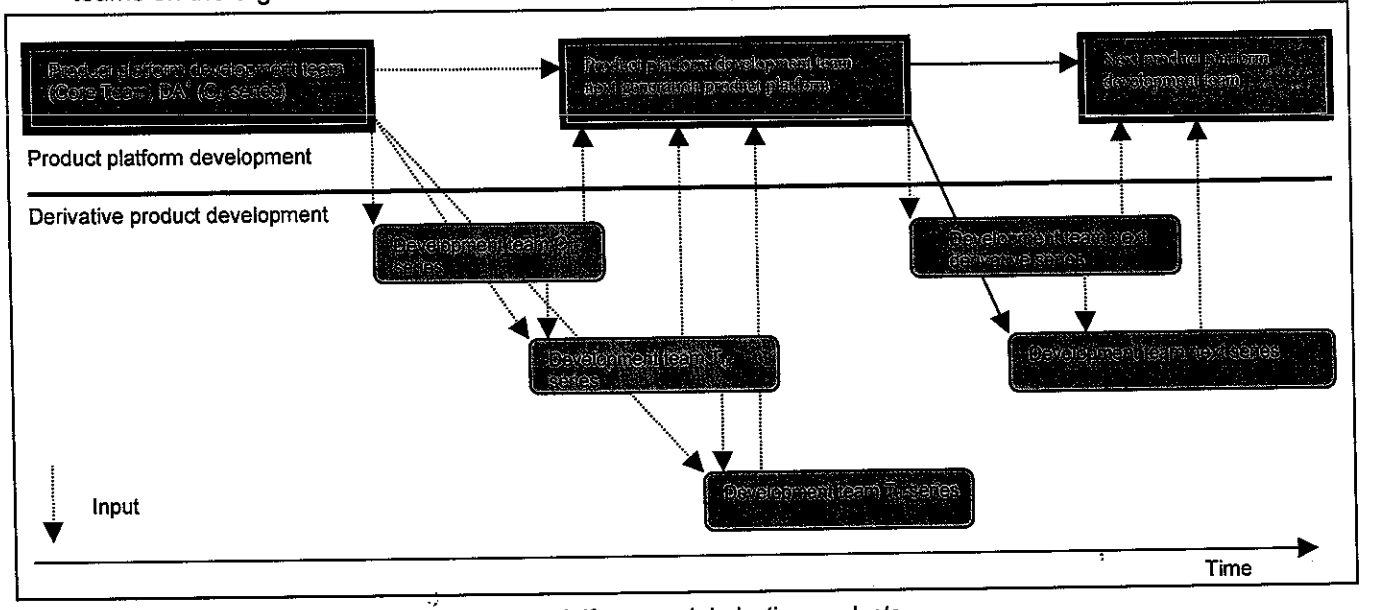


Figure 5.4: Simultaneous development of product platforms and derivative products

5.2 Developing the product platform strategy

In this paragraph a market segmentation plan for derivative products based on product platform DA^+ will be made and the process of technology roadmapping will be discussed. This provides insight in the platform strategy of product platform DA^+ by integrating technologies and functionalities. At the end of this paragraph a proposition will be provided for developing a next generation product platform strategy.

5.2.1 Market segmentation plan for derivative products based on DA^+

Literature in chapter 3 showed that it is essential to make a market segmentation plan for a platform strategy. Products can be better adapted to the customer needs of each market segment. A market segmentation plan has been made for the derivative products of product platform DA^+. This segmentation plan is new to the organization. Major market segments are arrayed horizontally, each representing the major customer groups of Vitatron's pacemakers: Brady, Brady + AF and HF. The vertical axis of the market segmentation grid reflects different tiers of price and performance, and functionalities within Vitatron's markets. It represents the three different product series: T-series (top model), C-series (mid model), and R-series (basic model). Within those product series the products are segmented in. single chamber, dual chamber, rate responsive or not rate responsive. The product types are summarized in table 5.1. The explanation of the abbreviations is given in Appendix X. The numbers shown in the table are the model numbers

Product types	Top T	Mid C	Stand R
HF	90		
DDDRP	80		
AAIRP	70		
DDDR	60	60	60
DDD		50	50
VDDR		40	
VDD			30
SSIR	20	20	20
SSI		10	10

Table 5.1: Product types

Figure 5.5 shows the market segmentation plan of product platform DA^+. The C-series will be introduced first. The product platform will then be upscaled into the T-series, mainly by adding new functionalities. Then it will be downscaled into the R-series, by turning off functionalities. The HF market is a new market for Vitatron. The derivative product that will be introduced in this market will be a top model with a high performance and high costs. This explains why the rest of the market in figure 5.1 is uncovered. AF therapy will also be introduced in a top model first, the T_0-series. This will be the first derivative product with AF therapy based on product platform DA^+.

5.2.2 The technology roadmap for product platform DA^+

Technology roadmapping is a process approach that contributes to business-technology integration and technology strategy definition by presenting the interaction between products and technologies over time, taking into account both short and long-term products and technology aspects [Groenveld 4]. Roadmapping gives a view of the future based on close cooperation between all disciplines. It develops a stronger awareness of how to serve markets with the right products at the right time and to improve the cross-functional processes required for new product creation. The roadmapping method has been used in this research project as a derivative of the strategy of Vitatron. It gives an overview of which functionality is related to which pacemaker and which technology is needed to realize that.

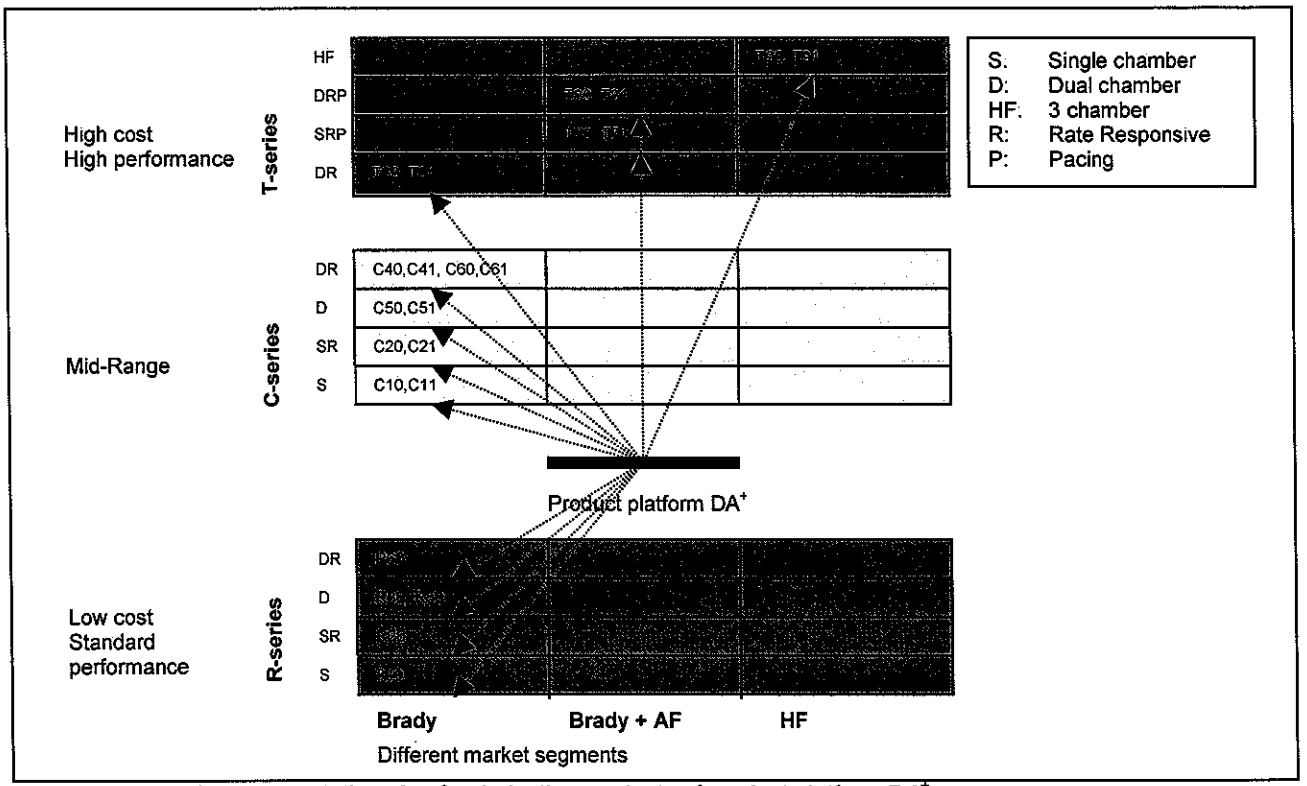


Figure 5.5: Market segmentation plan for derivative products of product platform DA+

The process of technology roadmapping is new to the organization of Vitatron and has been perceived with great interest and enthusiasm Usually products are only related with technologies in a technology roadmap [Groenveld 4]. The functionalities are added to this theoretical roadmapping model, because it gives additional insight in differences between the derivative products. These differences in derivative products would not be clear if technologies were used in the roadmap only. To understand the technology roadmap, it is important to gain insight in the subsystems and interfaces of the product platform DA+ These are summarized in figure 5.6. The product platform DA+ consists of all subsystems and interfaces included in the figure. The development project DA+ develops the hardware and software of the IPG and the software of the programmer, but it does not develop the programmer itself and the leads. An explanation of the subsystems can be seen in Appendix XI.

