Qualitative futures research for innovation

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ISBN*10*: 90-5972-115-2
ISBN*13*: 978-90-5972-115-9

Eburon Academic Publishers
P.O. Box 2867
2601 CW Delft
The Netherlands
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info@eburon.nl / www.eburon.nl

Cover design: Studio Hermkens, Amsterdam

QUALITATIVE FUTURES RESEARCH FOR INNOVATION

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof.dr.ir. J.T. Fokkema,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op maandag 29 mei 2006 om 15.00 uur
door Patrick Andrew VAN DER DUIN
doctorandus in de economische wetenschappen
geboren te Amsterdam

Dit proefschrift is goedgekeurd door de promotor:
Prof. dr.ir. A.J. Berkhout

Toegevoegd promotor: Dr. J.R. Ortt

Samenstelling promotiecommissie:
Rector Magnificus, voorzitter
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Dr. L. Hartmann, Technische Universiteit Delft

“And to all who hold that view, who regard the future as a perpetual source of convulsive surprises, as an impenetrable, incurable, perpetual blankness, it is right and reasonable to derive such values as it is necessary to attach to things from the events that have certainly happened with regard to them. It is our ignorance of the future and our persuasion that that ignorance is absolutely incurable that alone gives the past its enormous predominance in our thoughts. But through the ages, the long unbroken succession of fortune-tellers – and they flourish still – witnesses to that perpetually smoldering feeling that after all there may be a better sort of knowledge – a more serviceable sort of knowledge than that we now possess.”

H.G. Wells, The Discovery of the Future (1913)

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FOREWORD

It may seem strange to start the foreword of a PhD-thesis on futures research with a little history. Nevertheless, it may provide some useful insight in the motive of my research. In 1996, I got a job at KPN Research as a member of the Institute of Applied Organisation Research (Instituut van Toegepast Bedrijfsonderzoek) (ITB). The brochure of ITB caught my attention because it reported on a project containing societal scenarios for the year 2015, which strongly resembled various political theories and philosophies I had been taught during my education as a macro-economist at the University of Amsterdam. In the following years I did carry out many projects in the field of futures research related to the telecommunication industry. Gradually I discovered that I had a keen interest in the future, which seemed to manifest itself in a personal characteristic. That is to say, the part of the brain that, according to Norwegian neuro-biologist Ingvar, is responsible for making future plans, turned out to be very well-developed indeed (leaving not much room for other parts of my brain). Since mixing my pivate life with business is a hobby of mine (remember all my 'office-romances'), I decided to make 'the future' the future subject of my work. And after conducting many different futures studies for clients of KPN Research, I was eager to go back in history, back to the university, this time not as a student but as a fellow researcher (a job title that came with a better salary than that of PhD-student). I am not sure when I made the connection of futures research with innovation, but it is safe to assume that joining the sub-department Technology, Strategy and Entrepreneurship of the faculty Technology, Policy and Management (TPM) of Delft University of Technology involved in the management of innovation has something to do with it.

When I decided to do a PhD many people warned me of the solitary life I would be facing. "You will be spending at least four years behind a desk with the door of your office closed", they predicted. Nothing could be further from the truth. Doing a PhD-study is a very social activity that involves many people, sometimes even more than you care for ….. Therefore I want to use this foreword to thank those people who helped me and stood by while I was conducting my PhD-research and writing this thesis.

To begin with, I would like to thanks those who reviewed parts of the manuscript at an early stage:
Dr Harry Bouwman (also for introducing me to the scientific community and teaching me to write scientific articles….), Prof. Alan Porter, Prof. Bart van Steenbergen, Prof. Enid Mante (also for introducing me to the world of futures research), Prof. Guido Reger, Hans van der Loo, Jan Schoonenboom, Dr Jorg Thölke (also for all his advice on case studies), Dr Lisette Pondman (also for all her positive attitude), Roos Bonnier, Prof. Marjolein van Asselt, and Prof. Rein de Wilde.

Secondly, since this research would not exist without the possibility of conducting case-studies at companies, I would like to thank my contacts at the various organisations:
Gert van Duren (TNO Industry), Nicole Eikelenberg (TNO Industry), Hans Stavleu (KPN Research / TNO ICT), Rene Hartman (Syntens NT), Vera Philippens (Syntens NT), Bart Götte (PinkRoccade), Robert van Oirschot (PinkRoccade), Dr Frank Ruff (DaimlerChrysler STRG), Dr Jacco Wesselius (Philips Medical Systems) and, of course, all the interviewees who provided me with their time and information.

Thirdly, I would like to thank those who helped with the more practical aspects of the thesis: Debbie van der Hout of typing agency DEB for transcribing all interviews, Gert Stronkhorst for editing the English version of the thesis and for his very flexible attitude in the process, Michiel Nijhuis for his assistance in the Syntens NT-case, and Ron Koster for his important lessons of life.

Fourthly, I want to extend a very special thanks to my supervisory team. To Prof. Guus Berkhout, who is the embodiment of inspiration, who has put a lot of faith in me, and who has learned me to think cyclically and to formulate in a more concise manner. Dr Dap Hartmann for all his critical comments and his humour. Not a day at the office passes by without him teaching me something valuable, and I am glad that my thesis passed the 'Dap-test'. Dr Roland Ortt for his close reading, his belief in my ability to complete this PhD, and for giving me structure in my working processes. I hope we can continue our working relationship for a very long time. And Prof. Hans Wissema for giving me the opportunity to become a fellow researcher and for giving me room to develop my own ideas in my first months as a PhD-student.

Finally, many thanks to all my friends, close relatives and colleagues from Technology, Strategy and Entrepreneurship. A special thanks to my good friend and personal hero Hans Stavleu, with whom working is great fun. And a very special thanks especially to my parents Theo and Suze and my brother Ronald who were always very interested in my work and who supported me all the way. And last but not least, many thanks to my girlfriend Yolanda for all her love and care and for being, together with Bobbi ('our little and sweet future of Delft'), such an indispensible part of my own beautiful future scenario I could not have imagined.

Patrick A. van der Duin

The Hague / Delft, April 2006

CHAPTER 1 – INTRODUCTION: MOTIVES OF FUTURES RESEARCH AND RESEARCH STRUCTURE

In this thesis we investigate how commercial organisations look to the future and how they use information and knowledge about future developments in their innovation processes. Throughout history mankind has shown a great interest in and even has felt an urgent need to look to the future. Section 1.1. describes three important motives for looking to the future (or futures research[1], as we will call it in this thesis). In section 1.3 we discuss literature about the relationship between futures research and innovation. Section 1.3 presents the structure and method of this thesis and at the end of this chapter we provide a reading guide (section 1.4).

1.1. Motives for futures research

In this section we describe three important motives for organisations to look to the future.

1. *Increasing dynamics* - "The future is not what it used to be" - this famous statement by French philosopher Paul Valéry refers to the fact that during the past 20 to 30 years we have realised that the future holds so many new and surprising elements that we can no longer say that the future is a mirror image of the past. The overthrow of communist regimes in Eastern Europe and the rise of the Internet with all its side effects are just a few examples of revolutionary developments that surprised us all. Another example is the socio-economic and political situation in the Netherlands. During the fifties, sixties and part of the seventies, the country was 'pillarised', which meant that people were divided along protestant, catholic, and social-democratic vertical lines. For instance, someone within the Catholic pillar would read a Catholic newspaper, would vote for a Catholic political party and would be a member of a Catholic union. This meant that it was easy to predict a person's lifestyle. All one needed to do was figure out which pillar they belonged to and, for instance, their communication and voting behaviour could be easily explained. In the seventies and eighties these pillars began to break down and people increasingly began to behave in a 'strange' and thus unpredictable manner: attending a Catholic church, voting for a social-democratic party, and becoming a member of a general union all at the same time.

   The old segmented society has been replaced by a network and, because of that, society has become much more dynamic. Nowadays we often speak of *open* systems (as opposed to *closed* systems). The concept of open systems refers to the fact that

[1] See Appendix 8 for an overview of different terms used for looking to the future and for reasons for using the term futures research in this thesis.

different spheres of life, such as technology, economics, politics, and culture, are no longer separated. As a result, there are few so-called *autonomous* developments left but instead all sorts of developments influence each other. Because of this, it is almost impossible to determine by what development or event a change is triggered (causality). Due to the interdependency between the various developments in open systems, the complexity of society and its related dynamics is growing, which affects not only the current state of affairs but the future as well. It demonstrates that futures research has become very complex. After all, if we have limited knowledge of the past and different opinions about how things work out today, we will certainly have varying views about the future. What all this teaches us is that the greater the difference between the future and the past, the more interesting and important it becomes to study the future. After all, if the future were the same as the past, what would be the point of studying it?

2. *Anticipation as a strategic weapon* - for most businesses it is no longer sufficient to meet current needs by offering products and services with a good price-quality ratio. The American management guru Joel A. Barker (1996) has stated that, in addition to innovation and excellence, anticipation is a necessary capacity for an organisation to obtain a competitive edge. Knowing at an early stage how society will change, how the needs of customers will change, and which new legislation can be expected will give organisations time to adjust to new challenges. An organisation that fails to anticipate changes runs the risk of losing out to more alert competitors. Barker demonstrates that even a comfortable lead may soon be reversed. During the sixties, the Swiss watch industry had a solid position in the world market. In 1968 it produced more than 65% of all watches sold worldwide, but by 1980 their market share had dropped to 20%, and their leading position had been taken over by Japanese companies, dominated by Seiko. How was this possible? The simple reason was that the Swiss watch producers did not anticipate that the quartz electronic watch would be the watch of the future. They were so locked into their existing state of mind (often referred to as a *paradigm*) that they failed to recognize the potential of an entirely new concept that they themselves had developed. When they did realize what was happening, they managed to recover lost ground by focusing on product design (e.g., Swatch).

   This case teaches us that, although the position of an organisation may at one point (seem to) be strong, that does not mean that its future position is safe. Often organisations that believe themselves to be in control fail to heed early warning signs that will eventually lead to a future that they neither envisage nor want. They are so blinded by their need to focus on operational matters that they fail to anticipate future developments and then "the urgent drives out the important", to quote Henri Kissinger.

3. *Towards a demand-driven business* – In 'the early industrial days' many (large) companies were capable of controlling all of their environment. They were able to control developments in all relevant fields (technological, social, economic, and political) and the behaviour of all actors involved (competitors, customers, suppliers, politicians). New products were technology-driven and scarce. Customers could buy any car they liked, as long as its colour was black. Doing business was *supply-driven*. Companies were not particularly interested in the future, safe in the knowledge that it was going to be a prosperous one and they were in control. Their own internal business plans were identical with the 'overall future'.

   These days, however, the dominant trend in all businesses is one of ever-increasing competitive pressures. Due to technological and legal developments, markets have become more open and contestable. In addition, customers are well-educated and selective. A direct consequence of all this is that the power of organisations to control or strongly influence their business environment has weakened significantly. Their future is the result of a complex interplay of external developments (changes in the behaviour of competitors, suppliers and customers) and internal strategic actions that can to a certain extent be seen as a reaction to all this turbulence. Doing business has become *demand-driven*.

The three motives for looking to the future are closely related to current developments in society in general. These developments are not isolated from each other. As society becomes more dynamic, uncertainty increases, and so does the need to look to the future. Also, because the various segments of society are no longer isolated or driven by autonomous developments, the future should be considered in a much more integral manner. Although we would have to be able to actually look into the future to know whether or not there will be continued need for futures research, it can be expected that the future will stay on the agenda for some time to come. An important reason for this statement is that looking to the future is a self-reinforcing mechanism, especially with regard to innovation. That is to say, since futures research is often used to make decisions concerning innovation, future innovations will have a tremendous impact on the existing reality (innovations build on innovations), which makes it even more important to look to the future.

1.2. Research question and research approach

This section describes the research question of this thesis, the research approach, and the case selection criteria.

1. The research question.
The research question is:

How do commercial organisations use qualitative futures research methods in innovation processes?

Our research question is explorative in nature and is aimed at discovering (possible) relevant factors, such as the specific role of futures researchers and the various types of innovation. This research question is therefore empirically-descriptive. However, it is also our ambition to provide guidelines on how to combine futures research with innovation.

There is a theoretical as well as a practical aspect:

1. Theoretical: the findings are used to construct a conceptual framework describing the relationship between qualitative methods of futures research and the innovation processes of commercial organisations. This framework is not only meant to describe how futures research is used in innovation, but it also to give some direction to how futures research should be used in innovation. From this perspective the framework is also a design for using futures research in innovation.
2. Practical: the findings and the framework (design) is intended to help both futures researchers and innovators within commercial organisations apply qualitative futures research methods in innovation processes.

We address the research question by asking three sub-questions:

1. How do commercial organisations use futures research in general?
2. How is futures research embedded in the innovation processes of commercial organisations?
3. What are the factors that play a role in the use of futures research in innovation processes?

Sub-question 1 addresses the quality of futures research, sub-question 2 is about the place of futures research in the innovation process, and sub-question 3 assesses the impact of futures research on innovation. The conclusions of each case (i.e., the case-conclusions) are structured on the basis of these three topics (quality, place, and impact).

Given the many different types of futures research methods and the practical limits (time, resources), we focus on qualitative futures research methods (i.e., the scenario-method, roadmapping, and trend-analysis). Also, the reason we look in particular at the use of futures research in commercial organisations and not in government organizations is because the latter has already been researched extensively (e.g., Martin & Irvine; 1989;

Martin, 1995). Bear in mind that futures research within commercial organisations differs from futures research within government organisations. Table 1.1 table gives a selection of these differences:

Table 1.1: Differences between futures research within government organisations and within commercial organisations (Ruff, 2004).

	Government organisations:	*Commercial organisations:*
1.Specific objectives:	• Generating ideas and visions for technology and innovation • Identifying/prioritizing related policy measures	• Identification of opportunities/ risks in markets, technologies • Identifying strategic options • Identifying and evaluating options for innovation
2. Major actors:	• Government bodies • Expert communities • NGO's	• Strategic planning units • Research and technology divisions • Corporate think-tanks
3. Time horizon:	5 – 50 years	2 – 15 years
4. Duration of futures research projects:	1 to 3 years, repeated periodically	3 months to 1 year, repeated periodically

The main differences between the private and the public sector in terms of futures research are the time horizon and duration of futures research projects. Also, commercial organisations tend to have more concrete objectives. Given the fact that the current dynamics of society make it an increasingly open system (motive 1 from section 1.1), it is to be expected that the major actors in both sectors will be cooperating more often.

2. The research approach.

The case study method is a suitable approach for this exploratory research (Johnston, Leach & Liu, 1999). According to Yin (1994, p.4) the choice of a research approach (or strategy) depends on the type of research question (how, why, where, what, how many, how much), the required control over behavioural events, and the focus on contemporary events. Yin considers a case study appropriate when "a 'how' or 'why' question is being asked about a contemporary set of events over which the investigator has little or no

control" (ibid., p.9), which does apply to this thesis. Another relevant aspect in deciding what approach to adopt is the presence of a theory. In the next section we discuss literature on the use of futures research in innovation, and we conclude that at present there are no theories that *specifically* and *fully* address our research question. This does not mean that some parts of these theories are not valuable for our research. In Chapter 10 we will use the various theories to put the overall conclusions in perspective.

As stated above in the theoretical and practical aspects of this research, the goal is to build a theoretical framework on the use of qualitative futures research in innovation processes. We use a process-model by Eisenhardt (1989) that describes how to build theory from case studies:

Table 1.2: The process of building theory from case studies by Eisenhardt (1989) applied to this research.

Steps and activities:	Application to this research:
1. Getting started: • defining research question • possible a priori constructs	The research question is formulated in Ch.1, section 1.2: *How do commercial organisations use qualitative futures research methods in commercial organisations?* Futures research and innovation are the most important constructs and are defined in Ch.3, section 3.2, 3.3 and 3.4.
2. Selecting cases: • specified population • theoretical not random sampling	Two case selection criteria are defined (Ch.1, section 1.2): 1) organisation has a commercial objective, 2) *explicit* use of futures research methods in innovation processes.
3. Crafting instruments and protocols: • multiple data collection methods • qualitative and quantitative data combined • multiple investigators	Four *qualitative* research instruments are used (see Ch. 1, section 1.2): interviewing, document analysis, participant observation and group discussion. The research was carried out by one researcher.
4. Entering the field: • overlap data collection and analysis, including field notes • flexible and data collection methods	All interviews are transcribed and the findings of interviews or documents are checked in consecutive interviews. Data collection and analysis overlap which is common for case-studies (Stake, 1995).
5. Analyzing data: • within case-analysis	Using a case analysis framework, information regarding futures research and innovation at the

Steps and activities:	Application to this research:
• cross-case pattern search using divergent techniques	cases is structured and analysed by assessing them against 'good practices' and set of (partly normative) indicators.
6. Shaping hypotheses: • iterative tabulation of evidence for each construct • replication, not sampling across cases • search evidence for "why' behind relationships	The case conclusions are formulated on the basis of the analysis of futures research and by addressing the (possible) relationship between futures research and innovation directly in interviews and documents. The cross-case analysis is conducted by comparing the case-conclusions, the methods of futures research, the various ways of integrating futures research and innovation, and users of futures research in innovation. The overall conclusions (Ch.10, section 10.2) are based on the cross-case analysis. The theoretical framework is based on the overall conclusions. The theoretical framework is subsequenly projected on the cases. On the basis of the overall conclusions a set of recommendations is formulated (Ch.10, section 10.3). The construct, internal, and external validation of the research is determined in Chapter 10, section 10.4.
7. Enfolding literature: • comparison with conflicting literature • comparison with similar literature	The overall conclusions are reviewed by comparing them to theories on futures research in innovation (Ch.1, section 1.3). Although these theories do not fully apply to the research question most theories they are to a certain relevant for the overall conclusions.
8. Reaching closure: • Theoretical saturation when possible	Six cases are researched which according to Eisenhardt (1989, p.545) is a number that works well because less than four cases provides insufficient empirical material and with more than ten cases "it quickly becomes difficult to cope with the complexity and volume of the data" (ibid.).