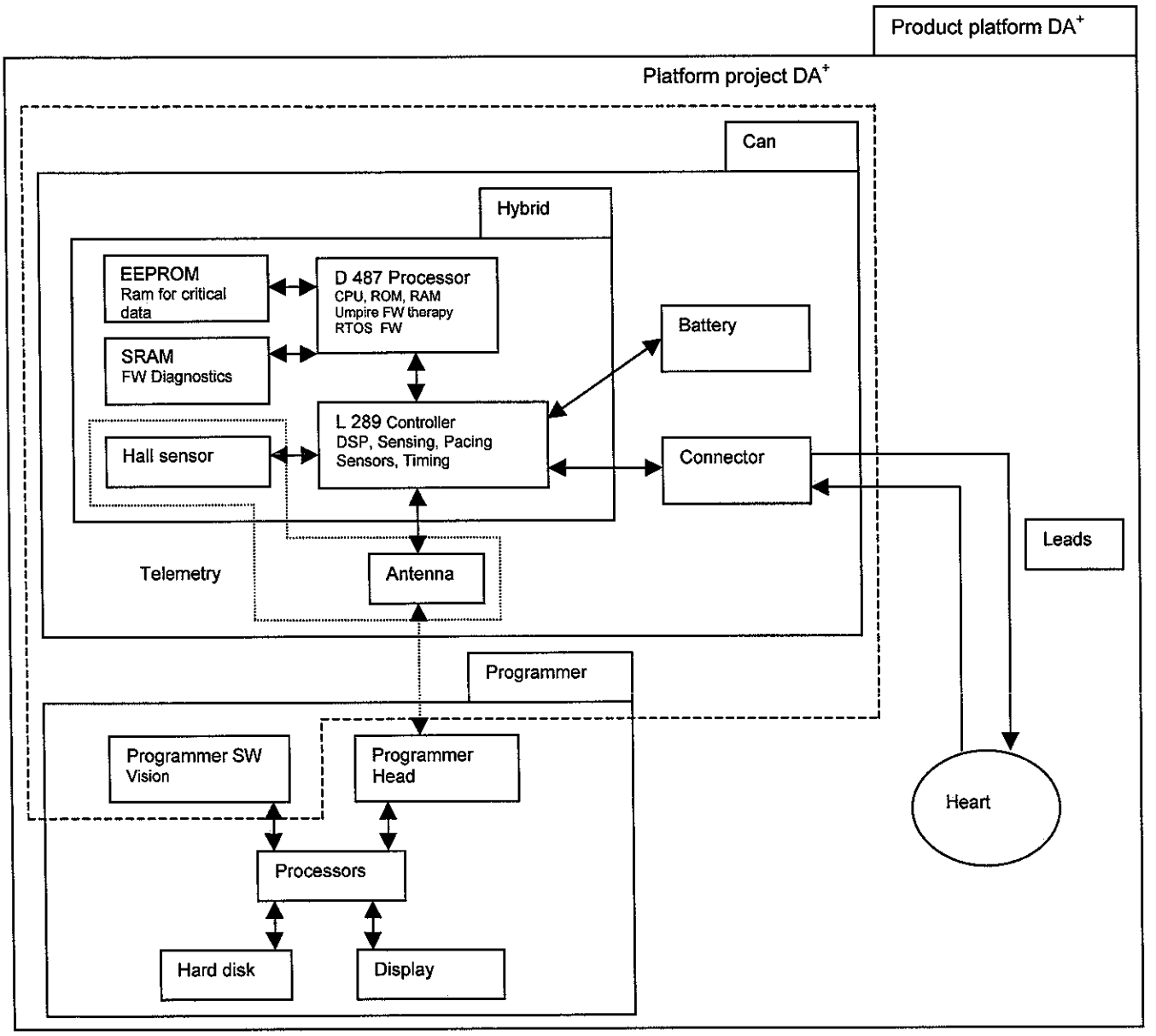
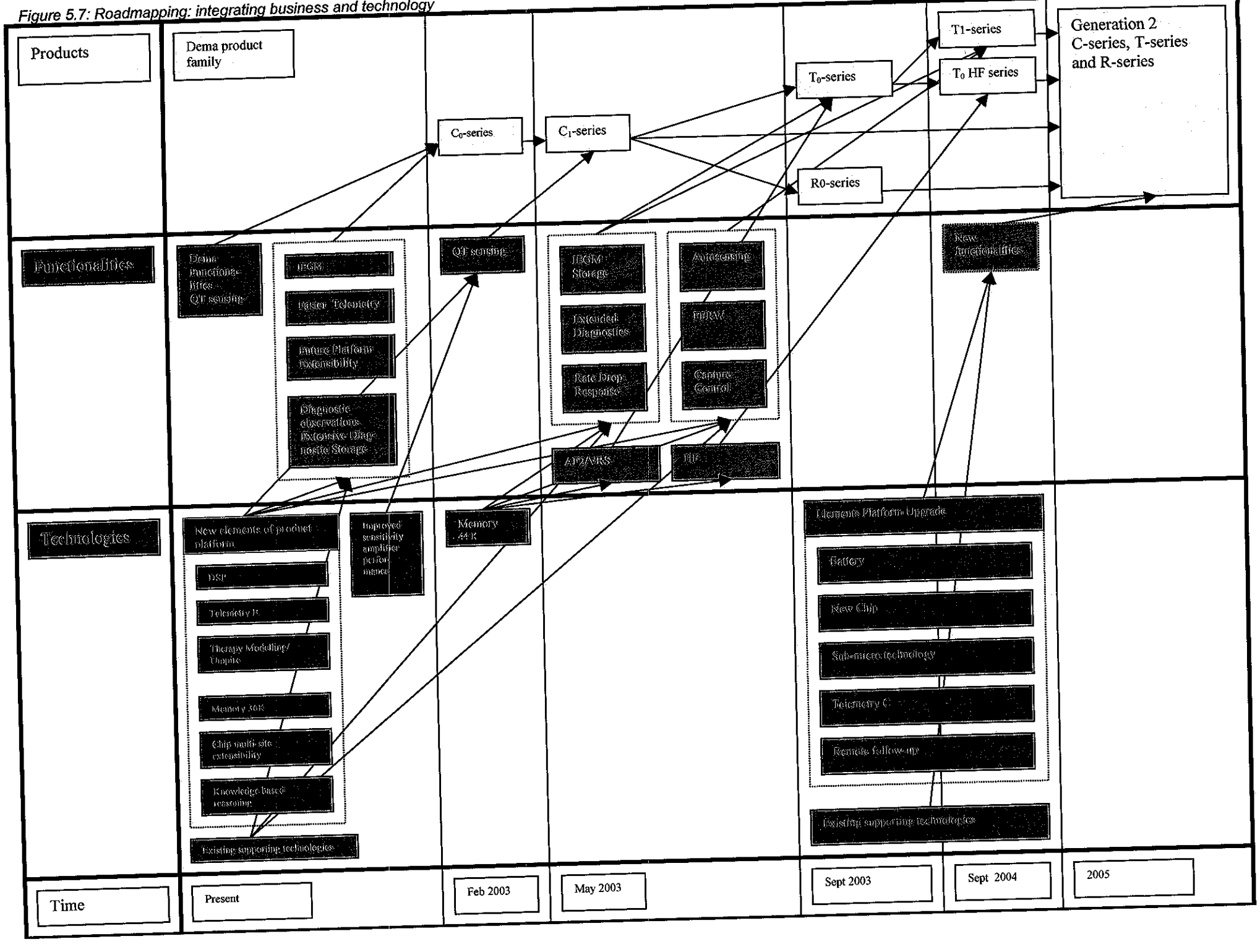


Figure 5.6: Product architecture of DA+

In Figure 5.7 the technology roadmap of derivative products based on product platform DA+ is shown. In the technology roadmap the derivative series (C-series, T-series, R-series) are integrated with the functionalities they incorporate and technologies required realizing these products for a period of about five years. The product platform DA+ forms the input for the technology roadmap. In the technology roadmap only the new technological components (compared to the previous product platform Dema) are summarized.
All these activities help to improve the product creation process by providing better information.

Figure 5.7: Roadmapping: integrating business and technology



5.2.3 Development of strategy for a next generation product platform

The pre-development homework before the start of a development project is a key factor to success [Cooper 2]. When a new product platform strategy will be developed, a multi-disciplined team should define the product platform strategy. The team's efforts should be guided by the following steps [Meyer 9]:

Technology roadmapping

In the previous paragraph the technology roadmap has been determined as a derivative of the strategy of Vitatron, but the process of technology roadmapping is an effective tool to contribute to formulating the strategy of Vitatron as well. Therefore an optional technology roadmap with all relevant technologies and functionalities should be made. Roadmaps can show alternative product or technology developments over time, thereby clarifying the options that are available. It also gives a clear overview of which technologies Vitatron has in-house and which technologies should be imported from companies like Medtronic, Inc or other companies. In addition technology roadmaps show the consequences over time by adding one or more technologies to one specific product or to another (next derivative) product.

Product technology roadmaps are the central part of the value chain market: product-technology-development. Composing roadmaps necessitates close cooperation between the functions responsible for those areas and it requires the simultaneous consideration of market pull, technology push and their interaction over time. This is shown in figure 5.8.

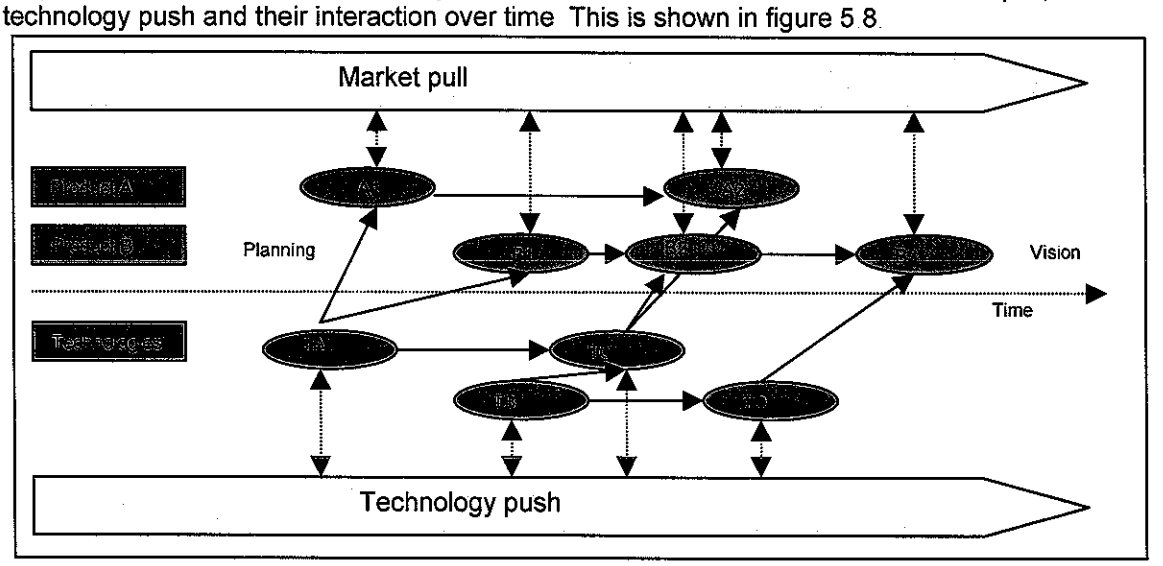


Figure 5.8: Technology Roadmapping [Groenveld 4]

Although it is easy to describe the principles of roadmapping, the process of building a roadmap is less simple. Differences in background, thinking and ways of working among different departments need to be reconciled.

The added value and cost offerings of new features of derivative products should be used to determine the strategy and planning of a derivative development project. This means that roadmapping should be used to prioritize the functionalities in a derivative product based on the added value of the functionalities and the cost offerings that should be made.

Building a technology roadmap should be done by a small cross-functional team. It should be used in the Portfolio Review Meeting as a tool to contribute in formulating the strategy of Vitatron and this meeting is the owner of the roadmap. Considering the changes in technologies and functionalities the roadmap should be updated twice a year.

Segment your markets

Major market segments and the price/performance tiers within them must be identified and a grid can be made (like the grid of paragraph 5.2.1). The current market segments of Vitatron are Brady, Brady + AF, and HF. Within those markets there will be many changes in customer requirements. It is important to look forward in time, incorporating emerging segments as well as

existing ones in the grid. An example of the market segmentation grid is summarized in the upper level of figure 5.9.

Identify growth areas
Growth opportunities in the market segments Brady, Brady + AF, and HF must be identified. These opportunities [Meyer 21] show 1) The current sales volume of Vitatron, 2) Vitatron's participation rate or market share in the niche, 3) the five-year growth rate of these markets, 4) the leading competitors in each niche, and 5) the driving customer need in each niche

Define and map product platforms
Working at the level of major subsystems and interfaces the team should work toward defining product platform architecture that will satisfy the key objectives in market coverage and scalability Considering the commonality of components in all pacemakers that satisfy all market segments, one product platform could satisfy all market segments of Vitatron.
A decision has to be made between scaling up the product platform and scaling down the product platform. Starting with a low end product platform that will be up-scaled into higher process/performance tiers through the addition of technologies or components is recommended. The benefit of this approach is that Vitatron is able to come up with the first derivative product relatively quickly and it implicates less risk because not all new technologies will be developed at once. A precondition for this product platform strategy is that the initial design of the product platform must be extensible for upgradability and reuse.

Perform In-depth research on customer needs
The overriding goal of product platform renewal is to bring excitement to the market in the form of value-cost leadership [Meyer]. This cannot be done by serving incremental, perceived needs on the part of customers with pedestrian "me too" products. The product platform team must work to uncover latent perceived needs and should pay attention to differences in the needs of customers in the different parts of the world This forms important input for the product platform

Understanding the core competencies of the product platform
Before building a product platform, Vitatron must identify its core competencies and distinguish between technologies if they are internally owned, externally available, or must be developed. The power tower depicted in figure 5 9 could be used to develop a next generation product platform. It directs energy and focus to the market applications of the derivative products. The core-competencies should be the basis for the definition of the subsystems and their interfaces.

Developing the roll-out plan for derivative products
Armed with the product platform strategy and the definition of the subsystems and their interfaces, a roll-out plan for the derivative products based on the product platform can be made. This roll-out plan can be integrated in the technology roadmap. Once Vitatron has identified the product platform subsystems, improvements on a sub-system basis can be staged across successive generations of the product platform
A Power tower as a decision tool for the development of a new product platform has been developed for Vitatron and is shown in figure 5 9

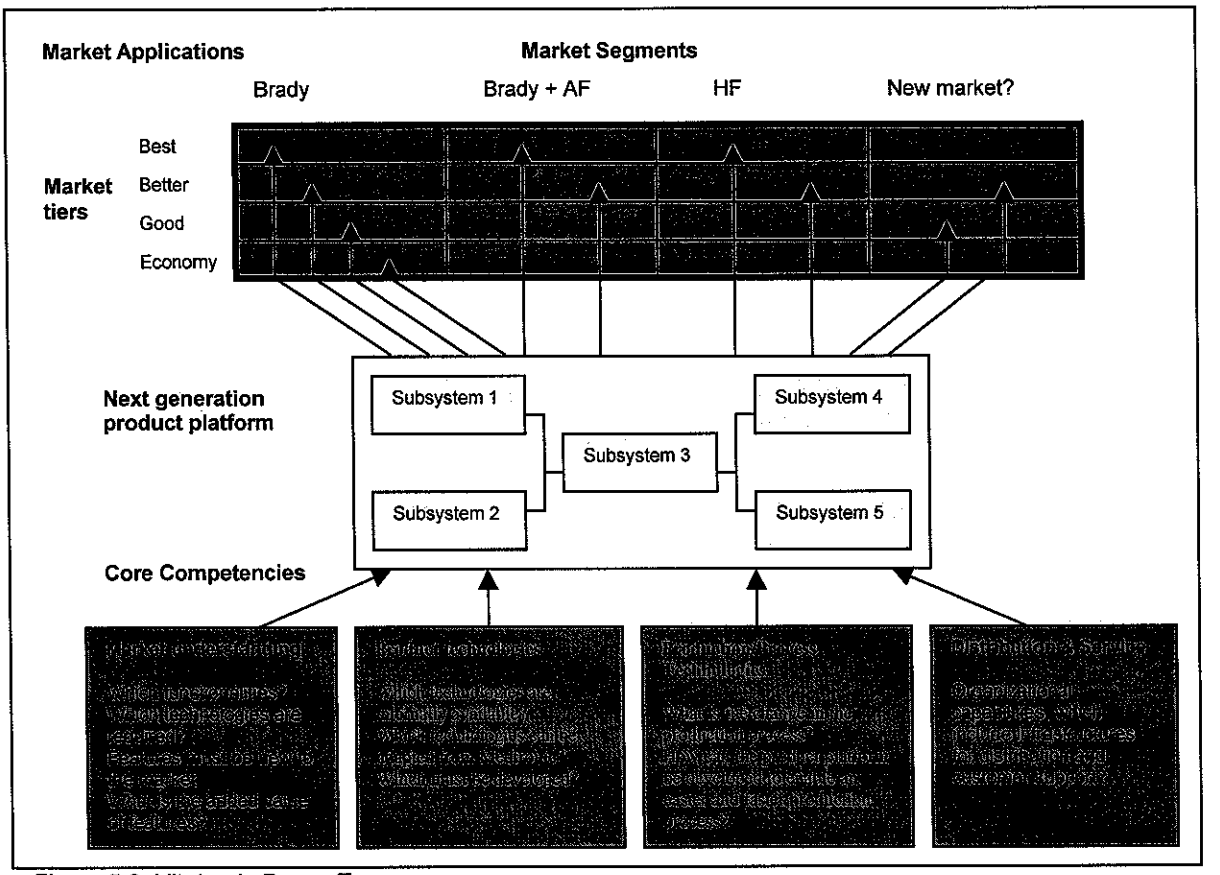


Figure 5.9: Vitatron's Power Tower

5.3 An organization structure and business process for derivative product development based on DA+

This paragraph describes a proposition of an organization structure and business process for derivative product development based on product platform DA+.

5.3.1 New organization that enables separate development of technology, functionality and products.

It has been discussed in chapter 4 that the integration of technology development and product development caused problems and a delay of a development project.
A product architecture is created when 1) a new product design has been composed into a system of functional components and 2) the ways in which individual components interact with other components. The component interface specifications in product architecture define the essential component interactions. These should be fully specified for all next development projects. Fully specifying and standardizing component interfaces in modular product architectures at the beginning of a product creation process creates an information structure that defines the required outputs of component development processes. Fully specifying the component interfaces in modular product architecture at the beginning of a development project requires a high level of architectural knowledge about how components will interact in a product design. Therefore modular product architectures must be based on technologies and components that are well understood at architectural level before a product development project will actually use those technologies and components. Thus, the development of new technologies must be de-coupled from and precede the development of new modular product architectures [Sanchez].
In the innovation process of Vitatron technology projects should be separated from development projects. In figure 5.10 the new project start-up process of Vitatron is shown with a separate technology team. The separate development of technologies, functionalities and products is depicted in Appendix XII. A market intelligence team screens and checks ideas that come from several inputs This team consists of three product planners A technology or functionality project

can be initiated. These projects will be done within research and will be led by dedicated project managers within the research department. The project managers of technology and functionality projects report to the functional manager of research. The PRC, that consists of representatives from marketing, project management, project planning, research, and development, can initiate development projects. This decision must be supported by the Management Team. The portfolio manager chairs the PRC meeting.
Only when a technology or functionality concept is viable and well understood it can become part of a product plan of a derivative product that enters the BA Phase. The technical feasibility of the technology component has to be totally clear and requirements of the technology components must be clearly defined. Then a component can become part of a project plan in the BA Phase. The Management Team makes all decisions about moving to a next stage in the stage gate model and about the go/no go of a development project. The separation of technology development, functionality development , and product development is depicted in Appendix XII.