The table presented above indicates that we did not adopt every single step and activity formulated by Eisenhardt in our research. For instance, no quantitative data is collected and (therefore) no specific cross-case pattern techniques are used. The reason for this is that Eisenhardt's process model and views on the case study method are of a more quantitative nature, whereas our research (and research question) are of a more qualitative by character. However, we feel that we have addressed the most important elements of this process model.

The case studies consist of five research elements:

1. *Interviewing*: We carried out interviews with employees of all the organisations involved. They work in their companies' head office, new business development departments, innovation offices or R&D laboratories. We asked predominantly open questions to take into account the frame of reference of the interviewees as much as possible (Van Engeldorp Gastelaars, 1998, p.71). The interview protocols for the different types of interviewees (futures researchers, innovators and other stakeholders) are presented in Appendix 1. The initial list of interviewees consisted mainly of the contact person of the various cases, and in addition the interviewees were asked to provide the names of other people who might be of interest (snowballing). Each interview has been transcribed in full and its main conclusions summarized. The conclusions of an interview were checked against other, consecutive interviews. This allowed us to develop the conclusions further and adjust them in the course of the interviews, in a creative process whereby the data (collected in the interviews) are linked to the research question.
2. *Document analysis*: Documents are studied to obtain information about ways companies use futures research in innovation processes, as well as about futures research and innovation processes in general. These documents can be divided into internal and external literature. Internal literature refers to reports and presentations published within organisations, and external documents to all publications about the organisation in journals and other external media.
3. *Participant observation*: By attending and reporting about workshops additional data is collected about the use of futures research in innovation processes. In this case participating predominantly means attending workshops.
4. *Group discussion*: The conclusions of the case studies will be presented to and discussed with the interviewees and a number of other persons. The group discussion helps us to validate the results further.
5. *The case analysis framework*: Data gathered from the cases about the use of futures research and about innovation (processes) will be analyzed by a case analysis framework to carry out *within case-analysis*. The case analysis framework consists of two elements:

1. *Analysis of futures research*: To analyze futures research at case level, we look at the methods, basic elements, and process of futures research (see Chapter 3, section 3.3, and Appendix 1C). In addition, we present a list of 'good practices' of methods of futures research with which futures research within the cases can be compared (see Chapter 3, section 3.3, and Appendix 1C), and provide a general characterisation of futures research within the cases.
2. *Analysis of innovation*: To analyze the innovation processes within the cases, we use innovation indicators. These indicators are discussed and described in Chapter 3, section 3.4 (see also Appendix 1D). They provide information about the input, throughput, and output of innovation process at the project level and at the organisational level.

When we tested the research structure (e.g., the interview-protocols and the case analysis framework) on KPN Research, we discovered that it is not always easy to find information about the input and the output of innovation processes. Often, information was specified insufficiently or confidential. Also, we found that more attention should be directed to innovation processes at the project level. Initially we focused mainly on gathering and structuring information at the company level, but when we discovered that that mainly sheds light on the way companies innovate in general, we adjusted our framework of analysis to include the innovation processes at the project level. Finally, the KPN Research-case made us ask ourselves what the exact boundaries of a case actually are: should we focus purely on the organisation, or take its customers into account as well? And should their innovation processes be described as well? Defining the boundaries of the case is especially relevant when organizations are supporting other organizations with futures research in innovation processes (external use). When that is not the case, defining the boundaries is an easier matter.

3. Case selection criteria.

We used two criteria to decide which cases we wanted to investigate:

1. *Commercial objective*: Organisations had to operate in a commercial market. This does not necessarily mean that we had to limit ourselves to privately owned organisations. For instance, Syntens New Technologies (Chapter 5) is subsidized by the Dutch Ministry of Economic Affairs. Since their method is used to support commercially operating small and medium-sized enterprises (SMEs) in innovation, they presented a suitable case study.
2. *Explicit use of qualitative futures research methods in innovation processes*: Organisation had to use qualitative futures research methods of in their innovation processes *explicitly*, to allow us to investigate the activities and principles with regard to the use of futures research more effectively and more easily. Explicit means that an organisation carries out studies of the future (described in reports, etc.) and employs futures researchers who apply futures research methods.

We then had to decide which organisations we wanted to investigate. Needless to say, candidates had to be willing to cooperate and provide access to relevant documents and key employees for the interviews. We started by compiling a list of suitable companies. In view of the exploratory nature of this thesis we wanted to include as wide a variety of different companies as possible, so we contacted Dutch multinational companies that we expected to meet our criteria. In addition, because 99.9% of all Dutch companies are SMEs, we contacted organisations that provide products and services to SMEs. We completed the list by adding a foreign organisation and a Dutch organisation whose size put it somewhere between an SME and a multinational company.

As far as the Dutch multinational companies were concerned, KPN and Philips Medical Systems were willing to cooperate. Syntens New Technologies and TNO Industry both service Dutch SMEs, and DaimlerChrysler was chosen because it has a large, well-known department of futures research in Berlin. Finally, we selected PinkRoccade because of its size in between an SME and a multinational company.

Appendices 2 to 7 provide additional information about the cases and describe their match with the case selection criteria. The cases are described in the Chapters 4 to 9 and have the following structure:

1. Structure of the case study (i.e., how the case was investigated).
2. General background.
3. Innovation and innovation processes.
4. Futures research.
5. *Optional*: Description of the method that specifically links futures research with innovation processes.
6. An example of the use of futures research in innovation processes within the case.
7. Case conclusions, structured on the basis of:
   - The place of futures research in the innovation process.
   - The quality of futures research.
   - The impact of futures research on innovation.

1.3 Review of literature about the relationship between futures research and innovation

In section 1.2 we argued that few studies focus on the way how futures research is used specifically in innovation processes in commercial organisations. This section reviews what studies are available and explains why they do not *specifically* focus on the specific relationship between qualitative methods of futures research and innovation processes.

Generally, there are three reasons for this consideration:

1. Some studies do not look specifically at the relationship between futures research and innovation, but remain superficial. That is to say, they only describe what the *general* role of futures research in the innovation process is or should be.
2. Although some studies do focus on the innovation process, they focus on *quantitative* rather than qualitative methods of futures research.
3. Some studies do not specifically address methods of futures research but in stead use terms like 'vision', which does refer to the future but cannot be considered a specific method of futures research.

Ad 1) The *general* role of futures research in innovation processes:

- Du Preez & Pistorius (1999) construct a framework that can be used to analyze and assess technological threats and opportunities, and which is meant as a decision-making aid with regard to innovation strategy.

  Their framework to a large extent focuses on ways to monitor, scan, and analyze information with regard to possible future developments in both market and technology. Apart from some general remarks on how to develop a strategy which functions as a response to the possible future developments, the framework does not show how these developments interact with the innovation processes within a company.
- Berloznik & Van Langenhove (1998) describe how technology assessment (a method of futures research aimed at describing the possible future social consequences of the use of a technology) can be integrated into R&D management practices by using a conceptual framework. Four levels are distinguished: 1. R&D environment, 2. the R&D institute, 3. the R&D process, and 4. the R&D project. The authors argue that awareness and capability play an important role at these four levels and that TA can make the two following contributions to R&D management: 1) increasing cost-efficiency, 2) increasing the social responsibility of scientists.

  The conceptual framework they present does not so much describe how the integration of TA with R&D takes place, but merely states that it is necessary for companies to integrate them, and it discusses two conditions (awareness and capacity) that are required to make the integration possible.
- Saul (2002) describes "a case study where a company in the general insurance industry used a combination of futures studies techniques (including scenario development, causal layered analysis, and back casting) to develop over 40 new product concepts (...)" (p.21).

  This article merely provides a description of the activities that were carried out in this project, without analysing how exactly the futures studies techniques were used in designing tomorrow's products and which factors played a role.
- Kärkkäinen et al. (2001) study the assessment of hidden and future customer needs with regard to product development in Finnish business-to-business companies.

Although the authors come close to the research question of this study, there are some important differences. Firstly, they use a survey method rather than case studies. A consequence of this is that they have listed answer categories in advance, i.e., possible problems with the assessment of hidden and future customer needs. However, it remains unclear how they have arrived at this list. Secondly, they mix methods of futures research with market research methods, which should be used separately (see Appendix 8). Thirdly, their research mainly addresses the importance of certain problems in assessing future customer needs and company satisfaction ('experienced success', p.395) with regard to current practices rather than focusing on assessing the future needs of their customers.

- Twiss (1992) describes what the (general) purposes of a technology forecast can be with regard to the various phases of the innovation process. These purposes are: importance (I), accuracy (A), and the financial effect of the forecasting error (F). They can have three different values: high, medium, and low. Table Appendix 9.1 shows this relationship.

Table 1.2: The relationship between forecasting and the technological innovation process according to Twiss (1992, p.21).

Phase of the innovation process:	*Technology forecasts:*		
	Importance	Accuracy	Financial effect of forecasting error
Idea generation	High	Medium	Low
Technical feasibility	High	Medium	Low
Design & development	Low	High	Medium
Preparation for production and marketing	Very low	High	High
Post launch	-	-	-

Although this framework provides a comprehensive overview, the relationship between forecasting and (technological) innovation remains fairly superficial in that it uses vague terms like 'high', 'medium', and 'low'. Also, Twiss merely speaks about forecasting, the predictive and quantitative aspects of looking to the future.

- Lemos & Porto (1998) discuss how technological forecasting (TF) and competitive intelligence (CI) are interconnected, and how they can help improve the innovation process.

  This article mainly describes what the advantages of TF are an how it can be linked to CI. Although the article briefly describes a case study conducted at Digitel, a company located mainly in Brasil, it sheds no light on how and why both methods improve the innovation process. It merely mentioned a number of advantages of using these methods.
- Barker & Smith (1995) describe how roadmapping can be used for R&D programmes and refer to a case study at British Petroleum (BP).

  The use of roadmapping for R&D focuses on the level of innovation strategy and is not related to innovation processes that can be derived from the formulated innovation strategy.
- Tschirky (1994) describes how technology forecasting (TF) and technology assessment (TA) are related to technology management, and how this is linked to other parts, functions, and management aspects of a company.

  This article remains fairly superficial and does not provide detailed information about the way TF and TA can actually be used for technology management. It mainly describes what TF and TA are and states that the two methods are important for technology management. Also, the article does not address the connection between TF and TA and innovation processes, but only with technology management, which is a level in the company that is close to innovation strategy.

Ad 2) Literature about the use of *quantitative* methods of futures research in innovation:

- Doctor, Newton & Pearson (2001) describe two techniques, decision tree approach and Option Pricing Theory, which are applied to a R&D department of a chemical company.

  Although the authors describe how futures research is used for R&D, the methods they describe are of a quantitative rather than qualitative nature. Also, they focus predominantly on the actual outcomes of the application of the two methods, without explaining which factors played a role.

Ad 3) Literature about looking to the future *in general* (and not about specific methods of futures research):

- Johne (1999) tries to show how market vision can steer innovation "in ways which exploit the full potential of a business". He sees customers as the most important factor in determining what a company should provide, the 'market champions' in a company as specialists who can decide which market the company should serve, and he argues that, to compete successfully in the future, it is necessary for companies to look beyond the present market and to imagine the 'total imaginable market' of the future.

Instead of explaining how the approach he suggests will steer innovation, the author merely states that many newcomers in markets "have used market vision to guide their aggressive efforts". Also, he does not speak of futures research, but instead uses the term 'vision', which is merely the content of how a company sees the future. The article provides no information about how these visions are formulated.

- Lynn & Akgűn (2001): these authors connect certain aspect of vision, such as clarity, stability, and support, to certain types of innovation, such as incremental, radical and evolutionary innovation. After investigating thirteen innovations by three companies and validating them by 509 new product teams from different companies, they conclude that "vision clarity is positively associated with success in evolutionary (market and technical), and radical innovations, but not for incremental projects. Vision stability is positively associated with success in incremental and evolutionary market innovations; and vision support is positively associated with success in incremental, and evolutionary technical innovations" (p.374).

  These authors also speak of visions and related aspects such as 'vision clarity' and 'vision support', but they do not specifically mention futures research and methods by which the visions they claim to have identified may be realised. Also, they relate vision to type of innovations and not to the process by which these innovations have been developed.
- O'Connor & Veryzer (2001) have researched how companies have linked advanced technologies to market opportunities. They have taken a sample of eleven radical innovation projects in nine large, mature companies and augmented this sample by four interviews. They came up with four themes: 1) vision is built and sustained through a variety of mechanisms that may operate in combination or serially, 2) individuals play different roles in creating and promoting a vision within the company, 3) there exist a few tools and methods to support the development of visions that do not strictly depend on individual initiative, but these are not systematically employed by companies, 4) visions undergo a process of validation and internal acceptance that may depend heavily on reaching out beyond the familiar customer/market set of the firm. Based on these four themes the authors arrive at two sets of insights: 1) there are three different ways that visions may develop, which means, they argue, that they did not discover a singular process across firms or even in a single firm in which visions are developed, 2) there are three elements that occur when a vision is being developed: motivation, insight, and elaboration.

  Despite the detailed character of this study, the authors do not explicitly refer to or define methods of futures research. They only speak of vision or 'visioning'.
- Okuyama & Matsui (2003) speak about 'vision-driven R&D' and try to determine its value by describing its use in a case-study.

  The article speaks about vision and not about specific methods of futures research. Also, although the article contains a framework that links vision to aspects such as

'images of products', R&D strategy, and global business strategy, it does not specify what these links mean and which factors play a role in those relationships.

Our conclusion is that the theories discussed above do not *specifically* address the research question. However, in Chapter 10, section 10.2 we will assess to what extent the theories presented here are relevant to and explain the founded overall conclusions.

1.4 Reading guide

Futures research is a very diverse area. The following chapters provide scientific insight by describing its history (Chapter 2), by defining futures research, giving an overview of methods of futures research, listing goals for which futures research has been applied, and by addressing the scope of studies of the future and the process by which futures research takes place (Chapter 3). Chapter 3 also addresses the concept of innovation, the generations of innovation management, and a list of innovation indicators. This thesis focuses on how commercial organisations use qualitative futures research methods in their innovation processes, on the basis of six case studies (Chapter 4 to 9). Based on a cross-analysis and the case and overall conclusions of this thesis we outline a framework that shows what the factors are that play a role in the use of futures research in innovation processes (Chapter 10). This framework will allow commercial organisations to apply futures research in their innovation processes. We end this chapter by assessing the validity of this research (construct, internal, external), by formulating a set of recommendations on the use of futures research in innovation, and by listing ideas for future research in this field.

Appendix 1 contains the interview protocols and background information about the cases, as well as the two building blocks of the case analysis framework: 1) general information about futures research in the various cases, the scope of a future study, and the good practices of the scenario-method, trend-analysis, and roadmapping (Appendix 1C), and 2) the innovation indicators at the organisational and project levels (Appendix 1D). Appendices 2 to 7 provide key figures and information about futures research and innovation processes at case level. Appendix 8 presents the entire innovation audit of Tidd, Bessant & Pavitt (1997).

CHAPTER 2 – THE MODERN HISTORY OF FUTURES RESEARCH

The working life of a futures researcher consists of two activities. The first one, obviously, is to look to the future by predicting or exploring it. The second one is to reflect on how the future was explored or predicted in the past. This chapter deals with the second activity and describes the modern history of futures research.[2]

'Looking to the future' is certainly not a modern phenomenon, instead it dates back to ancient times. That is why Sherden (1998) calls it the 'second oldest profession in the world'. We are all familiar with the Oracle of Delphi in Ancient Greece, who was consulted by Greek kings who wanted to know whether they had a chance of winning the wars they were about to wage. Religious history tells us of a long line of prophets who were able to predict the future course of events convincingly. They demonstrated that it is very important to pick the right subject, i.e., the rise and decline of humanity, when it comes to gaining as many followers as possible. More recent history has given us Utopian writers such as Thomas More, Tommaso Campanella and Karl Marx, all of whom had a clear vision of how the future would or should develop. Sometimes they could even clearly picture the path that would lead to the future they envisaged.

During the twentieth century we witnessed a more down-to-earth approach to looking into the future. Futures research, which was originally triggered by the ideas and novels of Jules Verne, soon began to adopt an increasingly scientific approach. Futures research received a significant boost during and immediately after World War II when non-profit organisations such as the RAND Corporation turned the simple 'what if' exercises performed by national armies into fully fledged futures research methods. Futures research proved successful when Shell used the scenario method to improve its strategic thinking and prepare for the 1973 oil crisis, an event that other oil companies to a large extent failed to anticipate. After the oil crisis, futures research methods became increasingly scientific and diverse, and more and more organisations started using them. At the beginning of the 21st century we can say that, although much missionary work still needs to be done, futures research has become part of the organisational and decision-making processes of many organisations – profit as well as non-profit.

In this chapter we limit ourselves to describing the 'modern history' of futures research, ranging from the end of World War II to the millennium. As the three main elements of futures research are its processes and methods, its use, and the futures researchers, we shall describe its history from the points of view of those three elements:

1. *Processes and methods*: how and by which methods has futures research been conducted?
2. *Use*: how has futures research been used and which ends has it served?

[2] See for other historical accounts: Cornish (1978), Coates et al. (2001), and Burmeister et al. (2002).

3. *The futures researchers*: who and what types of organisations have been involved in conducting futures research?

1. Process and methods of futures research:
In the 1950s, technological forecasting, as futures research used to be called, was an isolated activity within organizations that was focused on data gathering and, not surprisingly, on predicting future technological developments and their consequences. As Coates et al. (2001, p.2) put it: "the focus was on forecasting the rate of technological change. Quantitative exploratory methods, working from the past to the future, included trend extrapolation, leading indicators, and growth models. But normative forecasting, starting with perceived future needs, played a role as well". Burmeister et al. (2002) state that, due to the strong focus on predicting the future, it was in this period that "the future was invented". The future was how one wanted it to be and formulating one's future desires was not considered very difficult.

In the 1960s, futures research developed along the lines established in the 1950s. Many futures researchers kept trying to predict the future of technology and one can even say that futures research was dominated by an 'engineering ideology' (Burmeister et al., 2002). Since technological developments also benefited commercial companies, who translated them into innovations, futures research became an increasingly popular phenomenon. The Delphi-method was introduced and formed an important addition. The scenario-method was also introduced and became more popular in the 1970s through its successful use by Shell.[3]

In the 1970s significant changes occurred in the principles and applications of futures research in comparison to the 1950s and 1960s. Burmeister et al. (2002) argues that the limits of prediction and calculation strongly influenced futures research. In the 1970s it became clear that technological forecasting has a limited value when it comes to actually predicting the future, and there was a growing awareness that long-term forecasting can not be validated and replicated: "Technological forecasting was reduced in practice to a set of tools and methods; forecasts produced between 1975 and the early 1990s were relatively few, generally poorly defined, and executed without much attention to formal assumptions, time horizons, or limitations" (Coates et al., 2001, p.3). One response was to view the world (and its future) as more than a merely technological system, but instead to include economic, environmental, and socio-cultural phenomena as well. The Club of Rome published a report that was based on this more inclusive view, and the report predicted that, should existing developments continue, the world would be in an alarming condition in 2000, there would be overpopulation, energy-crises and major social problems (Meadows, 1973). Although we are to a certain extent faced with the problems that the report described, the world is nowhere near in the deplorable state envisaged by the Club of

[3] See Kleiner (1991) and Schwartz (1991) for a complete account of this success-story.

Rome. A reason for this is that the report itself served as a wake-up call to politicians and policy-makers, who formulated policies to prevent the problems described in the report from taking place (i.e., a *self-denying prophecy*). Although Coates et al. (2001) argue that people became disillusioned with systems analysis (a method of technological forecasting) in the 1970s, it was above all the decade when people began to look to the future from a broader perspective based on an awareness that it is very likely that apparently separate developments have a mutual impact on each other.

In the 1980s the process and methods of futures research continued to develop along the same lines as in the 1970s. Ecological problems, such as the nuclear disaster at Chernobyl, deforestation, and global warming strongly influenced consumer behaviour and the role of the state. Futures research reacted by focusing more on assessing ecological, global and technological risks, on the interconnection of global developments, and on future generations (Burmeister et al., 2002).

In the 1990s, the Internet and other developments in the field of information and communication technology (ICT), which already started in the 1980s, had a major impact on futures research. Futures research increasingly used the possibilities that were offered by these technological developments. Gerybadze (1994, p.133) views futures research in this decade as 'organizational intelligence' and emphasizes aspects such as interactive decision-making, the establishment of efficient (communication) platforms for futures research across corporations and networks, and futures research as a process instead of a final result. Developments in ICT also helped open up markets, increased the complexity of the environment in which companies operated, and played a role in worldwide political changes. Futures research is no longer an on-off activity: "As a response to increasing uncertainty companies devote more attention to permanent monitoring, knowledge development and scenario-thinking" (Burmeister et al., 2002). Today, futures research is a far cry from the technological approach most organisations used to adopt a few decades ago. It is more creative, combining various kinds of methods, it uses shorter time horizons, and has an altogether more 'modern' way of looking to the future.

The historical development of methods of futures research shows a shift from mainly predicting the future to mainly exploring the future. This does not mean, however, that predictive methods are no longer being used. Indeed, more exploratory methods have been added to the portfolio of futures management methods. Both types of methods can complement each other and are often seen in combination (Masini, 2001; Bouwman & Van der Duin, 2003). Nowadays, when new futures research methods are developed, the idea is to try and capture and describe possible future developments and variables rather than selecting a limited number of variables and using them to forecast the future course of events. Futures research has become more interactive, information sources have become more diverse, and the process has become less linear due to the growing influence of clients on its content and structure.

2. Use of futures research:
Initially, futures research was carried out mainly for national governments to formulate science and technology policy. This was, of course, related to the rapid increase of technological and economic developments. Also, in the first half of the 1950s, most input was provided by large (government) investments in science, technology and military equipment (for instance, radar guided missiles, and nuclear weapons). These investments were largely inspired by the Cold War, and the perceived need, in particular in the US, to stay ahead technologically (Coates et al., 2001; Burmeister et al. 2002).

In the 1960s, there was a growing conviction that technology, in addition to being an agent of prosperity, can also be damaging to human beings and their environment. Futures research increasingly began to be used to assess possible negative consequences. As a result of this, more and more companies beyond the military-industrial complex became aware of the possible benefits futures research may have for them.

In the 1970s, futures research often served more abstract purposes. The unfavourable economic climate and the social unrest it spawned reduced the need for a detailed picture of the future. Instead, futures research was used more to picture *visions* of the future, to provide organisations an indication of what my happen, allowing them to prepare for the unknown.

In the last 20 years or so, futures research has become more eclectic. That is to say, there no longer is a single dominant approach. Instead, most futures research projects nowadays are determined by a range of factors, such as the type of client, the goal of a study, or the level of uncertainty with regard to the subject being investigated.

3. The futures researchers:
The modern history of futures research has shown a gradual professionalisation of its practitioners. In the 1950s and 1960s, futures researchers took the first steps towards institutionalizing technology forecasting. All kinds of organizations (such as the RAND Corporation) and institutes (such as the World Future Society) that were involved in forecasting and/or technology assessment were founded. Also, new journals (such as Technological Forecasting & Social Change), and textbooks were published dealing with technology forecasting and the integration of technology forecasting in decision-making and planning. Most futures researches were scientific experts whose predictions and opinions were rarely viewed with any degree of scepticism.

In the 1970s, both the use of the Delphi-method and, to an even greater extent, the scenario-method reflected a kind of ‘democratization’ of futures research. Experts were not only asked to give their opinion on specific issues, but their opinions were also compared to each other and used for further discussion. With the rise of scenario-thinking even the input of *non-experts* became important, since they might be better in ‘thinking the unthinkable’, an important element of futures research in a time when people were more interested in discovering new aspects of the future than predicting what would happen

based on existing variables. Shell even introduced the concept of 'remarkable people' (artists, politicians, ordinary citizens, and even vagabonds…) who were appreciated for not being linked to the oil-industry.

Nowadays, futures research is to a large extent integrated with other disciplines and parts of organizations, thereby combining methods, using the possibilities of new software tools, new ways of gathering data, and all kinds of creative and interactive techniques. There is a marked contrast with the 1950s and 1960s, when futures research was primarily the domain of experts ('futurists') who used complex and quantitative models aimed at predicting the long term future. Futures research has become a specific discipline with its own institutions, practitioners, journals, and books. Rescher (1998) stresses the rise of a distinctive movement of futures research that even leads to an industry of 'futurism' whose members are unaware of the fact that many fellow scientists (still) view them as 'renegades'.

Over time, futures research has become increasingly sensitive to outside influences, with each passing decade serving as a distinct phase in this development. The influence of technological developments in general and innovation in particular on both method and content of futures research has been and still is very high. Rapid technological developments and the effects they have on other aspects of society and organizations were not only viewed as the main reasons to look at the future, they were also the topic of most studies of the future. It is not surprising that 'technological forecasting' and 'technology forecasting' were the most frequently used terms for looking to the future in the 1950s and 1960s. Because of the favourable economic climate and the high levels of consumer spending, governments as well as commercial enterprises could afford to adopt a broad time horizon. There were few short term problems that needed urgent attention, and there was room for a long term perspective. In addition, futures research was affected by developments in areas like operations research and mathematics, which initially gave futures research a highly quantitative and predictive character. Furthermore, it would appear that economic factors have an impact on the development of futures research. When times are good, the interest in looking at the future grows, and when times are bad, people tend to focus on more immediate problems. In the 1950s, 1960s, and 1990s times were good, which was reflected in the development of futures research (Linstone, 2002, p.321). In the 1970s and 1980s, the global economy went through some rough patches, and people tended to focus on finding their way back to prosperity, which meant a fall in interest in futures research. It may very well be that there is a greater interest in futures research when things are running relatively smoothly, people and organisations are optimistic and there is time and money to look ahead. And that when times are not so good, the time horizon of people and organisations is determined by the urgency of more immediate problems, and as

far as futures research is concerned their attitude reflects J.M. Keynes' famous phrase: "In the long run we are all dead".[4]

The modern history of futures research can be summarized as a transition of a hard, isolated, and conscious set of distinct activities and methods of technology forecasting, towards a softer, integrated, and communicating process. At present, large commercial corporations are among the most important clients of a futures research which is often characterized by a global focus and which aims at exploring the environment and the future. There is an awareness of the limits to technological and economic growth that at the same time increasingly influences the 'span of control' of organizations.

[4] See section 6.4. for a more detailed account of the relationship between (macro-)economic growth and the eagerness of Dutch SMEs for looking to the future.

CHAPTER 3 – FUTURES RESEARCH AND THE INNOVATION PROCESS

This thesis looks at how commercial organisations use futures research in innovation processes. The link of futures research and innovation is described in section 3.1. Section 3.2. discusses different definitions of looking to the future after which section 3.3 describes methods of futures research, the process of futures research, and the basic elements of a study of the future. This chapter closes with an overview of elements of innovation and a description of innovation processes and innovation indicators (section 3.4).

3.1 Linking futures research to innovation

Innovations can take many forms and they can be developed into many directions. Given the scarcity of resources, organisations have to make decisions with regard to innovations. An important criterion is the way future developments influence the course of the innovation process. And indeed, many authors have linked innovation to the concept of future and consider the use of futures research in innovation processes very important to the success of an innovation process (Cooper, 1980; Twiss, 1992a; Van Lente, 1993; Cobbenhagen, Hertog & Pennings, 1994; Floyd, 1997; Tidd et al., 1997; Johannessen, Olaisen & Olsen, 1999; De Jong & Kerste, 2001; Lin, 2001). Preez & Pistorius (1999, p.215) state that: "One of the major challenges in the management of innovation […] becomes one of managing the technological future". And: "There is a growing awareness that the ability to identify emerging technologies as well as the ability to assess the sustainability and demise of mature technologies are important elements in the process of managing technology" (ibid., p.216). The link between futures research and innovation can be established further by: 1) the lead time of the innovation process, and 2) the uncertainty of the innovation process.

1. The lead time of the innovation process.
Although many organisations put great effort in reducing the lead time of their innovation processes (Braaksma & Bruins, 1998), many innovations still take considerable time to develop. The lead time of innovations is sector-dependent. For instance, developing a new type of mobile phone takes about two years, developing a new car about seven years, and developing a new medicine about fifteen years. During the development time, many changes in, for instance, technology or business can take place. Twiss (1992b, p.258) states: "Nowadays, technical lead times are often so long that a market can be lost before a proper response is made". And: "…during the period the new product is under development market needs may change or they may be satisfied by a competitive product or an innovation based upon a different, and perhaps superior, technological concept" (ibid., p.132). An example of this is the development of Kevlar. Although expectations of

this new technology were high, it could not live up to its promise. Originally, Kevlar had the function of reinforcing radial tires. But the development and sale of Kevlar was slowed down by many unforeseen developments. For instance, there were many difficulties in the patenting process, steel wires in tires appeared to have fewer disadvantages than the experts had imagined, and because cars were becoming smaller there was less need for high performance tires (Mulder, 1992, pp.74-75).[5]

What all this means is that an idea for an innovation does not necessarily have to lead to an actual innovation. Things may happen that influence the potential market success of the idea. Collingridge (1980) views the lead time of an innovation in terms of a 'dilemma of control', which means that "the social consequences of technology cannot be predicted early in the life of the technology. By the time undesirable consequences are discovered, however, the technology is often so much part of the whole economic and social fabric that its control is extremely difficult" (ibid., p.11).

An alternative to Collingridge can be found in the theory of real options valuation or real R&D options (Paxson, 2001; Jacob & Kwak, 2003). This theory comes from the financial world where quick decisions with regard to financial portfolios and investments have to be made on the basis of new information and future expectations. In this theory the possible future cashflows (of a technology assessment or innovation) are not weighted against a fixed interest rate but is made flexible because (R&D-)managers can make decision that influence the future gains. This theory has some advantages, such as making addressing managerial flexibility, making specific future profit specific, linking R&D with top-management (financial) objectives, and giving insight into how risks can be reduced (Ellis, 1997; Jacob & Kwak, 2003; Barnett, 2005). However, disadvantages are present as well: the discontinuities of R&D and innovation processes are not being addressed, R&D- and innovation processes are often nonlinear, and technology is knowledge-based which makes it difficult to quantify (Ellis, 1997; Perlitz, Peske & Schrank, 1999; Jacob and Kwak, 2003). We conclude that, given the high uncertain nature of innovation processes (see also section 3.4) and the dynamic organisational environment in which it is developed, the real option theory is much too optimistic about the flexibility of innovators in making the necessary changes during the innovation process. Collingridge's dilemma of control still very much applies.

Futures research can prevent an organisation from investing time, money and other resources in existing ideas that may not be potentially successful innovations in the future. At various stages of the innovation process organisations collect information and knowledge about what an innovation will eventually look like or, even more important, how it will be used when it is finally introduced into the market. Based on that information, the innovation process is adjusted or even terminated. Alternatively, an idea (for an

[5] As we know, Kevlar fought back. It was applied very successfully in the development of bulletproof vests which ultimately became a far greater success than people had anticipated.

innovation) may also benefit from new developments that occur while it is being developed. For example, while an idea may initially not be technologically feasible, that may change thanks to new technological developments. For example, Delft-based professor Mick Eekhout has often designed new, almost futuristic buildings that originally could not be built because his designs required certain building matierials that did not yet exist. Due to the development of new (building) materials his designs can now be realised. It is also possible that (potential) users initially fail to see the use of a product, which may change due to certain market-related and social developments. Rip (1995, p.418) adds that products do not stop evolving once they have been introduced to the market, but that their development is an ongoing process: "The eventual shape of a technology, its usage and the way it is embedded in society can be very different after 5, 10 or more years than it looked at the beginning". This is also known as 're-invention' (Rogers, 1992).

2. The uncertainty of the innovation process.
Innovation processes are inherently uncertain and it is very difficult to know in advance how an idea will evolve in the future and which developments it will encounter (Trott, 1998, p.66; Schepers, Schnell & Vroom, 1999; Osawa, 2003, p.343; Freeman & Soete, 2000, p.6). Twiss (1992b, p.xvii) states: "For we are now concerned with two dimensions of uncertainty – that of the innovation itself, and of the environment into which it will be launched at some future date". During an innovation process organisations need to make decisions about how to cope with uncertain developments that (may) influence the innovation, and these decisions may in turn lead to uncertain and unexpected consequences with regard to the innovation. In addition, Trueman (1998, p.45) states that the amount of uncertainty is related to the type of innovation (see also: McDermott & O'Connor, 2002). That is to say, a radical innovation is more uncertain (and more risky) than an incremental one because developing a radical innovation involves more dimensions, such as new product, new technology and new market. Berkhout & Van der Duin (2006) rank innovations based on the number of stars. Each star represents a change in one aspect, for instance the technical element of the innovation. The maximum number of stars is five (changes in the scientific, technological, market, societal, and organisation elements at the same time) and can be called a *system innovation*. By using futures research methods in innovation processes, organisations can recognise and subsequently cope with elements of uncertainty. Futures research can provide an overview and help assess the effects of certain developments and make organisations aware of them.

3.2 Terminology surrounding futures research

Over the years looking to the future has been given many different names, which has made Cornish speak about 'a field in search of a name' (1978, p.155). In line with its historical

development (see Chapter 2), the 'art of looking to the future' has been given many different names, each of them emphasizing different aspects of futures management. In his famous 'Prognostics', Polak (1971) mentions *futurology*, *futurism*, *conjecture*, *forecasting*, and *prospectivism*, and he rejects all of them. He argues that *forecasting* is insufficiently international, *futurism* relates to an art movement, and *conjecture* does not take modern developments in the field of forecasting techniques into account. Because Polak finds it important to have an international term and a link with other academic fields, he opts in favour of the term *prognostics*: "…the science, with advanced methods and instruments, aims at exploring the future and acquiring probable knowledge of the future. It is also the science which tries to control the future, based on this systematic anticipation, by purposively guiding the future by socio-dynamic techniques. It comprises those areas of prognostic reflection, viz. concerning the possible, ideally essential and actually achievable future developments, in economic, social, technological, political and cultural areas, and on both a national and a worldwide scale" (ibid., p.21). Masini (1993) uses the term *futures studies*, which she gives the following characteristics: transdisciplinarity, complexity, globality, normativity, scientificity, dynamicity, and participation. Malaska (2001, based on Masini, 1998) differentiates between various approaches to the future (predicting, inventing, forecasting, making, researching and/or understanding) and mentions *futurology*, *futures study*, *prospective study*, and *futures management.* Many authors (e.g., Martin, 1995; Slaughter, 1995; Loveridge, 2001; Johnston, 2001) use the term *foresight,* which refers to the general human capability of looking to the future as well as to studying the future for and by governments. Finally, Fowles (1978) stresses the differences in time horizon and distinguishes between *forecasting* (predicting the future with varying probabilities), *long range planning* (time horizon of five to ten years), and *futures research* (time horizon of two to three decades from the present).