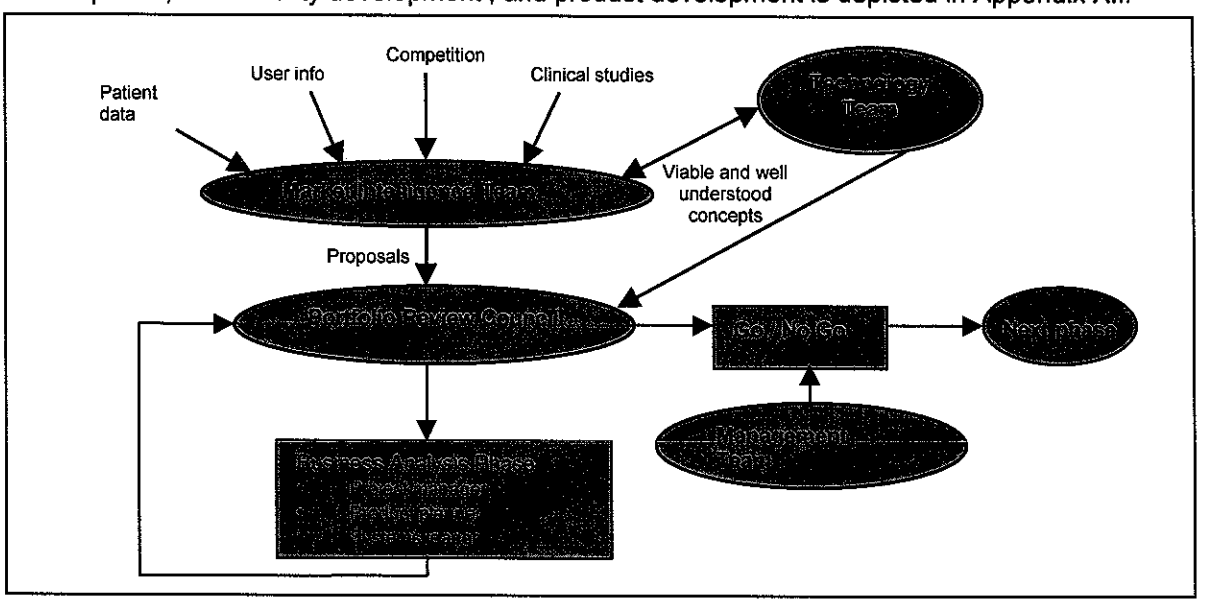


Figure 5.10: New project start-up process with a separate technology team

5.3.2 Functional specifications of a solution

From the analysis and evaluation of product and platform development in chapter 4 and the theoretical research of chapter 3 the functional specifications of a proposition of an organization structure and business process for derivative product can be derived:

- Clear tasks and responsibilities for all people involved in a development project. A balanced matrix structure should be made in which the functional managers do not outrank the project managers.
- Better collaboration and integration between the functional departments by cross-functional and co-located teams.
- More focus on a development project instead of a functional department by the introduction of heavyweight project managers and cross-functional teams.
- More commitment of functional departments to a development project by providing ownership to design teams.
- Easier coordination of a development project by a clear organization structure, a good business process and clear interfaces between the building blocks.
- A more effective composition of the system team of cross-functional system team members.
- The pre-development work of a development team should be done correctly so that it enables the development of a new, market driven and customer focused product, whereby the technical possibilities and impossibilities are taken into account in a preliminary phase

Options of an organization structure and business process for product development

Effective product and product platform development require that all of the organizational groups involved develop and bring to bear the appropriate specialized capabilities, and that the efforts of all these groups are appropriately integrated. There is no perfect organization structure that fits all companies and situations Based on the design criteria, three possible ways of managing and organizing product and product platform development were discussed with several stakeholders within Vitatron.

Matrix structure with lightweight project managers: In this structure people are grouped by discipline, each working under the direction of a sub-function manager. Each functional department designates a liaison person to represent the functional group. This forms the cross-functional Core Team. This organization would be an improved organization of the existing one with some incremental changes and better definitions of tasks and responsibilities. A balanced matrix structure should be created with clear tasks and responsibilities of all people involved in a development project. Strengths of this type of organization are that managers who control the resources also control the projects. This provides a clear structure. It also ensures that specialized expertise is brought in on key technical issues. A weakness is that there is little focus on and commitment to projects.

Heavyweight matrix structure with design teams. In this structure, in contrast to the lightweight functional, the heavyweight project manager has direct access to and responsibility for the work of all those involved in the project. The team is co-located Tasks and responsibilities are clearly defined. Better collaboration between the functional groups and more commitment to the project can be achieved by the introduction of cross-functional design teams.

Project team structure: Under this structure individuals from the different functional areas are formally assigned, dedicated and co-located to the project team. The project leader is a heavyweight in the organization and is given full control over the resources contributed by the different functional groups. A strength of this structure is focus. The individual team members and the team leader are concentrated on making the project successful. A weakness of this structure is that they do not re-use structures or working processes Everything has to be re-designed.

Considering the design goals, the second and the third option are the most likely ones The first option does not really solve the existing problems and does not meet the design goals. In the third option, the project team structure will be an enormous step to take. Research suggests [Wheelwright & Clark] that this step is "impossible" to take at once.
Based on the above and research within Vitatron it has been decided to choose for the second option and this one will specified and will be worked out.

5.3.3 Composition development teams for derivative product development

The general development process of Vitatron has been described in paragraph 1.6. In figure 5 11 the first 3 phases of the general development process are shown. These three phases consist of different tasks that should be done by a variety of resources The BA Phase used to be done by one person with the support of all representatives that person needed. The Commitment Phase and the Development Phase used to be done by one team that changed in composition as the development project continued. Because of the difference in tasks, three different development teams will be proposed to the different development phases with clear tasks and responsibilities. This will be a BA (Business Analysis) team, the BA team together with the system team, and the BA team together with design teams. These teams will be described per phase in the next section. Three people will do the BA Phase and they will lead a development project and will be involved in the entire project. The functions of all people involved in the first 3 phases will be described in the next section. Deliverables of the different development phases will be checked at the Stage Gate meetings. Different tasks in different phases can be done by the same persons. The above will be made explicit for each development phase.

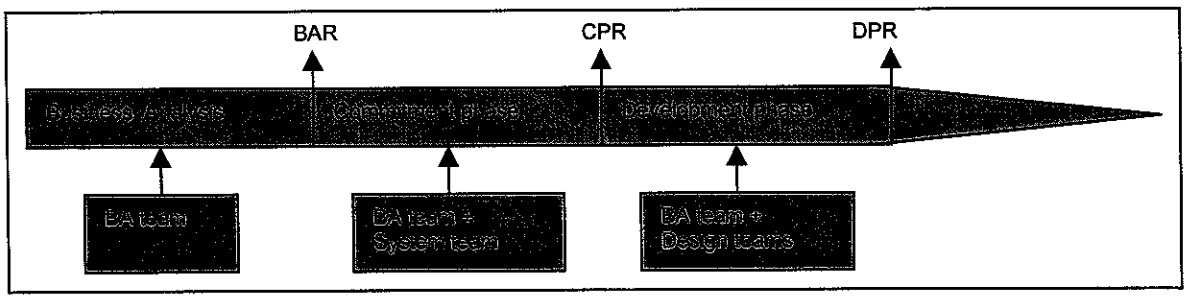


Figure 5.11. Teams assigned to development phases

Design teams around functional changes

Literature showed that effective organizations in competitive environments group their design tasks around a product's building blocks. The organization theory advises structuring tasks into groups of tasks as independently as possible in order to minimize overall coordination and increase speed [Oosterman 23]. Effective design projects aim to allocate the conception of each building block or sub-system to an organizational unit solving all interactions within the building block. This is a good approach for designing new product architecture for a new product platform. The product architecture for the derivative products based on the product platform DA^+ has been determined. There will be minor changes in the building blocks in the development of derivative products. Research within Vitatron suggested that for this reason it is more useful to look at functional changes in the derivative products based on the technology roadmap and the market segmentation plan. Based on the customer requirements, the system requirements of the derivative products can be determined. This is the task of a system team. This team looks at the consequences for the building blocks of DA^+ and determines how many and what kind of resources are needed for the development of a functionality. A design team will be formed around a functionality. This will be made explicit in the description of the development phase.

Business Analysis phase

In the business analysis phase a development project will be started In this phase an analysis will be made of the aspects as summarized. scope of the project, profit, budget, resources, timing, and risks. The project manager used to do the BA Phase with the support of representatives of other departments These representatives were not planned to spend time in this phase of the development project. A technical lead was not involved in this phase of the development project. It is essential to do the BA with a cross-functional team to get different views on the development from different perspectives. The BA team, however, should not consist of too many people, to keep the team effective. Finally should the team be co-located during this phase to improve communication and collaboration. Research has shown [Meyer Power] that co-location of development teams also fosters bonding between team members and the commitment needed for focused, high risk development projects. In the proposed composition the team will consist of a person with a customer view, a person with a technical view, an overall leader, the project manager. The project manager manages the development project on time, quality and costs. The three persons will be involved in the entire project. All project managers report to the manager of project management.

The advantages of this composition is that there is a multi-disciplined view in this phase on the project definition, the people can be planned to spend time in this phase of the project and the technical possibilities and impossibilities are taken into account in a preliminary phase. A composition of the BA-team has been proposed in figure 5.12.

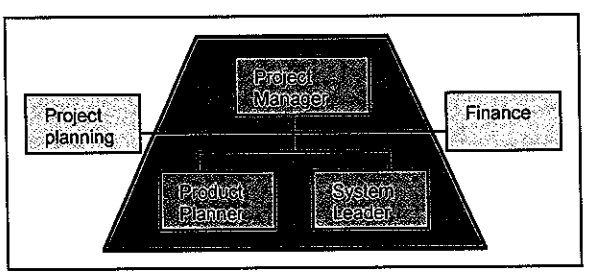


Figure 5.12. Composition of BA-team

Project manager (**PM**):
Overall leader and manager of the project.
Product planner (**PP**):
Representative from Marketing who takes care of the customer requirements
System Leader (**SL**):
This is the technical leader of the System Team.
This team will be supported by representatives from finance and project planning.

Commitment phase

When the BA has been approved in the BPR, a system team will be composed and will do the Commitment Phase together with the three people of the BA. In this phase the customer requirements will be translated into system requirements. The system requirements will be documented in the SyRS (Systems Requirements Specification). This will be done by the system team. Systems engineering is an interdisciplinary, collaborative approach that derives, evolves, and verifies a well balanced system solution which satisfies customer expectations. All the functional requirements of the new product will be determined and a top-level design solution will be produced. This has to be communicated effectively and the continuity of the concept should be monitored throughout development. This phase used to be done by too many people in the start of the DA+ project. The composition of the system changed many times and finally two people were left in this team. Critical success factors of a composition of the system team are.

- Focus on team activity and commitment
- Keep the system team compact, intact and cross-functional
- Knowledge transfer to development teams

The composition of the system team depends on the functional needs of a derivative project. The composition of the teams is shown in figure 5.13. The System Team consists of 6 people: System Leader and representatives from Software, Firmware, Hardware, Product Assurance and Technical Communications. The systems engineers report to the system leader. This team keeps controlling all changes in the development project necessary to the SyRS and other specification documents. The position of these teams in the organization structure is depicted in Appendix XIII.