These terms all stress different aspects of futures research. They vary in the extent to which the future can be predicted or forecasted (e.g. Staal, 1988), which aspect of the future is highlighted (only technology or other aspects as well), and to what extent studying the future can be seen as a scientific enterprise. Fowles (1978) stresses the differences in time horizon, Masini (1993) the characteristics of how the future can or should be studied, and Malaska's (2001) four terms express the way in which the future can be approached (predicting, inventing, forecasting, making, researching, and/or understanding). In the 1950s and 1960s, the technological character of looking to the future was dominant and terms like 'technology forecasting' and 'technological forecasting' were very popular. Tuininga (1978, p.193) states that, because forecasting must be executed in a multidisciplinary way, the term 'technology forecasting' would be better than 'technological forecasting'. Nevertheless, many classic books on futures research at that time used the term 'technological forecasting' (e.g., Jantsch, 1967; Martino, 1972). The strong quantitative character of futures research in the first two decades of its modern history was expressed by Helmer (1983, p.8), who viewed futures research as a part of

operational research ("its parent discipline"). According to him, the goal of futures research was to "provide decision makers with operationally meaningful assistance in the form of information and analysis" (ibid., p.114). The only difference with operational research was that futures research was aimed at assisting decision making for the longer term whereas operational research was meant for short term optimisation problems (ibid.).

After carefully reviewing the different terms, we opt in favour of using the term *futures research*, although, unlike Fowles (1978), we do not limit its time horizon to two or three decades. It is possible to apply futures research to a far shorter time horizon, such as three or five years from now. However, he does not see time horizon as an absolute unit. Whereas a decade may be a short term for an oil company, it is an eternity as far as mobile telecom providers are concerned. Deciding whether a specific time horizon is short term or long term depends on the how dynamic a business is and what its social environment looks like. If developments are going fast, expressed, for instance, in the time involved in innovating or marketing (new) products, companies will operate within a shorter time horizon, and vice versa.

Our reasons for using the term futures research are:

- *Multiplicity*: the term *futures* refers to thinking in multiple futures (instead of just one), which nowadays is very common or even dominant in studies of the future.
- *Multidimensionality*: the term *futures* also suggests that possible futures are considered from a social, cultural, economic, political, and technological point of view.
- *Investigation*: the term *research* implies that we do not adopt an *a priori* standpoint with regard to the question whether or not it is possible to predict, create or explore the future, emphasizing instead that the future can be investigated and knowledge about the future can be gained which can serve as a valuable input to today's decisions about the future.

Futures research must be clearly distinguished from *market research*. Although market research often yields predictions about the future and can be used in innovation processes (mostly in the implementation phase, i.e., the last phase of the innovation process), it is more oriented towards researching current and, sometimes, near future situations and developments. Also, it often focuses on a single aspect, for instance the current adoption of a specific product within a specific market segment. Futures research, on the other hand, has a more distant time horizon and also a broader scope, taking into account economic, social, technological, and political developments. Another difference is that market research (and its methods) mainly uses existing variables, whereas futures research is aimed more at exploring possible new variables and possible new relationships between new (and existing) variables.

Also, in this study a clear distinction is drawn between *methods* of futures research and the *tools* that are used when applying methods of futures research. A tool is a kind of instrument that can be used by futures researchers to execute a method. Examples of tools are: brainstorming, expert-interviewing, and group discussion. To carry out methods of

futures research various tools need to be used. Tools can be considered one of many basic elements of futures research (see section 3.3). Methods are much more comprehensive than tools because they indicate how the future should be approached (e.g., the future can be predicted), and they use tools, among other things, to do so.

3.3 Futures research: methods, process, and basic elements

Futures research has many different methods that are applied in a process that results in a study of the future consisting of various basic elements. In this section we describe three important aspects of futures research: 1) methods of futures research, 2) the process of futures research, and 3) the basic elements of a study of the future.

1. Methods of futures research.
There are many different methods of futures research and many ways to classify them (e.g., May, 1996; Glenn, 1999; Van der Duin, Drop & Kloosterhof, 2001). This thesis focuses on qualitative methods of futures research. Qualitative methods are methods that primarily use qualitative input (or data) in their process, as opposed to quantitative methods, which rely primarily on quantitative input (or data). Even within the qualitative segment there are many different methods, such as the *scenario-method*, *trend-analysis*, and *roadmapping,* which we investigate in this thesis because they are distinct methods that are often used by commercial organisations (Burmeister et al., 2002). Below, these methods and their *good practices* are described. The good practices are part of the case analysis framework (see Chapter 1, section 1.2 and Appendix 1C).

The scenario-method.
There are many different types of scenario methods and ways to classify them (e.g., Van Notten et al., 2003). Table 3.1 gives the classification by Dammers (2000):

Table 3.1: Different scenario-methods classified by Dammers (2000).

Variable:	*Type of scenarios:*
Breadth of the scenario topic:	Sectoral scenarios vs. multi-sectoral scenarios
Level of aggregation:	Micro, intermediate, and macro scenarios
Direction of time (from past to future or the other way round):	Projective scenarios vs. prospective scenarios

Variable:	*Type of scenarios:*
Amount of exploration:	Dominant (i.e., current developments continue in the same direction), limited explorative (i.e., different futures that do not diverge a great deal from the present), and highly explorative (i.e., scenarios that diverge very sharply from the present to investigate the limits of what is possible).
Focus of action:	Environmental scenarios (i.e., focus on developments beyond the control of policy-makers) vs. policy scenarios (i.e., focus on alternative ways of executing influence of the environment by carrying out different types of policy).

Alternatively, Van der Heijden (1996, p.5) draws a distinction between *internal* and *external* scenarios. *Internal* scenarios are about the future at an individual level where an action is linked to a personal goal: "If I do this then this will happen which will lead to that and so on until I achieve my objective of A". *External* scenarios are mental models of the external world by which ranges of possible future developments are projected.

In this thesis we focus on the scenario-method that is used to explore various possible futures. This means that a broad view is adopted, whereby not only the different possible futures of the 'scenario-issue' are defined, but the various possible social and business environments of the 'scenario issue' as well. This type of scenario-method is in line with Van der Heijden's *external* scenario method and Dammers' *multi-sectoral*, *meso/macro*, *projective*, *highly explorative*, and *environmental* scenarios. Although quantitative information and tools can be used for this type of scenarios, in general they are of a qualitative nature. Below a list of good practices of the scenario-method is presented based on Schwartz (1991), Van der Heijden (1996), Fahey & Randall (1998), and Van der Duin, Drop & Kloosterhof (2001). The good practices are positioned in the three stages of the process of futures research (see the next sub-section for a description of the process of futures research):

Pre-foresight/input stage:

1. Many different people, both inside and outside the organisation, are interviewed.
2. A desk research (i.e., a literature-study) was carried out.
3. The (right) time horizon has been determined by deciding the moment at which there is too much uncertainty to produce a reliable forecast. (The time horizon varies per sector.)
4. Attention has been paid to a broad support for the scenarios in the organisation.

Main foresight/throughput:

5. Interactive workshops have been organised to collect information and opinions from clients and stakeholders.
6. The scenarios do not merely present various endings, but also various 'roadmaps' that show the evolution of certain trends in the various possible futures.
7. A great deal of attention is paid to visualisation and communication of the scenarios.
8. The scenarios and the decision-making process are linked to each other.
9. The scenarios are internally consistent.
10. A great deal of attention is paid to the implementation of the scenarios in the organisation.

Post-foresight/outputs and action:

11. The number of scenarios is four.
12. The scenarios are described in sufficient detail for people who were not involved in the scenarios to understand them.
13. The scenarios are made both challenging and recognizable to users.
14. The scenarios can be modified to reflect the specific interests of the organisation and its sub-departments.

Trend-analysis.

Trend-analysis can be defined as a method that spots trends, investigates the type(s) of future(s) to which these trends may lead, and assesses their possible impact. In light of the research question addressed in this thesis, we have decided to investigate the qualitative version of trend-analysis. In this version, trends are described by futures researchers mainly through words rather than figures or numbers. Van der Duin, Drop & Kloosterhof (2001, p.23) define trend-analysis as: "…the assessment of the possible consequences of certain future trends or developments for an organisation with a specific problem or question". Concerning the notion of *trend*, they distinguish the following three characteristics (ibid., p.24):

1. A trend has already started and can therefore be identified.
2. A trend has a specific direction. A development that is constant over time does not bring any changes with it and cannot be considered a trend.
3. A trend will most likely continue for the next three to five years, so hypes and fashions (i.e., developments with a short time horizon) fall outside this category.

Although we do not agree with the third characteristic, the reason being that long-term and short-term time horizons are relative (i.e., sector dependent) and do not reflect an absolute amount of time, we feel that these characteristics provide a valid general definition of the concept of trend. Furthermore, trend-analysis is characterised by describing historical or current trends and extrapolating these trends into the future. Also, unlike 'technology forecasting' (see Chapter 2 and Appendix 8), trend-analysis takes more

than one topic into account. It aims at assessing trends in areas like economics, politics, society, technology, and demographics, and also pays attention to how developments in these areas fields interact. We want to point out that trend-analysis is more comprehensive than trend-*watching*, which is merely aimed at spotting trends and focuses less on assessing their possible impact. In line with the scenario method, trend-analysis also has some good practices. This list is based on May (1996), Glenn (1999), and Van der Duin et al. (2001):

Pre-foresight/input:
1. The concept of a trend is defined clearly.
2. The process and actions by which the trend-analysis is carried out are described.
3. The collection of information and data is defined.
4. The time horizon of the trend-analysis is defined.
5. Information and/or data is collected by using multiple and different sources (e.g., interviews, journals, Internet).
6. It is made clear how the trend-analysis is linked to the decision-making process.

Main foresight/throughput:
7. It is made clear how the information is collected and analysed.
8. To conduct the trend-analysis various supporting tools (e.g., GDR, content analysis) are used.
9. Trends are not only viewed in isolation, but their relationships and even their combinations are taken into account as well.
10. If possible, the trends are assigned a qualitative (conditional) probability (unlikely, likely, etc.).
11. The assumptions of the trends are clarified and validated.

Post-foresight/outputs and action:
12. Based on the trends that have been spotted and analysed an all-encompassing picture of the future (or futures) is presented.
13. The consequences or impacts of the trends are assessed.

Roadmapping.
There are many definitions of roadmapping. Farrukh, Phaal & Probert (2003, p.6) define roadmapping as "…a practical method to help explore the impact of backing different technological options in market and resource terms". Probert & Shehabuddeen (1999, p.647) see a *technology* roadmap as "…a means of depicting the link between the current, emerging and potential technologies that an organisation may choose to exploit, and the long term market opportunities to which it could apply them". Essential for a roadmap is that, whereas other methods of futures research often make a statement about one or more (possible) futures, the roadmap provides a possible pathway to one or more futures.

Actually, this (possible) pathway into the future is the most essential element of the roadmap. It must be seen as an action plan that contains various steps that need to be taken to reach that specific future. Alongside their technological origin, nowadays roadmaps often integrate different aspects of the future, such as market and society. Also, a roadmap not only provides a view of a possible future and which steps have to be taken to reach that possible future, it also provides insight into what an organisation must do to be able to reach that future. In other words, roadmapping looks to the future of an organisation as well as the organisation itself. We now present a list of good practices for roadmapping based on Barker & Smith (1995), Probert & Shehabuddeen (1999), and Phaal, Farrukh & Probert (2004):

Pre-foresight/input:

1. Input for the roadmap is collected from various areas (market, technology, society) and provided by experts with different backgrounds.
2. The roadmap is embedded in a broader strategy and in other types of decision-making processes.
3. There is a clear definition of the scope, focus, and unit of analysis of the roadmap.

Main foresight/throughput:

4. The process of building a roadmap is clearly and extensively defined in different (linear or parallel) steps.
5. The roadmap is constructed with the support of an interactive process.
6. The roadmap is approached both from the top down and from the bottom up, and/or from a technology push and market pull point of view.

Post-foresight/outputs and action:

7. The roadmap contains a clear and comprehensive vision of the future.
8. The various elements of the roadmap (e.g., business, market, technology, products) are clearly linked to each other.

2. The process of futures research.

Methods of futures research are applied within a process that consists of stages within which different activities are carried out. Processes of futures research can be described in different ways, two of which are presented below.

1. Horton (1990) states that the process of futures research has three stages:
    1. Input: in this stage information is collected. Some of the activities that take place and tools that are used at this stage are expert-interviews, desk research, and surveys.

2. Foresight[6]: this stage can be seen as the throughput stage in which the information that has been collected is analysed by futures researchers (individually or in groups).
3. Outputs and actions: in this stage the results are published and used by clients of the process.

2. Martin (1995) distinguishes three stages of foresight:
   1. Pre-foresight stage:
      a. Decision to initiate foresight
      b. Preparatory activities
   2. Main foresight stage:
      a. Design of the foresight process
      b. Strategic analysis
      c. Agreeing on the most promising options
      d. Diffusion of the results from the foresight process
   3. Post-foresight process:
      a. Policy decision to launch a scientific or technological programme
      b. Programme definition and steering or redirection
      c. Project definition and execution
      d. Diffusion and implementation of results.

Both Horton and Martin describe the process of futures research as a (simple) linear process. Horton's description is especially simplified and can be applied to any type of process. The supposedly linear character is an idealised description. In practice, processes take place simultaneously and within a process activities also double back or branch out (i.e., feedback loops). So, the practice of futures research is often much more chaotic and opportunistic than the well-structured and smooth process descriptions presented by Horton and Martin. Also, they pay little attention to how the process they describe is actually carried out, which transforms the second part of the process into a black box.

A process description should consider the non-linear character of the process of futures research. However, as long as we keep in mind that futures research is to a considerable degree a non-linear process, there is no need to abandon the linear process description completely. Also, a process description should provide more information about what activities are specific for a certain method of futures research. Neither Horton nor Martin provide this kind of information, although Martin is more specific than Horton with regard to the activities that are part of each stage. Finally, Martin does pay explicit attention to activities that link foresight and decision-making (something that Horton fails to do).

[6] Foresight is another term used for futures research. Although foresight is often used by government organisations, there is no problem using it here. See also Appendix 8 for a description of foresight.

3. The basic elements of studies of the futures.

Each study of the future has a set of basic elements (Miles, Keenan & Kaivo-Oja, 2002; Porter et al., 2004). Examples of basic elements are: time horizon, objectives, (geographical) coverage, participation, and duration and cost (ibid., pp.45-47). The process of futures research is used to structure these basic elements[7]:

Stage 1: Pre-foresight/input:

1. *Consultation/participation:* the kind of expertise being consulted. Who is engaged in the future study? Whose expertise or plain opinion serves as input for the study? And who contributes in any other way?
2. *Clients of futures research*: studies about the future are often commissioned by clients who need information or knowledge about the future and pay money to the futures researcher (or its parent organisation) to carry out a futures study. It is also possible that futures researchers investigate the future on their own initiative.
3. *Duration (or research period) and costs (or available resources):* the time it takes to carry out the future study and the amount of resources needed.
4. *Goals or objectives*: futures research is carried out to serve a specific goal set by the client or by the futures researchers themselves. Examples: constructing a vision of the future, developing an innovation, or predicting the market potential of a technology.
5. *Rationales:* the arguments for conducting futures research. The basic motivation and the reason why futures research is chosen and not another type of (futures research) method.

Stage 2: Main foresight/throughput:

1. *Communication flows:* the type and amount of communication between various participants and stakeholders during a future study.
2. *Futures researchers*: these are experts in the field of futures research who have knowledge either about *methods* or about *processes* of futures research (or both).
3. *Geographical coverage:* the geographical area of the future study. For instance: international, regional, national or local.
4. *Level of detail:* the political, economic, social, institutional, sectoral or organisational level at which the future study is carried out.
5. *Method:* the method (or combination of methods) of futures research used by futures researchers.
6. *Organisation and management:* the organisation and management of the future study. Assignment of responsibilities and division of different tasks.
7. *Time horizon:* on the period that is investigated.

[7] Although every basic element plays a role in each stage of the process, we have assigned them to the stage where their role is emphasised.

8. *Tools:* the tools that are used in the specific method (or combination of methods) of futures research, for example brainstorming or expert-interviews.

Stage 3: Post-foresight/outputs and action:
1. *Communication and visualisation:* the communication and visualisation of the results of futures research by, for example, building workspaces of the future, giving scenarios clear names, or making prototypes of the future.
2. *Decision-making:* the decisions the future study is meant to support. These are often strategic decisions.
3. *Dissemination:* the distribution of the results of the future study among decision-makers, participants and other stakeholders.
4. *Implementation*[8]*:* the actual use of the results regard to the decision-making process. This can take place in a formal way and decision-makers may even be obliged other executives to use the future study.

Table 3.2: The basic elements positioned in the three stages of the process of futures research.

Stage 1: Pre-foresight/ input:	
1. consultation/participation	4. goals or objectives
2. clients of futures research	5. rationales
3. duration (research period) and costs (available resources)	
Stage 2: Main foresight/throughput:	
1. communication flows	5. method
2. futures researchers	6. organisation and management
3. geographical coverage	7. time horizon
4. level of detail	8. tools
Stage 3: Post-foresight/outputs and action:	
1. communication and visualisation	3. dissemination
2. decision-making	4. implementation

The basic elements are part of the case analysis framework (see Chapter 1, section 1.2 and Appendix 1C) and are presented in Table 3.2.

[8] Decision-making and implementation are closely related to each other. The difference is that a decision is an intent to carry out a certain action and implementation is the carrying out of that decision.

3.4 Innovation: definition, processes, and indicators

Definition
Although there are many definitions of the concept of innovation, it is not the objective of this section to provide an exhaustive overview, as that can be found elsewhere (e.g., Cumming, 1999; Garcia & Calantone, 2002). In this section we discuss the various elements that clarify how we define innovation in this thesis and how it relates to the topic of this thesis. There are six elements in the various definitions of innovation that are relevant to this thesis:

1. Newness (or novelty) and change.
Innovation is strongly related to 'something' that is new, i.e., a process, a product, or a service that has not been introduced to a market earlier. We emphasize that, for something to be labelled an innovation, it does not have to be new to the organisation by which it is developed. Rogers (1995, p.11) emphasises this in his definition: "An innovation is an idea, practice, or object that is perceived as *new* by an individual or other unit of adoption". In this definition newness must be viewed from the perspective of the potential user and not from the actor that develops and produces the innovation: "If the idea seems new to the individual, it is an innovation" (ibid., p.11). The concept of newness is closely linked to the concept of *change* because the newness of an innovation will often have a specific (new) impact that will lead to certain changes. Changes can occur on the demand-side of the market (users may be attracted by the new product or service and change their spending pattern in favour of the innovation), among competitors (they may change the marketing strategy of their own products or start innovating themselves), or at government level (the use of the innovation may have a specific negative social consequence that requires additional legislation).

The element of newness is important to this thesis because futures research often aims at discovering future developments and assessing their possible future impact on the development of innovations. An image of future developments can then be regarded as a source of the newness of an innovation. For instance, a result of the predicted growth of the number of elderly people in the Netherlands will be that the average age of the people using products and services will be higher. This will have an impact on the development of mobile phones, for example, where companies may want to look at designs that are easier to use by people that are often less familiar with this type of product.

2. A broad view on innovation.
Because innovations traditionally entailed some kind of (visible) *technological* change, only product innovations used to be called innovations. Nowadays, innovations of a more intangible and non-technical nature, such as service innovations, organisational innovations, or new supply methods are also considered innovations. The concept of innovation has broadened over time.

As far as the use of futures research in innovation processes is concerned this means that more diverse developments in society should be taken into account and that (more) people with different backgrounds should be involved. These days, merely looking at technological developments will contribute little to the innovation process since many innovations are of a non-technical nature. For instance, in the 1950s many scientists (and futures researchers) were very positive about the future of nuclear energy because it had clear technological advantages over other types of energy. However, the fact that many citizens viewed nuclear energy as unsafe severely hampered its market diffusion and even brought it to a halt. Not surprisingly, the modern history of futures research (see Chapter 2) has shown a shift from forecasting only technological developments towards exploring various types of future developments (e.g., economic, social, political).

3. Process.
Innovation not only involves a new product or service, but it is also a *process* by which an idea or invention is generated and subsequently transformed into a new product or a new service which is successfully introduced to the market. Jonash & Sommerlatte (1999, pp.1-2) refer to Joseph Schumpeter in their definition of innovation: "…innovation encompasses the entire process that starts with an idea and continues along through all the steps from initial development to a marketable product or service that changes the economy". Chiesa (2001, p.3) defines innovation as invention plus exploitation and views both elements as processes whereby new ideas are created and implemented (the invention process), and in which, among others activities, the commercial development, application, and transfer is taking place (the exploitation process). Trott (1998, p.11) also views innovation as a process and compares it to education, "where qualifications are the formal outputs of the education process. Education like innovation is and cannot be viewed as an event".

With respect to this thesis, since innovation is interpreted as a process, futures research is regarded as one of many activities that provide input to the innovation process. If innovation were to be regarded merely as a result or outcome, it would be harder to indicate the contribution of futures research to innovation.

4. Implementation.
Innovation must be clearly distinguished from an *invention*, a *patent*, or an *idea*. Buderi (2000, p.30) quotes the director of PARC, the research centre of Xerox, who states that innovation is "invention implemented". Dunphy et al. (1996, p.279) view an innovation as

a "commercially feasible version of the invention". Tidd et al. (1997, p.23) add to this: "Definitions of innovation may vary in their wording, but they all stress the need to complete the development and exploitation of new knowledge, not just its invention". Rosegger (1986, p.7) argues that *ideas* do not belong to the domain of innovation but to the domain of *invention* because ideas do not necessarily lead to technological or economic change. This does not mean that inventions or ideas have little value. On the contrary, every innovation necessarily starts with an idea or invention. Nevertheless, the (potential) value of an invention or an idea for a market or society can only be established and/or assessed after it has been transformed into an innovation.

For the purposes of this thesis the distinction between an invention or idea and an innovation is very important. This distinction is realised by the transformation (i.e., the innovation process) of an invention, a patent or an idea into an (implemented) innovation, during which futures research can be applied.

5. Interconnectedness of innovations.

It is difficult to view innovations independent from each other. With regard to the development of innovations, Dunphy et al. (1996, p.281) state that innovations often do not come alone but in groups or clusters that develop in a parallel way, and Rogers (1995) refers to an encompassing *system* in which innovations are developed. Also, innovations often receive input from more than one source. In line with this, Smits (2002, p.7) views innovation as "a successful combination of hardware, software and orgware, viewed from a societal and/or economic point of view". In this definition the hardware is the apparatus, the software the idea, and the 'orgware' the imbedding of the innovation into market and society. Other terms that refer to interconnectedness are 'solution innovation' (Shepherd & Ahmed, 2000) and 'technology fusion' (Tidd et al., 1997). In an other publication Tidd et al. illustrate the interconnectedness of innovations by describing an example of three product generations (or standards) of mobile (cellular) telephony (NMT-450, NMT-900, GSM) that shows that each new product generation uses more technologies or innovations than its predecessor. Where the NMT-450 used 5 technologies, NMT-900 used 10 technologies, and GSM needed 14 technologies and more than 100 patents (2001, p.125).

Like the need to adopt a broad view on innovation, the fact that innovations are often interconnected means that futures researchers must include (possible) future developments in various areas of society (e.g., technological, political, social, cultural) because for different innovations the emphasis can be on different areas. For example, prepaid subscriptions to mobile telephony is a service innovation which is, among other things, made up of a business model innovation (i.e., a new type of subscription), a product innovation (i.e., a prepaid card which must be inserted into the mobile telephone), and a process innovation (i.e., new software needed for the billing process). Whereas for business model innovations, possible future developments with regard to spending patterns are relevant, which is part of the economic and social area, product innovation and process

innovation require information about possible future developments in the area of technology.

6. Uncertainty and creativity.
Innovation is strongly related to uncertainty and creativity. Uncertainty plays a role since at the start and during an innovation process there are many factors that may influence the development of an innovation and their contribution is difficult to determine in advance (see also section 3.1). Radical innovations have a higher level of market-related and technological uncertainty than incremental ones (McDermott & O'Connor, 2002). Trott (1998) refers to Pearson's uncertainty map which divides ways of managing innovation based on uncertainty with regard to the outcome of an innovation process and with regard to the means by which this outcome can be realised.

Being creative, that is to say, being able to think in new and different ways and to develop a new view on existing problems and opportunities, is an essential asset for the innovating organisation (Florida, 2003). Adopting a different approach increases the chances of an innovation with a high degree of newness, and allows an organisation to distinguish itself more from (potential) competitors.

The elements of 'uncertainty' and 'creativity' play a role in futures research. Uncertainty as to the outcome of an innovation process is caused (mainly) by the fact that the future is almost by definition uncertain. Also, the use of creativity in an innovation process can be stimulated by looking at possible new future developments and paying extra attention to developments that many people currently regard as unthinkable. In other words, creativity has to do with the ability to imagine, anticipate and cope with unexpected and possibly even highly implausible future trends.

Innovation processes.
Innovations are developed from an idea into a new product, service, process or any other type of innovation. Innovation processes can take place in different ways (for an overview: Saren, 1984). A simple way to structure and clarify innovation processes is to look at their historical development which indicates essential changes in the way organisations have organised and implemented their innovation processes. It is possible to draw a distinction between innovation at the *organisational* level and at the *project* level. Innovation processes at the organisational level have a more general nature than those at a project level. Chiesa, Coughlan & Voss (1996) more or less regard innovation processes at the project level as one of the core processes of the innovation processes at the organisational level. Both types of innovation processes follow the same historical development.

Innovation processes at the level of the organisation.[9]

When we look at innovation processes from an organisational angle, four historical generations of innovation processes can be distinguished.[10]

1. The first generation of innovation processes took place between the 1950s and mid-1960s. In this period, scientific researchers within the R&D department of an organisation were pretty much free to investigate any subjects they wanted. R&D, which at the time was equal to (industrial) innovation, was organised in large R&D-programmes that were heavily funded financed from corporate budgets. The selection and evaluation of R&D-programmes and projects did not formally take place due to the absence of suitable methods and techniques (Liyanage, Greenfield & Don, 1999). Because ideas or inventions often had a technical character, this process was called 'technology push'. Many R&D-programmes were not related to the strategy or mission of the mother organisation. This was considered neither bad nor unwanted, because scientific freedom was highly valued. In fact the organisation of corporate R&D centres strongly resembled the organisational structure of universities.
2. The second generation of innovation or R&D processes took place between the mid-1960s and the early 1970s. A slowdown in the economy meant that market competition was fiercer. As a result, innovation was aimed more and more at demand-side factors (Rothwell, 1994). Not surprisingly, innovation processes were called 'market-pull' due to the fact that the R&D process was initiated by market requirements. Also, innovators no longer worked in isolation, but instead had to ground their work more firmly in the organisation's strategy and vision. Finally, the time horizon of R&D-programmes became much shorter, which meant there was a shift from radical innovations towards incremental ones. In other words, attempts were made to shorten the time-to-market of new innovations, to minimise the uncertainty associated with innovation and to reduce the impact of external developments on the innovation process.
3. The third generation took place between the early 1970s and the mid-1980s. The two earlier models (i.e., technology push and market pull) were combined into a 'coupling model', in which these processes were no longer linear (Roussel, Saad & Erickson, 1991; Tidd, Bessant & Pavitt, 1997). Innovation processes could include various forward and backward loops and other types of interaction. Also, innovation mainly took place in smaller, more flexible projects rather than in large, long-term R&D-programmes. Again, innovation became more integrated with other parts and functions of the organisation.

[9] This section is largely based on Ortt & Van der Duin (2006).

[10] Our description of the historical development of innovation processes (at the level of the organisation) is limited to four generations. Although some authors (e.g. Rothwell, 1994) argue in favour of a fifth generation, we consider the fifth generation not distinct enough from the fourth generation to call it a separate generation.

4. The fourth generation emerged in the early 1980s and continues until the present. Because the product life cycle became ever shorter, it was considered important to try and shorten a new product's time-to-market as well. This meant that many organisations (sometimes even competitors) began to cooperate with each other with regard to innovation. Given the need to shorten the time-to-market and in light of the fact that organisations no longer had the (financial) resources and knowledge base required to innovate on their own, cooperating with other organisations was the only option to stay ahead of the competition (e.g., Miller, 2001). Also, because developments with regard to innovation processes continued to move in a less linear were direction, new innovation models appeared that had a more complex network structure. An example of a fourth generation model is the Cyclic Innovation Model by Berkhout (Berkhout, 2000) in which the innovation chain is replaced by an innovation *cycle* connecting the market to the soft sector of sciences.

It should be emphasised that the (historical) development of innovation processes is not set in stone, but that it is heavily influenced by, for instance, market-related and economic developments. Also, organisations were and still are capable of influencing this development by applying those aspects of the models of innovation processes that are most suitable to them. Finally, the various generations of innovation processes have influenced each other, indicating that each new generation has aimed at overcoming the disadvantages of the previous one, and that complexity has grown with each subsequent generation.

This historical account of the development of innovation processes can be nuanced. Firstly, the historical boundaries of the different generations has been questioned. Although, officially, the first generation is placed between the 1950s and the mid-1960s, even today many organisations (and governments) are still use (some of its) principles. Some books and articles on innovation management from the start of the 21st century still present its linear process (either technology push or market pull) as a way for organisations to organise their innovation (e.g., Douthwaite, Keatinge & Park, 2001; Dundon, 2002; Yu, 2003). Moreover, the linear innovation process was put into practice as early as the end of the 19th century, when the first commercial R&D-laboratories were founded (Bassala, 2001). Niosi (1999) even argues that fourth-generation R&D has existed, though marginally, since the beginning of industrial research. A second remark is that it is not always clear whether the various models or generations of innovation processes *prescribe* or *describe* the practices and principles of innovation within organisations. Thirdly, since there is some disagreement among different authors as to the exact timing of the various generation, the picture that emerges is somewhat confusing. For instance, Liyanage et al. (1999) state that doing research in projects with milestones, project accountability, project evaluation and so on, began in the second generation, while Rothwell (1994) puts that development in the third generation.

Lastly, nowadays companies no longer automatically follow the course of the history of innovation. They have adopted a *contextual approach* to innovation, meaning that they adapt their innovation processes to the specific context in which they operate and which consists of the type of innovation, organisation, industry and country or culture (Ortt & Van der Duin, 2006).

Innovation processes at a project level.

This thesis focuses on innovation *processes* which refers to the way innovations actually take place. These processes are often embedded in specific innovation projects. A historical approach can be used to show what is meant by innovation at the project level. Such a historical description is given by Cooper (1994) who distinguishes three generations of innovation processes, or so-called *new product processes* or *developments*:

1. The first generation was developed by the NASA in the 1960s. It was called the *Staged Review Process* and contained a detailed scheme for working with contractors and suppliers of space projects. This type of product development consisted of discrete stages with a review point at the end of each stage (i.e., an innovation *funnel*). Cooper considers this process very engineering-driven and argues that it applies only to the physical design and development of the product. However, at the time there was little to distinguish innovation projects from any other type of project.
2. The second generation is an improvement on the first generation, in that it has included several success factors that were identified after researching innovation projects. Cooper mentions eight success factors that characterise the second generation:
    1. Cross-functionality: at each stage players from different functions, such as marketing, R&D, engineering, and manufacturing take part in the project team.
    2. Integrating marketing and manufacturing with the product development process.
    3. Decision points or gates are also cross-functional: managers from different functions collectively decide about the progress of an innovation project.
    4. Approaching the innovation process from a more holistic point of view: focusing not only on the development stage but trying to capture the entire process (from idea to launch).
    5. Much more emphasis on up-front homework or pre-development work: putting great effort into defining the scope of the project and conducting a more detailed investigation before starting development.
    6. Much stronger market orientation.
    7. Introducing parallel or concurrent engineering.
    8. Improved decision-making process with clear Go/Kill criteria.
3. However, in spite of its success factors, Cooper argues that the second generation has six disadvantages: 1) projects must wait at each gate until all tasks have been completed, 2) overlapping of stages is all but impossible, 3) projects must go through all gates and stages, 4) 2nd generation product development does not lead to project

prioritisation and focus, 5) some new product processes are worked out in far too much detail, and 6) some new product processes tend to be bureaucratic. Cooper states that, in order to overcome these advantages and to design a product development process that is in line with market-related and social demands, the focus needs to be on efficiency: "on speeding up an already effective second-generation stage-gate process and on more efficient allocation of development resources" (idem, p.8). Furthermore, Cooper attaches four F's to the third-generation product development processes (idem, p.9):

1. Fluidity: "it is fluid and adaptable, with overlapping and fluid stages for greater speed".
2. Fuzzy gates: "it features conditional Go decisions (rather than absolute ones), which are dependent on the situation".
3. Focused: "it builds in prioritisation methods that look at the entire portfolio of projects (rather than one project at the time) and focuses resources in the 'best bets'".
4. Flexible: "it is not a rigid state-and-gate system: each project is unique and has its own routing through the process".

Indicators of innovation processes and activities.

The innovation process, both at the organisational and at the project level, can be described more specifically by using so-called innovation indicators. Several authors have formulated specific indicators by which innovation processes and activities within commercial organisations can be described. These descriptions range from general recommendations for organisations on how best to innovate (e.g., Dundon, 2002), to comprehensive innovation audits that use more specific innovation indicators (Tidd et al., 1997). For instance, Gaynor's innovation audit (2002) addresses a total of 26 topics, such as organisational resources, tolerance for failure, decision-making, and acceptance of change. The topics are divided into four clusters: 1) culture, 2) resources, 3) infrastructure, and 4) process. Gaynor regards these clusters as innovation input. Answers to the questions in the audit are measured on scales such as 'yes/no', or 'excellent – acceptable - needs improvement - not acceptable'. Another innovation audit is the one proposed by Tidd et al. (1997, p.364), who compiled a list "of possible measures and indicators which might be used to flesh out an assessment of how well an organisation manages innovation". This list has four categories:

1. Does the organization take a strategic approach to innovation?
2. Has the organization established effective external linkages?
3. Are there effective implementation mechanisms?.
4. Does innovation take place within a supportive organisational context?

Each category has a set of related sub-questions the answers to which can be scored on a scale. In addition to this innovation audit, Tidd et al. (1997) have formulated a set of general measures and indicators aimed at capturing the innovative performance of

organisations, which include specific outputs (e.g., patents, scientific publications) and strategic success (e.g., growth in revenue or market share). This set is made more specific by another set of measures, such as the number of new products introduced over the past three years or the number of man-hours dedicated to each new product.

Any indicator or measure of the innovative performance of organisations has its advantages and disadvantages. With regard to the innovation audit of Gaynor (2002), the answer categories provide little insight into *how* an organisation conducts its innovation process, despite the extensive character of the audit. Also, it only indicates whether a certain condition (formulated in a question) has been fulfilled or not, thereby suggesting that there is some optimal way of innovating that is not made explicit. Kleinknecht, Van Montfort & Brouwer (2002) discuss the strengths and weaknesses of several innovation indicators. For instance, the strength of an indicator such as expenditure on R&D is the large amount of data available which makes it easier to apply and its outcome more reliable. A weakness of this indicator is that it is an *input* to the innovation process and provides no information on the *output* of an innovation process, i.e. "the real introduction of new products, services or processes into commercial use" (ibid., p.110). The authors also propose a few new innovation indicators, such as overall innovation expenditures, and the share of a company's overall sales attributable to imitative and innovative products.

It can be concluded that, to construct a comprehensive view on the innovative performance of an organisation, it is important to collect information not only about the input of the innovation process but about its throughput and output as well. The next step involves determining which indicators or set of indicators are most appropriate for our thesis to describe and assess the innovation processes and activities of organisations. To make this choice three criteria are used:

1. Access to information: Although an indicator can provide a good indication of innovative performance, collecting the information or data required may be too difficult, for instance for reasons of confidentiality.
2. The level of the organisation: Because we look at the organisational level, we have little use for indicators that refer to the national or industry level.
3. Neutral or objective nature of indicators: Since there are no 'golden rules' for innovation, indicators that imply that there is an underlying set of best practices must be discarded.