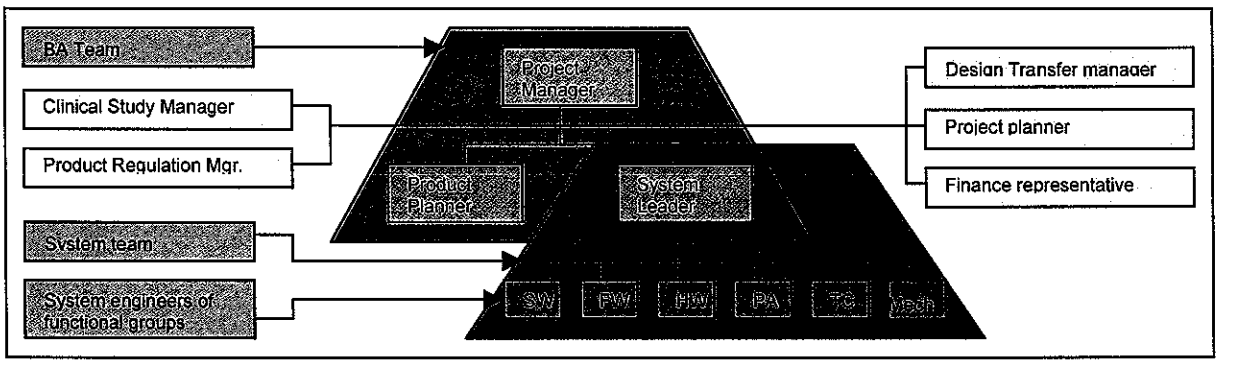


Figure 5.13: Composition of system Team

The project manager will be assisted by:

Clinical study manager:	representative of clinical
Product regulation manager:	representative of regulatory affairs
Design Transfer manager:	representative of mechanical, test design, and design transfer
Project planner:	supports in project planning
Finance representative:	supports in the finance of the project

The advantages of this composition are the cross-functional composition of the system team that remains intact during the entire development project. The organization structure is clearly defined and co-location improves collaboration and communication. It also reduces the coordination effort.

In the commitment phase the impact of the development project on resources will be determined. In this phase all the system engineers determine how many persons they need to develop a new component or new function of the derivative product. These will be assigned to the design teams in the development phase.

Development phase

After the commitment phase has been approved in the CPR, the design phases can start in the development phase. This phase used to be done within the functional groups and caused many problems (as discussed in chapter 4).

A more effective way of organizing the development phases is the introduction of design teams. As discussed before a design team for the development of a derivative product can best be

formed around a new functionality. Design teams are cross functional teams that focus on the functionality, look at the consequences for the building blocks and interfaces and are responsible to get that functionality in the final derivative product. In the commitment phase an analysis of the impact of a functionality on resources has been made by the system team. All resources of the several functional groups together will form a design team around a functionality. This team will be led by a team leader of one of the functional groups and should be co-located. A proposition for the organization of a development project is shown in figure 5.14. The BA team will be supported by a product regulation manager, a project planner and a representative from finance. A clinical team will start the preparation for the clinical study in this phase. The design transfer manager will form a design transfer team with the following tasks: Mechanical, Configuration management, Design testing and Transfer. The system team still consists of the system leader and the team leaders of the functional groups. The Core Team consists of the BA-team and the team leaders of the design teams. The system engineers keep the responsibility for the changes of the system requirements and they are responsible for overall tasks of a functional department. In chapter 2 the project manager of development projects within Vitatron has been defined as a lightweight project manager. The weakness of a lightweight project manager is that the power still resides with the sub-function and functional managers (CC-managers). As a consequence, expectations for improved efficiency, speed, and project quality are seldom met [Wheelwright & Clark 30].
Research in the automobile and electronics industries has shown that heavyweight project organizations have resulted in successful performance. In contrast to the lightweight set-up, the heavyweight project manager has direct access to and responsibility for the work of all those involved in the project. Such project managers are heavyweights in two aspects. Firstly they are senior managers within the organization, they are at the same level as the functional managers. As a result they do have expertise and experience, but they also have significant authority in th organization. Secondly, heavyweight project leaders have primary influence over the people working on the development effort and supervise their work directly through key functional people

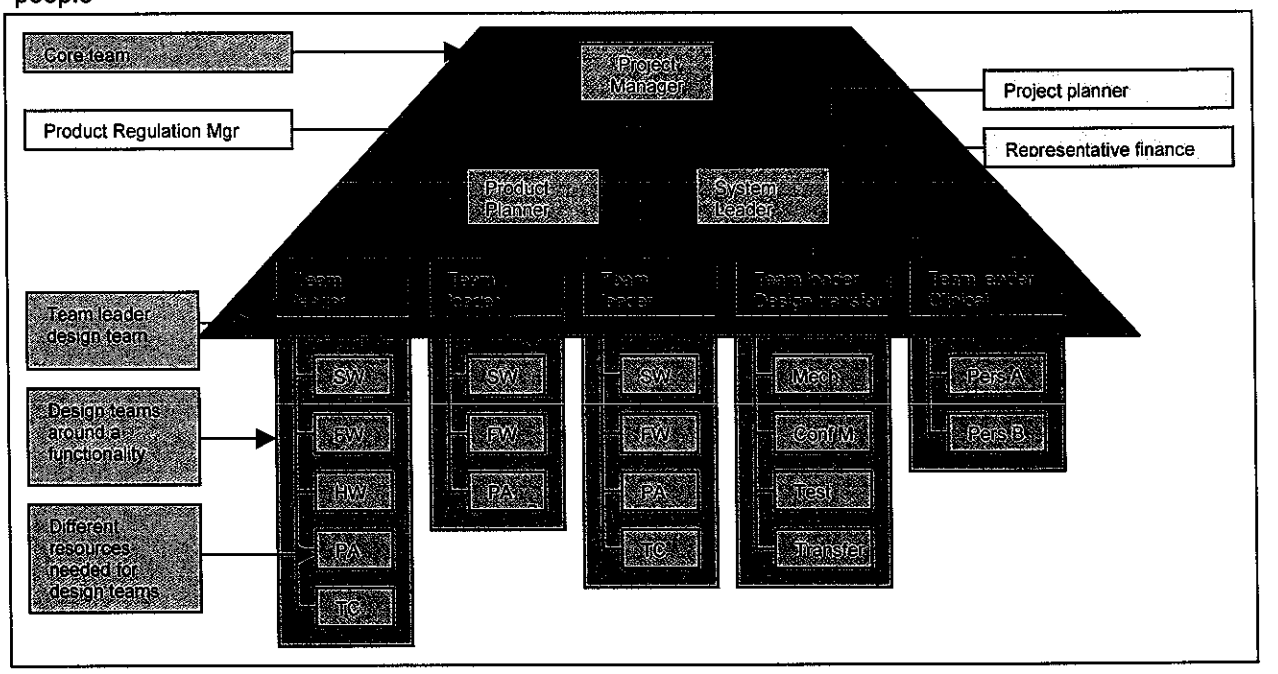


Figure 5.14. Composition of the Design teams

Wheelwright & Clark [30] conclude that heavyweight teams offer improved communication, stronger identification with and commitment to a project, and a focus on cross-functional problem solving.
The team leaders of the design teams should be heavyweight project managers. Every team member reports to the heavyweight team leader for operational and functional tasks.

Hierarchically he reports to the functional manager The functional manager allocates the resources as described in paragraph 5.1 4 How this organization structure is positioned in the organization structure of Vitatron is shown in Appendix XIV.
The core team of the development project consists of the Project Manager, the Product Planner, the System Leader and the design team leaders. The project manager is fully responsible for the budget. The composition of the Core team can be seen in figure 5 14 In Appendix XV all responsibilities of people involved in the project are summarized per development phase.

Evaluation phase
In this phase the clinical evaluation of the product will be completed, all regulatory approvals will be obtained and the design transfer must be optimized. Only two design teams will be left: The design transfer team to support the product of the pacemakers and the clinical design team to do the clinical study. The team will be supported by the project planner and the representative of finance if necessary.

Building capability for multiple approaches
Not all development projects that Vitatron undertakes require the creation of a dedicated cross-functional heavyweight team. Heavyweight teams may be highly effective for platforms or big derivative projects, but these teams approach an overkill for those projects so small that only a few engineers need to work on the project [Wheelwright & Clark 21]

C_1-series
The first derivative product series after the introduction of the product platform and the C_0-series will be the C_1-series. The C_1-series will contain all the technologies and functionalities of the C_0-series and it will contain the QT sensing functionality. This means that Dual Sensor Rate Response will be added and higher sensitivity is required as well These are mainly small hardware changes. A cross-functional design team will be an overkill for the design of this derivative product, because this is an incremental change only. A more functional core team will be preferable. The stable environment of design teams around functional areas and the limited amount of change involved in the project makes it relatively easy to subdivide tasks and to pass the project successfully from one function to another
The development of this derivative product should be organized as explained in figure 5.14, but the design teams should not be composed cross-functional around the functionalities in the product, but around the changes in each functional area, which will be mainly Hardware for the C_1-series.

T_0-series
The second derivative product series will be the T_0-series. To this product series the AF therapy, IEGM storage, extended diagnostics and Rate Drop Response will be added This is a much bigger derivative development project with new features. For this project a cross-functional approach of a heavyweight team around a functionality would be very effective

The composition of the design teams is shown in figure 5.15.

Advantages of new organization
The proposition of an organization structure as discussed in this paragraph has many advantages. These are summarized:
- Clear tasks & responsibilities for all people involved in the project
- Effective cross-functional composition of system team that will be kept intact
- More focus on the project compared to the previous organization structure
- Efficiency and speed of the development process will be improved through better commitment to the project and clear ownership of design tasks.
- Cross functional co-located teams improve collaboration and communication within the design teams and they focus on cross-functional problem solving
- Clear collaboration between functional departments and projects.