Based on these criteria, we reject Gaynor's innovation audit (2002) because it implies that there is one optimal way to innovate (criterion 3). A meta-analysis carried out on the success and failure factors shows that not much overall consensus is present about which factors contribute positively to the innovation process (Van der Panne, Van Beers & Kleinknecht, 2003). Indeed, a contextual approach to innovation where the 'best way' to innovate is determined for each occasion nowadays seems to be the common approach among organisations (Ortt & Van der Duin, 2006). The innovation audit presented Tidd et al. (1997) is more suitable because, although it implies that certain elements are generally

more relevant than others with regard to the success of innovations, the authors do not establish a direct connection to any optimal approach to carrying out the innovation process. In addition, the authors pay a great deal of attention to the throughput of the innovation process. Nevertheless, we will not use the entire innovation audit proposed by Tidd et al. (1997), but only those elements that are relevant from the perspective of futures research and only the most essential indicators of each of their four categories The entire innovation audit by Tidd et al. (1997) can be found in Appendix 8. Elements of the list of indicators suggested by Kleinknecht et al. (2002) are useful because they can be applied both to the input and to the output side of the innovation process. Figure 3.1 shows which of the elements from Tidd et al. (1997) and Kleinknecht et al. (2002) we have selected:

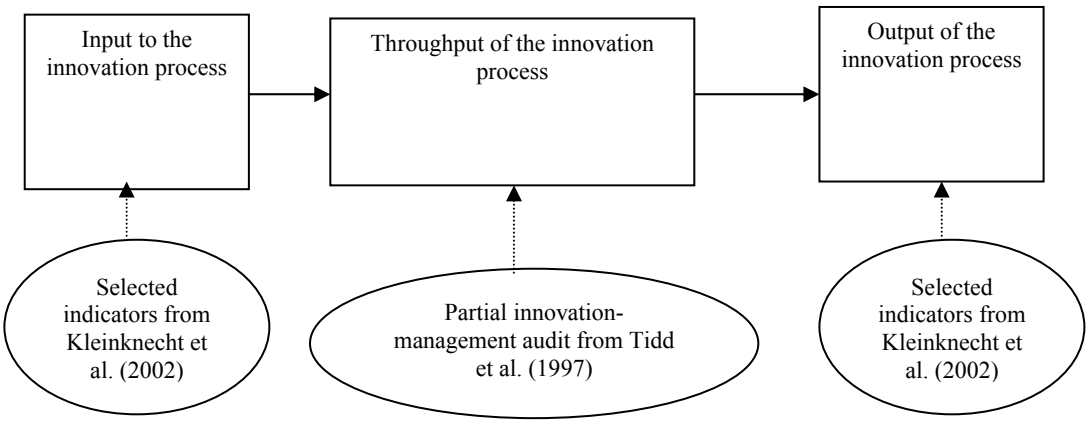


Figure 3.1 Input, throughput, and output of the innovation process with the innovation indicators (see also Table 3.3).

It must be noted that the lay-out of Figure 3.1 is not meant to imply that innovation processes are linear. It does not present a model that describes (or prescribes) how innovation processes take place within commercial organisations, but instead offers a framework that structures the different innovation indicators. The throughput-stage of innovation (the middle part) is the actual innovation process which can take on many different forms (see sub-section *Innovation processes at the level of the organisation*). Table 3.3 shows the list of indicators and their position in the innovation process:

Table 3.3 The innovation indicators at the level of the organisation placed in the input, throughput, and output stages of the innovation process.

1. Input: • Total innovation expenditure. • Number of persons involved in R&D and/or innovation. • Number of patents and patent applications.
2. Throughput: • In which broad technological trajectories is the organisation active? (science-based, scale-intensive, information-intensive, specialised suppliers or supplier-dominated) • What are the technological competencies and where are they located within the firm? • How does the organisation identify potentially new technological competencies? (corporate visions, technical judgments, product-technology matrices, incremental trial, error and learning) • How are R&D and other innovation expenditures evaluated? • How are innovation strategy and corporate strategy linked? • Does the organisation use exploratory techniques to identify and predict future trends, e.g., brainstorming, scenario analysis and Delphi? • Does the organisation seek to develop and maintain networks of formal and informal knowledge? • Does the organisation systematically search for new product opportunities? If so, how? • Does the organisation have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? • Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this procedure used in practice or are there alternative 'short-cuts'? • Is there top management commitment to and support for innovation? • Is there a clear shared sense of strategic vision and ownership of the business plan? • Does the organisation have a supportive climate for new ideas – or do people have to leave in order to carry them forward?
3. Output: • Number of innovations introduced over the past three years. • Percentage of annual turnover due to innovations. • Part of portfolio that has undergone an incremental change, a radical change, or that remained essentially unchanged. • Amount of sales of imitative and innovative products and services.

The indicators described above mainly refer to the organisational level, which means that we need to look for indicators at the project level. To do so, we can use the success factors of the third generation innovation processes described earlier. Unlike the indicators

that refer to the organisational level, most project-level indicators are relevant in the input, throughput, and the output stages of the innovation process, which means that it makes little sense to organise the two groups of indicators in similar ways. Therefore, they are listed below in table 3.4. The project-level indicators are less neutral than the ones that refer to the organisational level. Project-level indicators tend to focus more on good ways for organisations to innovate, rather than on the ways organisations are actually innovating, because at the project level the influence of contextual factors is less important than at the organisational level.

Table 3.4 The innovation indicators at a project level.

• Cross-functionality
• Integrating marketing and manufacturing with the product development process
• Decision points or gates are also cross-functional
• More holistic rather than merely looking at the development phase
• Much more emphasis on up-front homework or pre-development work:
• Much stronger market orientation
• Introducing parallel or concurrent engineering
• Clearer decision-making process, with clear Go/Kill criteria
• Fluidity
• Fuzzy gates
• Focused
• Flexible

Innovation indicators at both levels are part of the case analysis framework (see also Chapter 1, section 1.2 and Appendix 1D).

Futures research and innovation (processes) complement each other. Since innovation is aimed at the future, the application of futures research can help organisations improve their innovation process. Furthermore, it can be assumed that the type of innovation is related to the type of futures research. The more radical an innovation is, the longer its lead time and the greater the uncertainty of the innovation process will be, which means that futures research should be of a more explorative nature, since the innovation process is too uncertain and the time horizon is too long to be able to make accurate predictions.

Both futures research and innovation are carried out in processes. These processes are not constant but change over time due to new developments in, for instance, market, technology, and society.[11] The historical development of both futures research and innovation follow roughly the same line. In the 1950s and 1960s, 'technology push' was dominant in innovation management. At that time, futures research equalled 'technology

[11] For an overview of historical developments in futures research, see Chapter 2.

forecasting', in that it tried to predict the future course of technological parameters as accurately as possible. Later on, organisations broadened their view on innovation, which is reflected in the increasingly integrated nature of futures research.

CHAPTER 4 – THE INNOVATION CHAIN OF KPN RESEARCH

This chapter describes and analyzes the Innovation Chain (IC) of KPN Research. The IC uses the scenario-method to explore new ICT-products- and services. KPN Research applies the IC for customers of its mother-company KPN. The scenarios have a strong societal character and the IC is quite interactive. The aim is not to find different versions of existing ICT products and services, but to focus on genuine innovations by identifying future communication needs of KPN customers.

4.1 Structure of the case study[12]

This case study has been carried out in three phases:
1. Interviews and collection of relevant internal and external documents.
Interviews: in all we interviewed 20 people. Fourteen of the interviewees were directly involved with the *Innovation Chain* (IC): four of them were employees of KPN Research, seven were employees of KPN Sales, and three were customers of KPN. The remaining six interviews were with employees of KPN Research responsible for innovation strategy. On average the interviews lasted one hour. The interviews were transcribed and sent back to the interviewee for feedback (five interviewees responded). The interviews took place between May 2002 and July 2002.
Documents: internal and external documents about, for example, the IC, the corporate scenarios, and the use of futures research methods by KPN Research.
2. Analysis of documents and interviews using the case analysis framework (see Chapter 1, section 1.2 for a description of this framework).
3. A group discussion to present and discuss the conclusions of the case. The group discussion was held at KPN Research in Leidschendam on October 30, 2002, and took two hours. It was attended by interviewees as well as other employees of KPN Research who were related to the IC. Minutes were made of this meeting (G).
In this chapter we use the following references:

- Interviews: (I_number)
- Documents:
    - Internal: (DI_number)
    - External: (DE_number)

[12] During the case study, the author of this thesis was a part-time employee of KPN Research (my other employer was Delft University of Technology). In 1999 and 2000, he was project-leader of the 'Destination 2005'-project (see Section 4.5). He was not responsible for developing the Innovation Chain (IC) and he was not involved in organizing and/or facilitating the IC itself. He occasionally gave presentations about the corporate scenarios at IC-meetings.

- Minutes of the group discussion (G)

The references of this case study are listed in Appendix 2.

4.2 Background of KPN Research[13]

Short history of KPN Research.
KPN Research is the R&D department of KPN, the former Dutch incumbent telecom operator (PTT). It was established 50 years ago from a merger between two laboratories of the PTT: the Radio Laboratory and the Telegraph & Telephony Laboratory (DE02). At the start of the 21st century, KPN Research merged with KPN Valley, which was established in 2000 as an 'incubator'. In 2001, KPN encountered serious financial problems due to the high cost of obtaining UMTS-licenses, and KPN Research was extensively reorganized. In 2002, KPN Research became a private partnership of KPN. From then on the relationship with KPN became looser and KPN Research started serving other customers as well.
In January 2003, KPN Research became part of TNO, a Dutch non-profit research organisation, and nowadays it is known as TNO Information and Communication Technology. 'Future Scanning' (FS), the group involved in futures research, is still part of TNO Information and Communication Technology.

Organisational overview of KPN Research.
KPN Research consists of two departments. The Knowledge Innovation Center (KIC) is involved in knowledge *development* and the Business Innovation Center (BIC) is involved in knowledge *exploitation* (DE23). The KIC is divided into Knowledge Innovation Teams (KITs), which are sub-divided into 'knowledge networks'. One of these knowledge networks is 'Future Scanning' (FS), which is involved in futures research, the Innovation Chain, and the 'Destination 2005'-project. FS is part of the KIT 'Human, Market & Business'. The BIC is divided into Business Innovation teams (BIT). In addition to these two departments, there is a third (small) department called 'Business Creation' (BC), which is responsible for the commercial exploitation of ideas by facilitating and (partly) financing small start-ups ('product-companies') (DI15). Figure 4.1 shows the organisational structure of KPN Research.

[13] Although the official name was 'KPN Valley' we use the name 'KPN Research', since that was the brand-name. KPN Valley was a special department of KPN which was set up in 2000 and which merged with KPN Research in 2001. KPN Research was also known as the *Dr. Neher Lab.*

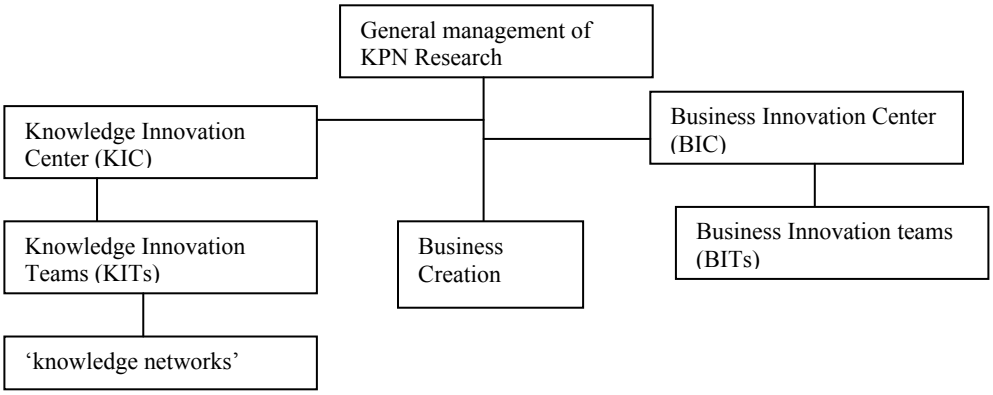


Figure 4.1 The organisational structure of KPN Research.

KPN Research has an annual budget of about € 40 million. It employs some 400 researchers, and it holds about 20 active patents. Although it is the biggest R&D lab in the Dutch telecommunication industry, within a European context its size and role is considerably smaller. In 2002, its budget was cut due to financial difficulties at KPN, and early 2002 it planned to fire 80 people (about 20% of its workforce) as a result. To compensate for this loss of income, KPN Research tries to do projects for other companies.

4.3 Innovation and innovation processes at KPN Research, KPN, and customers of the IC

With regard to innovation as well as innovation processes various perspectives are represented: KPN Research, KPN, and customers of the IC.

Innovation.
KPN Research develops and exploits (new) knowledge by cooperating with universities and other knowledge institutes, by working for customers on a project basis, by employing recently graduated academics, by facilitating students who are writing their Master's thesis, and by financing professorial chairs. The knowledge that is obtained is applied in projects it conducts for its customers (both KPN and external parties). Its motto is: "from money to knowledge and from knowledge to money" (DI03).

KPN Research makes a considerable effort to renew or innovate its knowledge by keeping in touch with universities, other knowledge institutes, and customers (DE24). In 2002, it had six part-time professors at Dutch universities and hosted a number of students involved in graduate research (e.g., DE01). In addition, it is involved in standardisation institutes, although it has slowed down research into standards (for instance, research into Ipv-6, a new standard for Internet (I04, p.3)). Many of its external contacts, however, are of an informal, personal and ad hoc nature. There are no competitors watching, there are not many regular meetings with other partners, employees rarely visit conferences, and other expert meetings take place on an ad hoc basis. KPN Research has no formal way of evaluating its R&D expenditures or activities (I11, p.1; I12, p.1), although in 2000 consultancy company Arthur D. Little advised them on this matter.

As market leader in most sectors of the Dutch telecommunications market, *KPN* is often the first to introduce new telecommunication products or services on the market. However, there is no Chief Technological Officer (CTO) or Chief Innovation Officer (CIO) at KPN's head office. Also, there is no formal link between KPN's corporate strategy and the innovation strategy of KPN Research. In view of the growing competition in the Dutch telecommunication market and the subsequent pressure on KPN's general financial position and margins, the company's efforts with regard to innovation are not likely to increase in the years to come.

Given the diversity of *KPN's customers of the IC*, it is difficult to describe how much effort these companies put in innovation. However, given the fact that they were willing to do the IC, we may assume that they see innovation as an important element of their company and its strategy.

Innovation processes.

KPN Research, rather than developing innovations itself, above all contributes to the innovation process of its customers (i.e., mainly KPN). It does so by carrying out specific projects in which (new) knowledge is developed that can be used in the customers' innovation process. These projects do not have a standard set of activities but vary according the specific question or problem being addressed. Also, in these projects there is often a close cooperation between KPN Research and its customers (i.e., the principals of the projects) and the members of the project team often come from different departments within KPN Research to ensure the multidisciplinary character of the project.

Innovation processes at *KPN* are relatively simple and linear. Basically, rather than actually developing (network) technology and telecommunication products and services, KPN buys them from suppliers and implements them, which means that it executes only the last part of the innovation process and is mainly involved in the implementation of new telecommunication technology.

It is difficult to describe the average innovation processes of *the customers of KPN* (and the IC) because it is such a diverse group of companies. However, most customers of KPN

are large organisations who, like KPN, are part of the end of the innovation process and are mainly occupied with implementing new products and services and much less with developing them from scratch.

4.4 Futures research at KPN Research

Companies that operate in infrastructure-based industries always need to look to the future because of the long time it takes to earn back their investments. KPN is no exception. As a monopolist KPN had little difficulty in predicting the future. Future demand of telecommunication services and products could be accurately estimated by using historical data. Because of a stable market, an easy way to segment customers, and an almost complete absence of competitors, this was not a difficult task (DE04, p.21).

The liberalisation of the Dutch telecommunication market at the end of the 1980s and the privatisation of KPN in the 1990s changed the way KPN Research conducted futures research. Market-related and technological developments have become more uncertain making it almost impossible to predict the future by means of simple extrapolation. Futures research at KPN Research has shifted from predicting towards exploring the future (ibid.). In 1995, this shift was illustrated by a project called *Services 2015* (DE07). Due to its explorative and societal character this project contrasted sharply with a project conducted in 1990 which was called 'Open deuren' and presented (only) one vision on the future of telecommunication infrastructure (DI16). *Services 2015* was succeeded in 1997 by a project called *Trend-analysis*. In this project, future developments were viewed from various points of view (telecom and non-telecom), and their strategic consequences for KPN were described.

After the Trend-analysis-project, many other futures research projects were carried out, such as scenario projects for various business units of KPN. Also, there was an increasing focus on the methodological aspects of futures research, as can be derived from a report on building scenarios (DI07), and from a report on the various futures research methods used at KPN Research (DI06).

In 1999, the Destination 2005-project (see section 4.5) was set up to come up with corporate scenarios. The corporate nature of the scenarios, the focus on society as main driver for future developments, and the visualisation of the scenario-stories made this project resemble the *Services 2015*-project. *Destination 2005*, however, had a much shorter time-horizon due to the increased dynamics of the telecommunication industry, and it focused much more on the application of the (corporate) scenarios.

KPN Research has an informal expertise network called *Future Scanning* (FS), which is part of the KIT *Human, Market & Business*. The core of FS consists of three people who are occupied (almost) fulltime with futures research, supplemented with three people who conduct futures research on a part-time basis. In 2002, FS had a turnover of about €300,000. It mainly uses exploratory and qualitative futures research methods. Its staff

often works together with the BIT *Business & Network Optimization* (BNO) which is involved in quantitative business modelling. FS conducts futures research in an interactive way by using (expert-) interviews, workshops and a Group Decision Room (GDR).[14] Visualisation and communication are important elements, as can be concluded from the 'workspaces of the future' which were built for the Destination 2005-project. FS sees societal trends as the most important driver in the telecommunication industry. The time horizons of its future studies is often five to ten years, which, considering the dynamics of the telecommunication industry, is a relatively large time span. Most of its futures studies are used for innovation and vision-building rather than for strategy. FS sometimes works together with consultants (e.g., Samhoud, Trendslator) or research institutes (e.g., TNO), and it often uses reports from research organisations like Statistics Netherlands, the Netherlands Bureau for Economic Policy Analysis, Forrester, and GFK. In 2002, the budget for futures research within KPN Research was drastically reduced due to the unfavourable financial position of KPN.

4.5 The Innovation Chain

History of the Innovation Chain.
In 1999, Hans Stavleu of KPN Research and Jan van Dijk of KPN Sales introduced a new way for KPN Research and KPN Sales to work together. The concept of the *Customer Days* already existed, which involved visits from large business customers of KPN to the KPN Research premises, where they were exposed to presentations and demos of new technologies, products, and services. The results of these visits were often disappointing which, according to Stavleu could be explained by the lack of interactivity and by the predominantly technical nature of the presentations and demonstrations (I19, p.1). As a result, there was often no follow-up. With the image of a place were new products and services were developed in mind, Stavleu and Van Dijk agreed to focus more on thinking about the future. They came up with the concept of *Future Days*, which besides presentations and demonstrations, included looking to future developments *together* with visiting customers. To this end they used the GDR and they focused the GDR and the presentations and demonstrations on specific topics.

An important factor in the development of the *Future Days* was the four scenarios of the 'Destination 2005' project (I19, p.1). Through the use of these scenarios the meetings became more interactive than the *Customer Days* and earlier meetings of the *Future Days*, where participants were passive observers of the presentations and demonstrations. From then on a more structured approach was used to engage customers into looking to the future

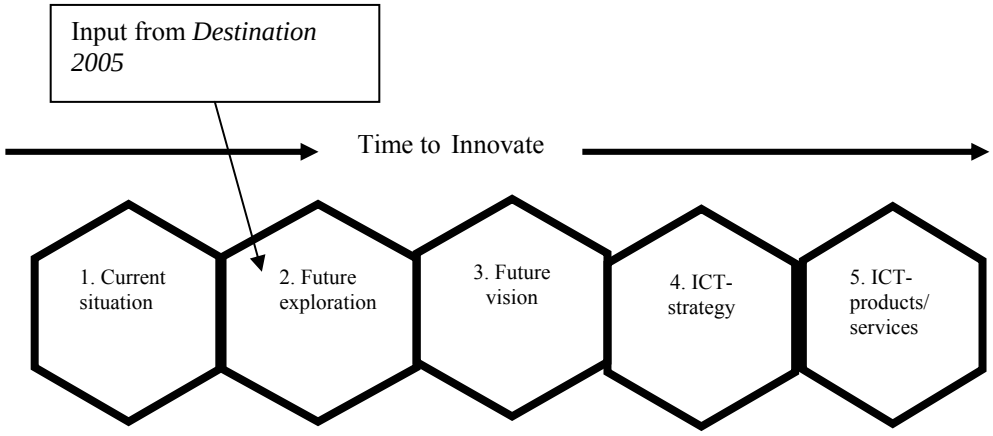
[14] A Group Decision Room enables electronic meetings and brainstorming sessions. It consists of a network of computers and dedicated software (groupware).

and developing ideas about how to respond to possible scenarios. The scenarios needed to be easy to understand by customers who were not accustomed to working with them, and they needed to allow customers to picture themselves, their customers and their portfolio in the four scenarios, which made it easier for them to use the scenarios (ibid., p.2). The new concept was called *Innovation Chain* (IC). Since the IC often took place within one day, KPN Research used the name *Innovation Day* or *Customer Innovation Day*. In 2002, KPN Sales offered the IC to external customers of KPN. In 2001, about 20 ICs were organized and it was expected that the number for 2002 would be roughly the same.

Description and goal of the Innovation Chain.
The Innovation Chain (IC) is a method that uses (four) scenarios in an innovation process. According to one interviewee who facilitated the IC, the goal of the IC is "to bring customers and experts together to think about innovation" (I07, p.1). The IC can be seen as a "process-plan to come from a rough idea to cooperation on a specific topic" (ibid.). The IC consists of five successive steps (DI01; DI02; DE05):

1. *Current situation*: Often the IC starts with a topic or a problem. One interviewee argued that "if business goes well there would be nothing to innovate" (I07, p.1). However, sometimes the IC also looks at how to get more value in the future from existing products, services or telecom infrastructures (such as an intranet). In this first phase of the IC, a tool called 'Business opportunity scan' is sometimes used to signal possible bottlenecks or opportunities. This allows the IC to be more focused from the outset.
2. *Future exploration*: The second step of the IC is exploring the future by using the four scenarios of 'Destination 2005' and by projecting its main topic onto those scenarios. However, before that the organisation at hand or its customers need to be placed in the scenarios. For instance, if an idea is developed about how a company could use its intranet in the future, it first has to project itself (i.e., the company and its employees) into the four scenarios. It is in particular in this second step that a connection is made between the scenarios and the innovation process.
3. *Future vision*: This step can be seen as a wrap-up of the second step. That is to say, after exploring the topic with the support of different scenarios, the information is condensed into a single future vision on the topic. Generally speaking, this involves determining which elements of the information belong to which scenario. In other words, it involves identifying what the main topic and the four scenarios have in common. In a number of cases this step is simplified by just choosing one scenario and working out that scenario in further detail.
4. *ICT-strategy*: The fourth step is to determine a 'road' towards that future. Here, the decision is made which actions need to be taken to realize the future vision.
5. ICT-services: The future vision and strategy are specified in greater detail by identifying new ICT products and services that allow the IC customers to improve the interaction with their customers.

Figure 4.2 illustrates that the IC is a linear, stage-gate type of innovation process. There are three different versions: 1) 'Innovation Day', 2) 'Innovation Enacting', and 3) 'Innovation Empowerment'. Each version is an extension of the former one, both in ambition and in duration. The Innovation Day is the version that is used more often that the other extended versions. Although the IC was originally designed to cover the entire process from idea to innovation, its ambitions were toned down in later descriptions. Interviews with the facilitators indicate that its ambitions were actually never fully realized and that the original set-up is no longer mentioned in its documentation and in the communication with (potential) customers (e.g., I08, p.2; I10, p.3).



An important aspect of the IC is that it involves participants from various backgrounds. A high amount of interactivity with the customer is considered important to its success: "The Customer Innovation Chain offers KPN and its customers the possibility to build up *together* a solid vision on the future, to choose an innovation-strategy, and to define and facilitate the matching pattern of actions" (DI02, p.2).

In addition to the futures researchers of KPN Research, other actors involved in the IC are KPN sales and their customers. The innovators and futures researchers of KPN Research carry out the IC commissioned by KPN Sales (the sales department of KPN). KPN Sales can thus be regarded as a customer of KPN Research. KPN Sales are involved in the IC because it gives them the opportunity to interact with their customers at a strategic level. Some ICs focus on the future needs of major business clients of KPN Sales (for instance in the IC for Robeco Advies) even though the business clients themselves do not take part. Participants do not have to be the actual end-users of a product or service,

they can be *internal* users as well. For instance, at the Robeco Advies-IC the question was how to improve the use of the company's intranet to provide its own employees with better and more up-to-date information. Figure 4.3 shows the various actors involved in the IC.

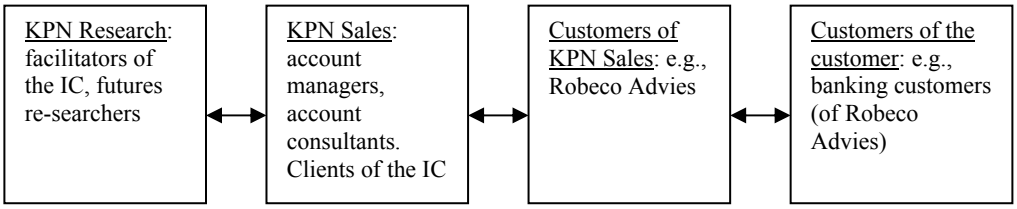


Figure 4.3 The actors involved in the Innovation Chain.

Although the concept of the IC and the scenarios do not change, many IC facilitators state that every IC is and should be custom-made (e.g., I19, p.2; I07, p.2). For every IC an extensive intake interview with the customer is conducted, and almost every IC has a different topic, which means that the content of the presentations and demonstrations can be different. Because the topic and the customer are different, the outcomes of the scenarios are also different. For instance, the Robeco Advies-IC addressed how they could improve the use of the existing intranet. This resulted in a set conclusions and recommendations that was different from those for the ABN Amro-IC, which aimed at discovering possible new ways of using wireless communication within the organisation.

Destination 2005: the project and the scenarios.
An important input to the IC are the corporate scenarios that were designed in the Destination 2005-project. The idea behind this project was to develop scenarios for KPN at a corporate level, as an addition to existing business unit scenarios. In the summer of 1999, at the request of a member of KPN's Board of Directors, two representatives of two business units combined their scenarios into a single set of corporate scenarios, which they presented to business unit directors of KPN, who responded with enthusiasm and commissioned a project to incorporate more business units into these corporate scenarios. After some debate with *Corporate Strategy & Public Affairs* concerning who should be the head contractor of this project, the assignment went to KPN Research. In August 1999, a project team was formed. The scenarios were used many times and for various purposes until the summer of 2002, when KPN Research decided to design new scenarios.

In addition to the idea that the scenarios should have a 'corporate' character, the project assignment stated that the scenarios they should focus on the needs of end-users. Because KPN's (corporate) strategy focused mainly on technology, and lacked vision with regard to customer needs (both consumer and business), the project team decided to come up with

scenarios that had a strong societal character. As it was felt that it was important to visualize the scenarios extensively, they built four 'workspaces of the future' based on the scenarios, as well as an Internet-based *scenario-community*. Many interviewees stated that the workspaces played an important role in the IC (I08, p.1; I10, p.2; I19, p.3; I20, p.2). IC-participants would visit the workspaces, which helped them in thinking about new products and services.

Many interviewees referred to the societal aspects of the scenarios, which made the scenarios not only applicable to KPN's specific business situation, but also to companies in other industries and to non-profit organisations (I05, p.2; I19, p.2). The scenarios allowed all kinds of organisations to place themselves in the scenarios, because they contain general elements that affect every organisation in some way or other. It is only the way societal developments affect consumer behaviour that varies. For example, the trend 'individualisation' has a different outcome depending on whether one is using a financial service or buying flowers.

The scenarios were designed on the basis of four activities:

1) *Interviews*: Fifteen interviews were conducted with KPN's board of directors and with employees from other parts of the company. To prevent the scenarios from focusing too much on telecommunication in general, and on KPN in particular, seven external experts were also interviewed.
2) *Desk research*: Reports about various topics (not only telecommunication) were analyzed. Again, to ensure a broader focus, reports from other companies such as Gartner and Forrester were also taken into account.
3) *Designing the scenario framework*: To determine the most important uncertainties around which the scenarios could be built, the developments and trends that had been identified were ranked by the project-team based on the impact they had on the communication needs of end-users, and by their level of uncertainty. It was decided that trends with the largest impact on the communication needs of end-users, trends with the largest uncertainty, and trends that deal with society, were suitable to be used as scenario-dimensions. This decision was inspired by the emphasis in the assignment on including a social and market-related perspective in the scenarios.
4) *Building scenarios (scenario stories, visualisation and communication)*: After building the scenario framework, the scenario stories were written by an external consultant. The project group decided to give the scenarios names (and abbreviations) that were easy to remember: *Adventure*, *Budget*, *Comfort*, and *Durable*. There were three other ways of communicating and visualizing the scenarios:

    4.1 Scenario-archetypes: for every scenario, a typical day in the life an archetypical married couple was described.

    4.2 Workspaces of the future: four workspaces of the future were built at the KPN Research premises in Leidschendam. For every scenario, it was imagined what the

workspace would be like in that particular future. IC-participants walked through these workspaces to develop a general feel for the scenarios
4.3 Scenario-community: an internet community was built with the goal of enabling anyone, at any time, anywhere, to read, use, and chat about the scenarios.

The corporate scenarios are based upon two scenario-dimensions: 1) individual versus collective, 2) passive versus active. Combining these scenario-dimensions produces four scenarios:

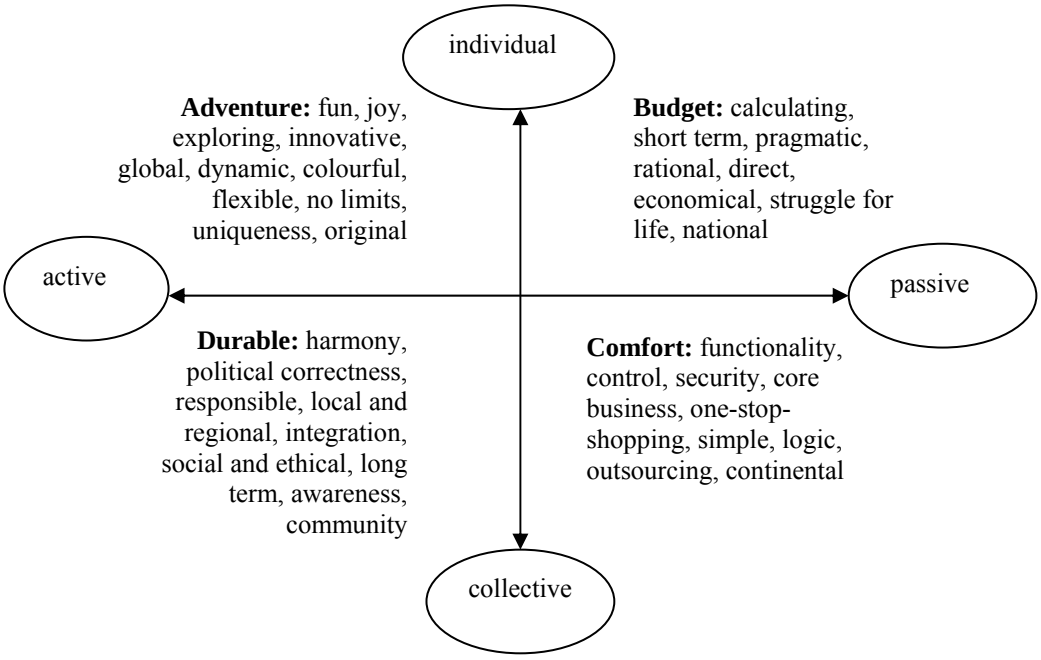


Figure 4.4 The corporate scenarios.

Although the IC has a basic structure (see figure 4.2), every IC is, in principle, custom-made (e.g., I19, p.2; I07, p.2). In other words, every IC customer is considered to be different (e.g., different organisation, different industry). However, the use of the corporate scenarios (originally developed specifically for KPN) shows that scenarios do not necessarily have to be custom-made, despite scenario-guru Arie de Geus' remark that "nothing is as boring as another man's scenarios". From the interviews, especially those

with customers of the IC, it can be concluded that De Geus' remark is not necessarily true. Because the corporate scenarios have a strong societal character and focus on end-users (i.e., consumers), participants are in a position to place their own company and business in the scenarios (I09, p.2; I15, p.2). One of the 'inventors' of the IC said that a major advantage of the scenarios is that it takes little time to explain them to users (I19, p.2). Nevertheless, the interviews show that users do not always find it easy to remember all the names of the scenarios (despite the effort to come up with catchy names), although many find it easy to describe their general character (e.g., I09, p.3; I15, p.3). Supplementing the scenarios with trends aimed at the business sector in which the IC customer operates would make them more custom-made. Some interviewees, especially account managers, said that, in addition to the scenarios being of a general nature, the IC can be used for other types of innovations besides new telecommunication products and services (e.g., I13; I03; I05, p.3). Again, this has to do with the strong focus on societal developments.

4.6 An example of the Innovation Chain

This section describes a case in which the IC was applied to the development of a wireless office (based on: DI01; DI02).

Definition: "A wireless office is a business environment that uses only mobile devices and in which the use of wires and cables has been kept to a minimum".

Step 1: Current situation: the first step includes identifying the company's current strategy, the way it serves its customers, and its general attitude towards ICT. Possible previous experiences (such as pilots) with the wireless office are investigated as well.

Step 2: Exploration of the future: what does the wireless office look like in the four scenarios?

Adventure: the wireless office is completely integrated into the innovative company. Every employee is connected to the broadband wireless office through a modern intelligent mobile device.
Budget: the wireless office is only implemented in those parts of the organisation where it offers measurable added value. For example, the wireless office makes it possible to use mobile workplaces, which means that the organisation needs less office space.
Comfort: the organisation (a full-service provider) makes sure that its loyal customers can access all the information they need through the wireless office. The wireless office is fully integrated with domestic workplaces.

Durable: as the wireless office makes it possible to move around, it will be easier for employees to keep in touch with their colleagues, which will have a positive impact on the social cohesion within the organisation.

Step 3: Future vision: this step has to do with establishing the future vision of the company and determining which concept of the wireless office provides the best match with this vision. Because the future is notoriously difficult to predict, all four scenarios must be taken into account. However, there are some things the various versions of the wireless office have in common. For example, a high reliability or security of information through a wireless connection is considered important in most scenarios.

Adventure: in a very competitive market companies will want to prevent competitors from finding out about their strategic plans.
Budget: certain customer information cannot be allowed to become public.
Comfort: if a company is to maintain a close relationship with its customers, it has to insure that information about these customers does not fall in hands of other organisations.
Durable: in this scenario the protection of privacy, both of customer and of employees, is very important.