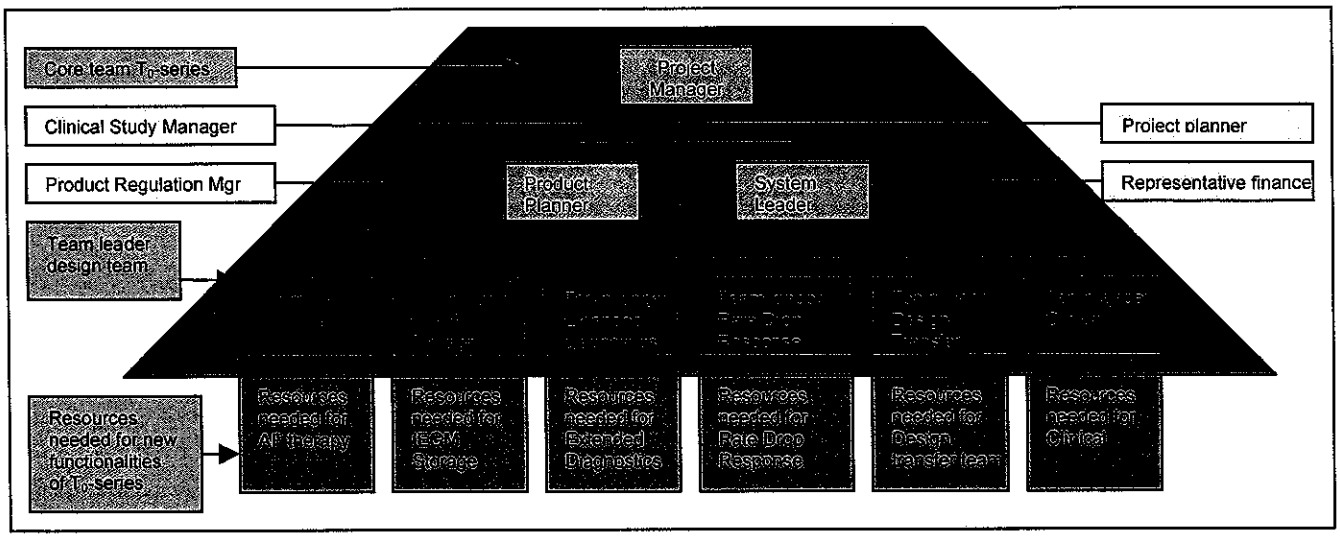


Figure 5.15: Composition design teams T_0-series

5.3.4 Managing interfaces and specifications on system level

Chapter 3 pointed out that interfaces between the building blocks can be incredibly important. They should be standardized, managed well and defined in the pre-development phase. Currently Vitatron does not have good interface specifications between all functional groups. The interface specifications between Software and Firmware function quite well, but there are poor interface specifications with Hardware and other departments

In the Commitment Phase, the building blocks of a new product and their interfaces will be determined. This process starts with the determination of the functions of the product that will be mapped on the building blocks of the product. The system leader leads this process

Interfaces between design teams and the rest of the system should also be determined in this phase. If these interfaces are specified clearly and before the development process starts it will allow processes for developing features or components to become loosely coupled, because they can be efficiently coordinated simply be requiring that all developed components conform to the standardized component interfaces specifications. The system leader is owner of management of all interfaces between the building blocks and the design teams

5.3.5 Risk diagnosis and management

Chapter 4 discussed that Vitatron does not have a well functioning risk management tool. Project risks are not analyzed very well and they are not managed

RDM (Risk Diagnosing Methodology [Keizer & Halman & Song 7]) is an effective method to identify and evaluate technological, organizational and business risks in product innovation projects.

The true nature of project risk is determined not only by its likelihood and its effects, but also by a company's ability to influence the risk factors.

The project manager is owner of the project management risk. In the business analysis phase an analysis should be made of potential risks. A project should be labeled very risky if:

- The likelihood of a bad result is great
- The ability to influence it within the time and resource limits of the project is small
- Its potential consequences are severe

Too often risk analyses are directed exclusively towards either technological, organizational, market or financial factors. The success of product innovation, however, is determined by external influences and internal circumstances in which all these factors interact. To be effective, a risk assessment method therefore needs to help identify potential risks in the following domains:

- Technology: product design and platform development, manufacturing technology and intellectual property

- Market: consumer and trade acceptance, public acceptance and the potential actions of competitors
- Finance: commercial viability
- Operations: internal organization, project team, co-development with Medtronic, clinical studies and supply and distribution.

The project manager should facilitate a workshop to identify potential project risks. This will only cost a few days. A risk management plan should be added to the production process procedure VVPM 446 as a deliverable of the BA Phase It is beyond the scope of this research project to develop a fully risk management tool for Vitatron in this research project, but some very essential topics about risk management in product development projects are mentioned in this paragraph.

5.4 Next generation product platform development

One of the considerations in deciding when it is appropriate to go to a next generation platform is when there have been sufficient advances made in technology, features, and knowledge of customer needs on a range of dimensions so that they can be bundled into a significant better platform project. Paragraph 5 1 discussed the separation between product and platform development, arguing that product platforms should be pre-developed. Paragraph 5.2 described how a technology roadmap should be used and has been discussed how the strategy of a next generation product platform should be developed. This paragraph describes an organization structure and management process for the development of a new product platform.

5.4.1 Design teams around building blocks

It has been argued in chapter 3 that effective organizations in competitive environments group their design tasks around a product's building blocks. Effective design projects strive to allocate the conception of each building block to an organizational unit solving all interactions within the block. When the functions of a new product platform have been determined as described in paragraph 3.2 these functions should be mapped on the building blocks of the product architecture of a next generation product platform. One function could be supported by one or more building blocks. One building block could also support more functions. A function is a design goal, describing what needs to be achieved The building blocks are purely physical and are described as the physically chunks of a product. Concepts of functions and new technologies will be developed by the technology team as described in paragraph 5.3.

Figure 5.16 illustrates that design teams are formed around the new product platform's building blocks. The design teams have interfaces with each other, but these are weaker than the interfaces between the tasks within a design team

5.4.1 Composition of development teams for the development of a next generation product platform

The organization structure will be almost the same as the structure designed for the development of derivative products in figure 5.14. When developing new product platform design teams, a team should not be formed around functionalities, but around building blocks. This reduces coordination effort, enables de-coupling of development processes and enables an effective development of a new product platform. It also improves system level coordination. This is shown in figure 5.17 The platform development team will be positioned in the organization structure of Vitatron identical and parallel to derivative product development teams. This is illustrated in Appendix XVI

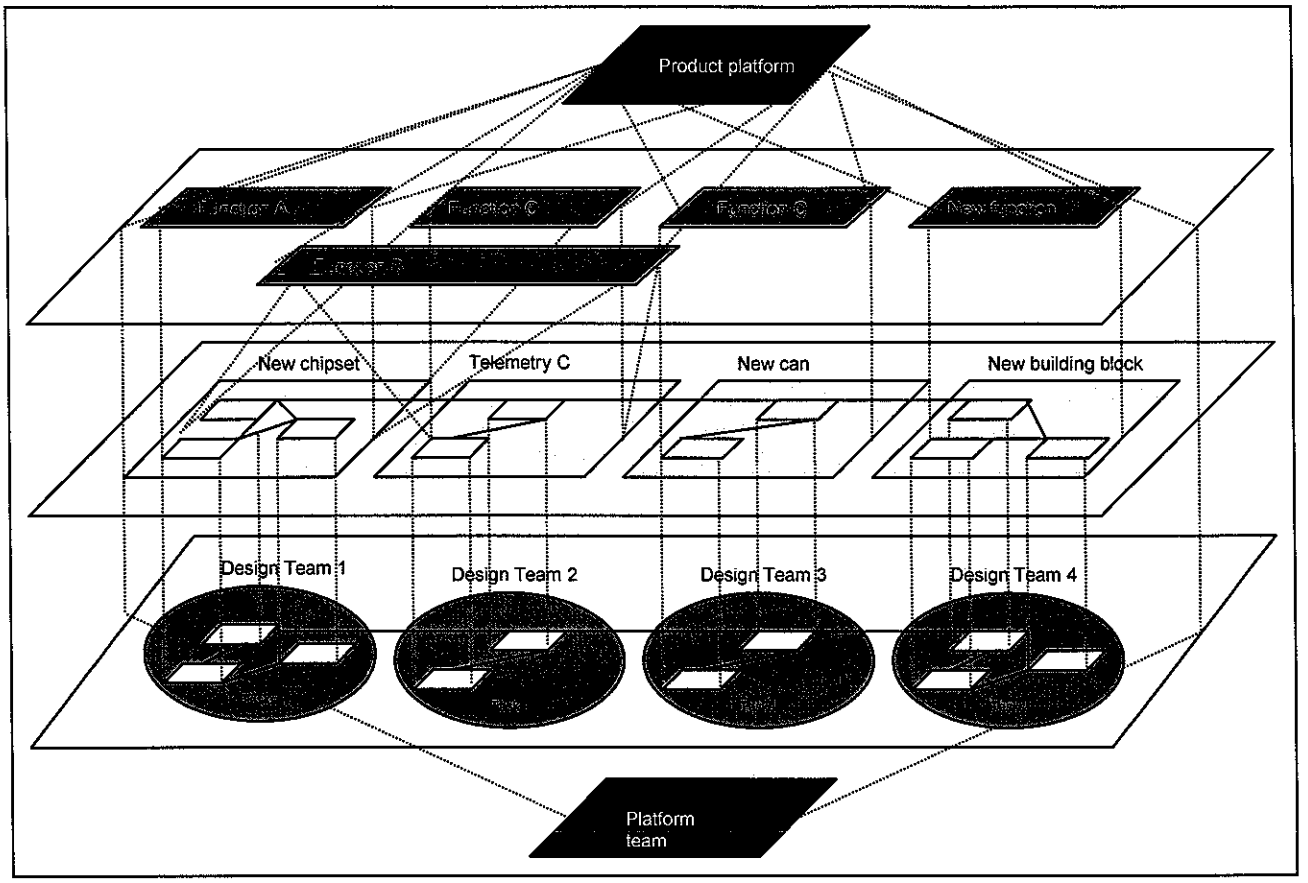


Figure 5.16: Design teams around building blocks

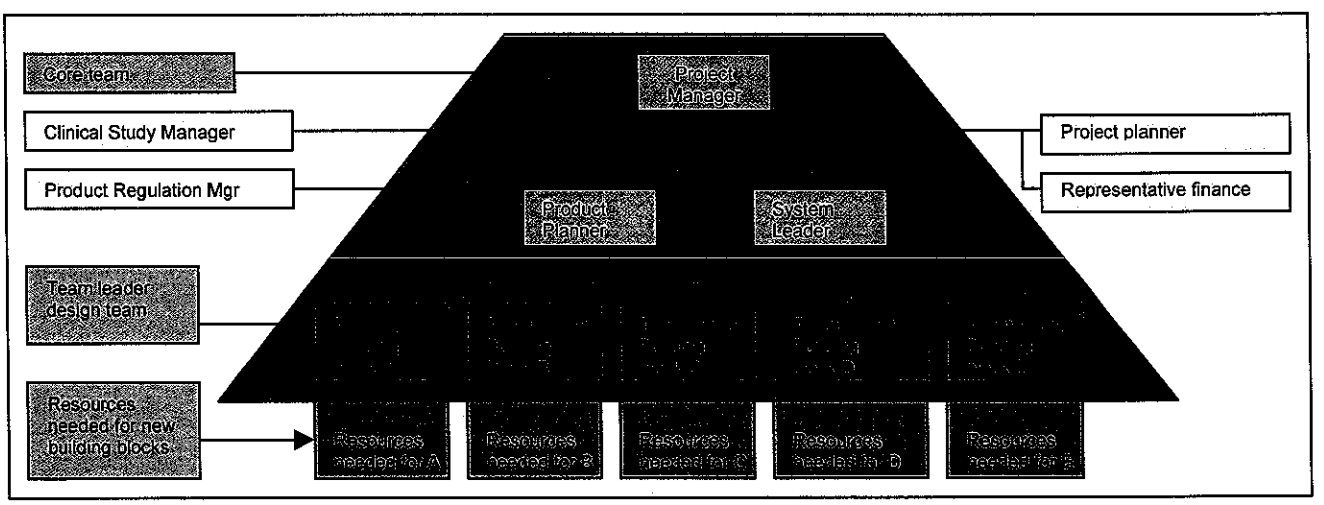


Figure 5.17: Composition design teams new product platform

6. Implementation

In this chapter the implementation of the proposition of managing and organizing product and platform development will be discussed. First, paragraph 6.1 provides insight in implementing organizational innovation in a development organization. Then, paragraph 6.2 discusses the implementation plan.

6.1 Implementing organizational innovation

A change in the organization structure and business process of product and product platform development of Vitatron starts at the level of top management. They have to diagnose the problems and have to commit to the proposition.
Organizational innovation is an ongoing process. People resist to changes in organization, working procedures, and management processes. Incremental innovation based on the PDCA-circle (Plan, Do, Check, Act; [van der Bij, Broekhuis, Gieskens 28]) has proven to be a successful tool for the implementation of an organizational innovation.
In the plan phase the strategy is translated into specific actions and goals. In this research project a proposition of an organization structure and business process has been made. The do-phase comprises the implementation of the proposed activities. The check phase consists of an analysis and evaluation of the new way of managing and organizing product and platform development. It is a review on the performance. The results of this analysis and evaluation may lead to changes in the design and should be implemented
Because this research project affects many aspects within the development organization such as portfolio management, product strategy definition, and managing and organizing product development, the owners on a high level that are responsible for these different areas will be made explicit first. These are summarized below:

- **Business strategy** focuses on key business drivers and goals.
  Responsibility: Management Team
- **Product strategy** focuses on which products are needed in each market and what is the most optimal product platform solution
  Responsibility: Management Team supported by PRC
- **Portfolio management** focuses on total product, technology and functionality investments to meet integrated product strategy and to ensure coordinated multi-project execution.
  Responsibility: PRC within the strategy concept determined by Management Team
- **Project management** focuses on individual project execution management
  Responsibility: Project management manager
- **Resource management** focuses on pro-actively minimizing bottlenecks, ensuring proper capacity and skill sets, and individual project allocations.
  Responsibility: CC-managers allocate resources in cooperation with the project managers

6.2 Implementation plan

Different actions will have to be performed to implement the proposition of an organization structure and business process for product and platform development at Vitatron. The sub-designs are categorized and summarized below. These have been described in chapter 5. As a start will be described what already has been implemented at Vitatron. Then will be described what else should be implemented. A person or group will be assigned to a sub-design, then will be explained how it should be implemented and what else should be done for successful implementation of the sub-designs. A special meeting within Vitatron has been conducted to discuss how the sub-designs should be implemented and who should be responsible for that.

Portfolio management

- **Portfolio manager**

The sub-design of the portfolio manager has been partly implemented. Vitatron introduced one person who is responsible for all development projects (portfolio management manager) and

Vitatron introduced a person that is the initiator and leader of a portfolio meeting and he is responsible for all project planners.
The most effective structure will be one that consist of one portfolio manager who is responsible for planning, managing and coordinating all development projects. This prevents sub-optimization and struggles between the two different people who are now responsible for portfolio management. Management Team is responsible to integrate the two functions in one function.

- **Quarterly portfolio meetings**

The sub-design of the portfolio meetings has partly been implemented. Vitatron management introduced the PRC (Portfolio Review Council) as a substitute for the PPC. The PRC meet every two weeks and has an initiating and managing role. In these meetings mainly operational issues about the overall development projects are discussed.
A quarterly portfolio meeting should be initiated that will not discuss operational issues, but will check if the projects are in line with the strategy, will balance the development portfolio, and will prioritize development projects. The PRC is responsible for implementing this quarterly portfolio review meeting

- **Consumer technology matrix**

The consumer/technology matrix has been designed and presented during the mid-term presentation. Agreement has been reached on the design.
The consumer/technology matrix should be used as a tool to balance the development portfolio in the PRC meeting. The PRC is responsible to implement it. The matrix should be stored on the intranet and updated in the meeting. It is a tool to determine the competitive strength of the development portfolio and to balance it.

- **Separation of product and platform development**

A proposition of the separation between product development and platform development has been constructed and will be presented during the final presentation of the research project at Vitatron. The recommendation will create awareness of the importance to separate product development and platform development.
Management team is responsible for the separation of product development and platform development. They have to commit resources to the pre-development of a next generation product platform

Product and platform strategy

- **Market segmentation plan**

A market segmentation plan for product platform DA^+ has been constructed together with the product planners of Vitatron. This sub-design will be presented during the final presentation at Vitatron.
The Product planners should use the market segmentation plan as input for the development of a new product or platform. This plan should be updated and stored on the intranet so that everyone who is interested in the plan can see it. Products will be better adapted to the different customer needs.

- **Technology roadmap**

A technology roadmap for product platform DA^+ has been constructed and presented during some management meetings and during the mid-term presentation. Agreement has been reached on the design. The roadmap has been used as a communication tool at some meetings and also provided insight in the strategy of product platform DA^+.
The PRC is the owner of the technology roadmap. It should be updated in the quarterly portfolio review meeting. The roadmap should be stored on the intranet, so that many people can take advantage of it and that many people can provide input for the technology roadmap.

- **Steps for the development of a new product platform**

Steps for the design and development of a new product platform have been constructed and will be presented during the final presentation.

Management team is responsible for the adaptation of the development steps for the design and development of a next generation product platform. Agreement should be reached on the development steps at the final presentation.

Managing and organizing product and platform development

- **Managing and organizing the development of derivative product development**

A proposition of a design for managing and organizing has been constructed and discussed at some meetings. The composition will be presented during the final presentation. Agreement has been reached on the design and the intent is to manage and organize derivative product development as has been constructed in this research project.
The current project management manager is responsible for the implementation of the new composition of the development teams. Agreement has been reached on the design.

- **Risk diagnosis**

An organization structure has been constructed that facilitates the implementation of a risk diagnosis method in the Business Analysis Phase of a development project. This will be presented at the final presentation
The risk diagnosis should become a deliverable in the standard development procedure VPM 446. This should be managed and controlled at the Stage Gate review meeting by the Management Team.

- **Separation of technology, functionality and product development**

An organization structure for the separation of technology development, functionality development, and product development has been constructed and agreement has been reached on the design. This sub-design has already been implemented A separate technology team develops technologies and functionalities. Only then when these concepts re viable and well understood these concepts can become part of the project plan of a product development plan Management Team was responsible for this implementation.

- **Managing and organizing the development of a next generation product platform**

An organization structure and business process have been constructed for the design and development of a next generation product platform. This will be presented during the final prevention. Management Team will be responsible to implement this approach.

In table 6 1 the different actions that have to be performed to implement the proposition of the design are summarized. The Plan, Do, Check, Act circle has been used as a framework for the plan. It assigns a person to the sub-design, it explains briefly what has been developed and by whom, it provides insight in what has been implemented already and what still has to be implemented. In the evaluation phase it makes explicit what the results of the evaluation are and what should still be evaluated. Finally, actions should be defined to improve the entire innovation process.

The final chapter of this report, Chapter 7, will provide conclusions and recommendations

PDCA circle	Actions				
	Who	Plan (presented and agreement on)	Do (implemented on 01-04-2002)	Check	Act
Portfolio management					
Portfolio manager	Project management Dick	Design of organization structure and goals of function of portfolio manager have been constructed Constructed by author	One person is owner of all dev projects and manages them together One person owner of project planners and initiates a PRC meeting	Two separate functions should be integrated in one function of a portfolio manager Should be evaluated	TBD (To Be Defined)
Quarterly portfolio review meetings	Project planning Systems engi-neering (Harry)	Goals and tools for PRC meeting and relation with Stage Gate Meeting have been developed Constructed by author	A weekly prc meeting has been implemented for operational issues about all development projects	Quartlerly portfolio review meeting should be implemented and evalu-ated, Tools should be used	TBD
Consumer technology matrix	PRC	A matrix and its interpretation has been constructed Constructed by author	Should be accepted, assigned to and used in PRC	Should be evaluated	TBD
Separation of product and platform dev	MT	Proposition of organization structure for separation of prod. and platf. dev. has been designed Recommended by author	A next generation product platform should be pre-developed	Should be evaluated	TBD
Product and platform strategy					
Market segmentation plan	Product Planner	Construction of market grid for derivative prod. DA+ Constructed by author	Should be assigned to PP's and used as basis for new development projects	Should be undated, checked and evaluated	TBD
Technology roadmap	PRC	A technology roadmap has been constructed Constructed by author	Has been used as communication tool and provided insight in the strategy of Vitatron in several meetings	Should be used as tool to contribute in formulating the strategy in PRC	Tool for contributing in developing the strategy
Steps for development of new product platform strategy	PRC	Development steps, power tower, and roll-out plan have been formulated Constructed by author	Should be accepted, assigned to and used when a new product platform development project will start	Should be evaluated	TBD
Managing and organizing product and platform development					
Derivative product development	Project management (Dick)	Composition of development teams and tasks and responsibilities have been constructed Constructed by Dick, Harry and author	Intent is to manage and organize all derivative products in the near future as has been developed	Should be evaluated	TBD
Risk management tool	Dick	New task of project manager and deliverable in BAR Recommended by author	Should be developed	Should be evaluated	TBD
Separation of technology and product development	PRC	Design of organization strucutre Constructed by Dick, Harry and Author	Has been implemented	Should be evaluated	TBD
Next generation product platform development	Dick	A composition of design teams around a product's building blocks has been cosntructed Constructed by author	Should be used in the development of a next generation product platform	Should be evaluated	TBD

Table 6.1: Implementation plan

7. Conclusions & Recommendations

This is the concluding chapter of this research project. In paragraph 7 1 the most important conclusions of this research project are set out. In paragraph 7 2 recommendations for Vitatron are formulated. In paragraph 7.3 external validation and suggestions for further research are discussed.

7.1 Conclusions

Product platform development is very important to Vitatron, because all future products will depend on a product platform. This research project analyzed and evaluated product and platform development at Vitatron and provided an approach for managing and organizing derivative product development and next generation platform development at Vitatron.

Analysis and evaluation of product and platform development
The development portfolio of Vitatron and the strategy of product platform DA$^+$ have been analyzed. Using a conceptual model the development of product platform DA$^+$ has been evaluated. The analysis and evaluation showed:

- There was no portfolio management in the development organization of Vitatron and there was no balance in the development portfolio of Vitatron between long-term and short-term, and between high risk and low risk development projects.
- The strategy of product platform was a high-risk strategy, there was not a thorough insight in the strategy and some essential elements (market understanding and segmentation plan, sharp project definition) of the pre-development work were missing.
- The evaluation of the organization structure and business process of the development of product platform DA$^+$ showed that there was an unbalanced weak matrix structure and it showed that tasks and responsibilities of all people involved in a development project were unclear. There was not an effective composition of all development teams; the different departments did not cooperate well enough and there was no risk management tool.
- There was an integration of the development of processes, technologies, functionalities and products that caused many problems (delay, unnecessarily complexity) in a successful realization of the product platform

Portfolio management
Introducing portfolio management into the development organization of Vitatron, a new function will be created: the portfolio manager. His responsibility is to manage all development projects and he will be the driver of the PRC meeting. This is a quarterly meeting with the aim to ensure that 1) all development projects will fit in the strategy of Vitatron, 2) the value of the development portfolio within the product platform concept will be maximized, and 3) the development portfolio will be balanced.
Balance in the development portfolio will be created through usage of the technology/consumer matrix in the portfolio review meeting and through separate product and platform development. Next generation product platforms should be pre-developed while derivative products are still produced on the "old" platform. This reduces risk and enables a continuous stream of new products.

Strategy of the development of derivative products
A technology roadmap and a market segmentation plan have been developed as a derivative of the strategy of Vitatron. These tools provide insight in the strategy of Vitatron and they are good communication tools between the different departments.
In the near future the technology roadmap and the market segmentation plan should be used as a tool to contribute to strategy development of Vitatron. Therefore an optional roadmap including relevant technologies, functionalities, and possible new products should be created. It will provide insight in the consequences over time of adding new technologies and new functionalities to one or more derivative products.

Strategy of the development of a next generation product platform
For the development of a new product platform a Power Tower has been constructed. This is a decision tool that consists of several development steps, including the segmentation plan and technology roadmapping. It will improve the process of designing, developing and revitalizing a product platform. This has proven to be a valuable approach. The Power Tower shows that the pre-development work of designing a product platform is extremely important. The description of this tool has been provided in paragraph 5.2.3.
Considering the commonality of all pacemakers one product platform should be sufficient to develop the next derivative pacemaker series in the future. The strategy of developing a low cost standard performance product platform to satisfy the lower market segments first, and then satisfy higher market segments by upscaling the product platform is recommended. This will reduce risk, because not all new technologies will be implemented at once and it will enable a quicker development of the first derivative product based on the product platform.

Managing and organizing derivative product development
An organization structure has been proposed that will separate technology and functionality projects from product development projects. Only when new concepts are viable and well understood they can become part of a product plan. This will prevent many problems in product development.
A proposition of co-located cross-functional design teams has been made for the development of derivative products based on product platform DA^+. In the commitment phase the customer requirements will be translated into system requirements by representatives from the functional areas (system engineers). In the development phase design teams will be composed around a functionality. This approach will improve focus, collaboration, and communication within the project and as a consequence it will speed up the development process

Managing and organizing a next generation product platform
For the development of a next generation product platform, design teams should be composed around the product platform's building blocks. This approach will reduce coordination effort and interfaces with other development teams. It will also enlarge commitment of the design team to the project and it will improve the focus of the design teams.

Conclusions considering the objectives of this research study
The organization structure and business process of the development of derivative products for Vitatron have been improved in many aspects. The commercial, technical, and financial advantages of the new proposition of an organization structure and business process will appear when the proposition will have been completely implemented.
An organization structure and business process for the development of a next generation product platform is suggested and will be implemented within several years. This proposition will improve the process of designing, developing and revitalizing a next generation product platform for Vitatron.
Considering the objectives as specified in chapter 2, the conclusion can be drawn that the objectives of this research project have been realized.

7.2 Recommendations

Recommendations for Vitatron have been formulated and are categorized. The recommendations with highest priority will be mentioned first.

Portfolio management

- **Dare to choose for the pre-development of a next generation product platform**
  In the AOP a trade-off must be made between allocating extra time, funds and resources to derivative product development or to allocating time, funds and resources to the pre-development of a next generation product platform. To choose for the pre-development of a

next generation product platform will be best for the long-term. This will balance the development portfolio and will enable a continuous stream of new products over time.

- **Standardize the process of development prioritization**
  Project prioritization has become an important aspect of the Portfolio Review Meeting. For an effective prioritization of development projects the process should be standardized and structured. Decisions should not be made ad-hoc.

Developing a strategy for derivative product development and a next generation product platform

- **Marketing Attack plan**
  If Vitatron wants to maintain their status as fastest growing pacemaker producer in the world it should define clear marketing attack plans. A marketing attack plan translates strategy into an pro-active attack plan for the target market. Marketing attack plans should be developed to capture market specific strategic analysis and associated planning. The plans should characterize and prioritize the target market segments based on a thorough understanding of customer problems and trends. They define the winning vectors of differentiation that optimally balance high priority customer problems against Vitatron's capabilities and competitor weakness.

- **Collaboration with Medtronic**
  Vitatron is too small to develop a next generation product platform or a new breakthrough product all by itself. In the future Vitatron will depend heavily on the research and development of Medtronic. It is important for Vitatron to define collaboration plans with Medtronic in a preliminary phase for breakthrough and next generation product and platform development.

- **The use of a technology roadmap in the formulation of the strategy of Vitatron**
  To ensure an enterprise-wide integration of strategy, research and development the technology roadmap should be used. Technology development should be focused on product platforms and timed to support the derivative development projects. The technology roadmap should be updated continuously and should be well communicated within Vitatron. The input of technologies and functionalities should be relevant, but also as broad as possible.

Managing and organizing product and platform development at Vitatron

- **Specification of the risk management tool**
  An effective implementation of risk diagnosis in the BA of a development project requires a further specified risk diagnosis tool that becomes a deliverable of the development procedure VPM 446.

- **Commitment to the stage gate model**
  The stage gate model of Vitatron should be managed professionally by the project managers and the Vitatron Management. This means for instance that the content of a development project can not be extended after the BAR and that the SyRS should not be changed unnecessarily. New technologies or functionalities that are not specified in the BAR should be reserved for next derivative products. The development process should stick to the standard procedure and development phases can not be repeated

- **Evaluation of development projects on a project basis**
  Development projects should be evaluated in a systematic way like the evaluation of product platform DA^{+} in paragraph 4 3. Stakeholders close to an innovation project, who influence the project should be involved in the evaluation of an innovation project. Moreover the internal processes should be evaluated. The internal processes consist of the objectives of the development project; specification of time, quality, and funds; management and organization

of the project; and the realization of the objectives. Development projects should be improved according to the Plan, Do, Check, Act circle as described in chapter 6.

7.3 External validation and suggestions for further research

External validation

To validate the proposition of an organization structure business process for product and platform development of this research project "best practices" of how other companies manage and organize their product platforms have been studied. Therefore the results of a study by W. van Vuuren & J.I.M Halman [20] named:" Platform driven development of product families: Linking theory with practice" have been studied, a Congress about Competing through Innovation at Eindhoven University of Technology has been attended, a dissertation by B.Oosterman [23] about matching product architecture and organization at Philips DAP has been studied.
ir. P de Wit who is involved in the process of developing product platforms at Philips Consumer Electronics has been interviewed. This interview validated some elementary topics of this research project. The most important of these are:

- Philips separates the development of technology, functionality, platforms, and products
- A system engineer who leads the development phase that defines the product architecture.
- A senior project manager manages a product development project.
- Technology roadmaps are important tools in contribution to the strategy of consumer electronics.
- Philips CE uses matrices like the technology consumer matrix to determine the competitive strength of the development portfolio.

Further external validation

Vitatron does not know how its competitors manage, and organize their product platforms. If Vitatron analyzes its competitors much can be learned from them. Acquiring competing products and studying them on the level of subsystems and interfaces or analyzing the organization structure of their innovation process is recommended.

Suggestions for further research

When managing a product platform, a decision must be made on how many derivative products can be produced by several product platform extensions and when a next generation product platform should be developed. A suggestion for further research is to investigate the trade-off between incremental or breakthrough innovation.
Vitatron is too small to develop a next generation product platform or a breakthrough development project all by itself. A suggestion for further research is how Vitatron should cooperate with Medtronic on product platforms and what would be the best product platform or breakthrough strategy.