Step 4: ICT-strategy: at this stage the changes an organisation needs to make to guarantee the reliability of the wireless office have to be identified. Again, each of the scenarios will present a different outcome.

Adventure: more room and tools for employees themselves to protect their ICT-applications against viruses. Because in this scenario organisations are heavily decentralized and the use of ICT is highly personalised, it makes no sense to impose safety regulations from the top. Employees have sufficient expertise to secure a certain level of safety.
Budget: employees receive instructions about what they are allowed to do with the ICT-applications. Security is managed from above to minimise the risks involved.
Comfort: employees do not have to concern themselves with ICT security. New updates of virus-scan software are implemented almost automatically without alerting employees or customers. The company goes to great lengths to ensure ICT security is handled professionally.
Durable: in close contact with employees agreements are made about how to cope with the security of customer and employee information. Possible mistakes are dealt with in a confidential manner and the company favours highly certified security products and services.

Step 5: ICT-products and –services: to make the wireless office more concrete new ICT products and services must be generated. Below a few examples per scenario are described:

Adventure: a do-it-yourself virus-scan with which each employee can determine the security levels in general and designate areas that require specific protection. In today's high-speed digital world it is important that new releases are available quickly.
Budget: a firewall that uses the same protection levels for the entire organisation and that offers sufficient protection. Areas that are costly to protect are disconnected from the wireless office.
Comfort: a full security package including firewalls, virus scanners, etc. that offer high security levels, with maintenance and operationed outsourced to a permanent ICT supplier.
Durable: products and services that should protect the wireless office are chosen in accordance with rules of conduct with regard to the use of the wireless office. The company not only believes in 'technology fix', but emphasizes the moral aspects of the use of ICT applications as well.

4.7 Case conclusions

1. The place of the corporate scenarios in the IC.
The corporate scenarios are predominantly used in the second step of the IC; the stage in which the future of a certain topic or problem is explored ('future exploration'). The scenarios' main function is to encourage people to think about the future and to come up with new ideas for innovation (DE05, p.1). The scenarios are not used to assess the value of certain ideas for innovation, although on a few occasions a telecommunication network or (software) platform (such as an intranet or a wireless LAN) was used as the starting point for the session. In those cases the scenarios were used to explore how a product or platform could be used in the future and to identify possible additional services.

However, some interviewees argued that it was not enough merely to think about possible new ideas by using scenarios (I05, p.3; I07, p.3). They indicated that the scenarios ought to be supplemented by trends that occur in the business sector of the customer involved (I05, p.3). This would allow the IC to focus specifically on the problems and practices of its customers, which would extend the use of the outcomes of the IC. A few interviewees argued that paying attention to the customers specific business context can play an important role in the follow-up stage, that is to say, in the latter steps of the IC (such as ICT strategy and ICT services) (e.g., I10, p.2). Other interviewees pointed out, on the other hand, that this approach may well affect the inspiring character of the scenarios, since trends are much more predictive than scenarios and cannot include the variety of elements that make the scenarios such a valuable tool.

2. The quality of the IC.

Futures research at KPN Research is conducted quite extensively and professionally, and the IC is generally seen in a positive light. Many interviewees involved in the IC, whether as facilitators or customers, are very pleased with the method and its execution during the so-called *Innovation Chain Days* (I10, p.3; I09, p.3; I15, p.3; I16, p.2; I17, p.1). Generally speaking, the evaluation forms of ICs with NOB, ABN Amro, Schiphol Telematics, Elsevier, Postbank, and De Staatsloterij were quite positive (DI17). Also, KPN account managers consider the IC very valuable, which is proven by the fact that they have put the IC in their product portfolio (I05, p.3; I09, p.2; I15, p.2). They all see it as a tool that adds value to the existing telecom products and services (ibid.). They all say that the scenarios play an important role in the IC because it enables KPN as well as its customers to think about new ideas for innovation from a market and future perspective.

However, given that futures research and innovation are two sides of the same coin, this does not automatically mean that the futures researchers and innovators are closely cooperating at KPN Research. FS is not involved in the trend-analysis which was carried out for the innovation *strategy* of KPN Research for 2002. Some interviewees found it odd that a method (i.e., the IC) that is used to advise their customers should not be used for internal purposes (I02, p.5; I07, p.4; I11, p.5; I18, p.4; I19, p.4).

Different explanations have been offered for not using the IC for the innovation strategy of KPN Research itself. Some interviewees, specifically those responsible for or involved in innovation strategy, said that they know too little about the IC and that it did not cross their minds when they were carrying out the trend-analysis (e.g., I02, p.5; I06, p.2). One interviewee said that that KPN Research has many *experts* on all kinds of subjects, and that being an expert automatically means that you are also able to form an opinion about the future of your own expertise. He said that he did not need the (specific) expertise of FS for that (I02, p.5).

The fact that those responsible for the innovation strategy are not using the expertise of FS deserves further attention. In their report 'The world of futures studies according to KPN Research' (DI6), FS employees characterizes themselves as *future process experts*, that is, people who are capable of applying methods of futures research. The innovators (or experts) of KPN Research can be regarded as *future content experts*, that is, people who know a lot about (possible) future developments but who are much less familiar with methods of futures research. One interviewee said that he was prepared to conduct an experiment applying the IC to the innovation strategy of KPN Research (I07, p.4.). Another interviewee said that he regretted not using the expertise of Future Scanning (I04, p.4), and that next time he would definitely use their expertise because he had encountered some problems during the process of spotting and analysing trends that he found difficult to solve. FS expertise may indeed be of value, since the trend-analysis has several shortcomings:

- Many scope elements of the trend-analysis have not been not defined. For instance, no time horizon is set, no specific definition of a trend is given, and there is no indication as to the probability of the trends (e.g., DE20, pp.7-10). A disadvantage of not (properly) defining the scope elements is that it becomes difficult for those carrying out the trend analysis to decide which trend to include and which not.
- Some people responsible for or involved in the innovation strategy of KPN Research said that an important aspect of the innovation projects is the fact that they are multi-disciplinary (e.g., I02, p.3). However, the trends that were identified are of a predominantly technical nature and only a small portion of them is aimed at market developments. No societal trends are spotted. In other words, the trend-analysis can be described as a *technology forecast* rather than a trend-analysis that covers a wider range of topics.
- The trend-analysis is not used as an input for the innovation strategy. Also, it is not checked whether ongoing or finished projects were addressing (or had addressed) the trends from the trend-analysis (I12, p.3). However, during the group discussion, a participant said that the innovation strategy of KPN Research is not meant as a filter by which it can be decided which project to do and which not, but as a means for testing if the projects are still in line with the innovation strategy (G, p.1). Thereby bearing in mind that it would not be a problem if a certain amount of projects are not captured by the innovation strategy, he added (ibid.).

3. The impact of the IC on innovation.

Many interviewees said that the IC has resulted in several *ideas* or *plans* for innovation, but that as yet it has not resulted in any specific innovation (e.g., I07, p.2; I10, p.3). They also said that the IC and the scenarios have a positive effect on other current innovation projects in which KPN and its customers participated (e.g., I13, p.2; I14, p.1; I10, p.2). An account manager of KPN Corporate Sales for Robeco confirmed this and said that he landed an order from another project because the customer told him that the IC and the scenarios convinced him that KPN was the suitable partner for his company (I09, p.3; I15, p.3). Knowing this story, an innovator at KPN Research involved with the IC, argued that KPN Research (as facilitator and 'owner' of the IC-method) should receive a certain percentage of the turnover attributable to that customer (I19, p.3). So, although the IC does not result in any specific innovations, it does have a positive influence on some of the innovation projects of KPN and its customers.

To conclude, the IC of KPN Research is an interactive method that specifically takes the future (communication) needs of customers of KPN as the starting point of a (linear) innovation process. Although the method is greatly appreciated by a majority of IC customers, the account managers of KPN Sales, and the facilitators of the IC, the results are sometimes disappointing because there is often no follow-up of the IC. One approach to solving that may be to be more critical as to what customers are to be considered suitable

candidates for an IC. This approach would involve selecting only those companies that are genuinely looking for new ideas on innovation and that are able to send employees who are in a position to make the decisions that need to be made. In addition, using more specific industry trends next to the broader societal scenarios would ensure that the IC appealed to its customers, which in turn would increase the chance of a follow-up in which ideas could be worked out to actual innovations. It would also make it much easier to promote the IC if KPN Research were to decide to use it to formulate its own innovation strategy. It could serve as a showcase that could convince potential customers of the IC. After all, why not practice what you preach?

CHAPTER 5 – THE 'TOEKOMSTWIJZER' OF SYNTENS NEW TECHNOLOGIES

In this chapter we describe and analyze the 'ToekomstWijzer' (TW) of Syntens New Technologies (Syntens NT). Syntens NT's method is mainly used for and together with Dutch SMEs. The main output of the TW, which is based on an expert-meeting, is a list of new ideas for innovation. The TW is carried out at various levels: at national and regional as well as at industry and company level. The TW is an interactive method and participants are constantly reviewing each other's ideas.

5.1 Structure of the case study

This case study was carried out in three phases:
1. Interviews and the collection of relevant internal and external documents.
Interviews: a total of 28 people were interviewed, of which 21 face-to-face. Three interviews were with employees from Syntens New Technologies, seven with advisors of Syntens, five with SMEs, two with people from the advisory board of Syntens, two with employees of the Ministry of Economic Affairs, and, finally, two with innovation experts from SMEs. The average interview lasted one hour. All interviewees gave us permission to tape the interview. The interviews were transcribed and sent to the interviewee for feedback (seven interviewees responded). The interviews took place in December 2002 and January 2003. Seven other people answered a short questionnaire by e-mail. All the people we interviewed had attended TW-meetings.
Documents: internal (e.g., reports of and scripts for 'ToekomstWijzer'-meetings) and external publications (e.g., reports from Statistics Netherlands, EIM (an organisation focused on studying the economic aspects of SMEs)).
2. An analysis of the documents and interviews using the case analysis framework (see Chapter 1, section 1.2 for a description of this framework).
3. A group discussion in which the conclusions of the case study were presented. The discussion lasted two hours and was held at Syntens NT on March 13, 2003. It was attended by twelve people; two from Syntens NT and ten from Syntens. Minutes were made of this meeting.
In this chapter we use the following references:

- Personal interviews: (I_number)
- E-mail questionnaire: (E_number)
- Documents:
    - Internal: (DI_number)
    - External: (DE_number)
- Minutes of the group discussion (G)

The references of this case study are listed in Appendix 3.

5.2 Background of Syntens & Syntens New Technologies

Syntens.
Syntens is an independently operating foundation subsidised by the Dutch Ministry of Economic Affairs. It was established in 1998 under the name 'Syntens, innovation network for entrepreneurs' (its former name was 'Innovatiecentra'). Its mission is to stimulate and promote innovation among Dutch small and medium-sized enterprises (SMEs[15]), because the level of innovation among this large set of companies (SMEs constitute 99% of all Dutch companies) is considered too low. The Ministry of Economic Affairs regards Syntens an important policy instrument. In 2002, Syntens employed 450 people divided among 15 Dutch regions, with headquarters in The Hague. Figure 5.1 illustrates the organisational structure of Syntens.

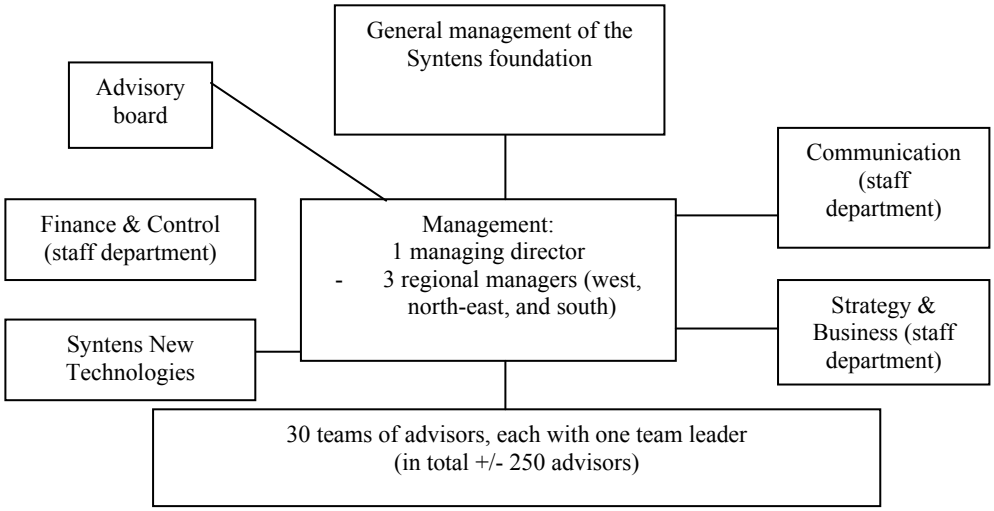


Figure 5.1 The organisational structure of Syntens in 2002.

[15] There are various definitions of SMEs in terms of company sise measured by the number of employees. Syntens defines SMEs as companies that employ between 1 and 200 people (DE10, p.7). Small enterprises employ between 1 and 50 employees and medium-sized enterprises between 50 and 200 people.

Syntens has expertise in the field of innovation and knowledge transfer between SMEs, and provides specialised advice to entrepreneurs. Their areas of expertise are:

- Information & Communication Technology
- Product & Process Development
- Human Resources & Organisation
- Cooperation
- Marketing & Strategy
- 'New Entrepreneurship'

Its advice often transcends these areas of expertise. If questions or problems from SMEs have a more specific character, Syntens refers them to other external parties, such as universities, consulting companies, and research institutes, who may be in a better position to address them. Syntens does not limit itself to one economic sector or one element of innovation. Syntens has been positioned as an intermediary in the concept of the 'Dynamic Innovation System' (DIS) of the Ministry of Economic Affairs. Other actors and factors in the DIS are: research and education organisations, large companies, SMEs, and technostarters, consumers and producers, infrastructure (e.g., intellectual property rights, standards, venture capital), and external conditions (e.g., entrepreneurial spirit, mobility of labor).[16]

Syntens New Technologies

Syntens New Technologies (Syntens NT) is a staff department of Syntens and was founded in 1999 to develop methods and tools to help SMEs assess future developments to explore possible new ideas for innovation. Its main tasks are (DE10, p.6):

- Trendspotting and trend-analysis;
- Organising and facilitating internal knowledge management;
- Developing new (national) projects.

Syntens NT is the originator of the 'ToekomstWijzer' (TW), an interactive method aimed at SMEs in which future trends are identified and analyzed, and subsequently used as a source of inspiration for innovation.

Syntens NT is located in Veenendaal. It consists of five fulltime and twelve partime employees who are delegated from various Syntens departments. Syntens NT serve SMEs as well as internal advisors of its mother company to apply their tools and methods to advise SMEs. Each area of expertise is covered by two 'knowledge explorers' whose task it is to monitor relevant (future) developments in their area.

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[16] More about DIS: Ministry of Economic Affairs (2002). *Benchmarken om te groeien*. The Hague (DE17). On innovation systems in general, see: Edquist, C. et al. (1997). *Systems of innovation, technologies, institutions and organisations*. London: Pinter (DE19). On the specific role of SMEs in national innovation systems, see: Lankhuizen, M. & R. Klein Woolthuis (2003). *The national system of innovation approach and innovation by SMEs*. Zoetermeer: EIM (DE18).

At the beginning of 2004 it was decided to dismantle Syntens NT. Some of its employees went back to their former job as advisor at Syntens, others left the organization. The responsibility for organising and carrying out the TW was handled over to the Strategy & Business Planning department at the main office of Syntens in The Hague.

5.3 Innovation and innovation processes at SMEs

The TW is used by Syntens NT to develop new ideas for innovation that can be used by Dutch SMEs in their innovation process.

Innovation.
It is extremely difficult to comment on the level of innovativess of SMEs, due to their extreme diversity and large number (99% of all Dutch companies are SMEs) (DE26, p.3), in spite of the large amount of studies devoted to this issue (e.g., DE02; DE04; DE05; DE12; DE13). Furthermore, the impact of definitions on the outcomes of these studies, their rather quantitative nature, and the limitations of the samples (considering the large amount of SMEs) do not provide us with a clearer view either. For instance, if the definition of innovation includes more than new technology, the percentage of innovative SMEs rises from 25% tot 70% (I21, p.1). Also, most studies attempt to produce very precise measurements of the behaviour of SMEs with regard to innovation, which is quite an impossible task, given the diversity mentioned above (in terms of, for example, the number of employees, the nature of the industries, geographical location, and the position in the value chain).

Classyfing SMEs is not easy either. In 2000, the EIM conducted a survey among 3,000 SMEs based on the taxonomy of Pavitt (DE24). SMEs were categorised in four groups (DE04, p.34):

1. Output-oriented companies (14%), that, among other things, employ highly educated personnel, have incorporated innovation into their strategy and owe a large part of their turnover to new products/services.
2. Allround companies (19%), that are characterised by a high use of subsidies and a dynamic organisational structure, and that own many patents.
3. Process-oriented companies (33%), that are characterised by a low level of innovative activities, have below average innovation outputs, and that engage in a variety of different innovative activities.
4. Companies that lag behind (34%), characterised by below average scores on almost every indicator and the lowest level of automation, and that hardly innovate at all.

A major problem with this categorisation is that a company may fall into more than one category, which somewhat defeats the purpose of a categorisation. For example, an SME

may employ highly educated people (group 1) and produce process innovations (group 3) at the same time.

The only general remark one can make in this respect is that the innovativeness of SMEs should definitely not be overestimated. The existence and work of an organization as Syntens, whose mission is to make SMEs more aware of the importance of innovation and to support SMEs in their innovative activities, is an indication of that.

Innovation processes.
Most SMEs have a very formal and unsystematic approach to innovation (e.g., I08; I06, p.8). Many SMEs, especially the smaller ones, have neither a (formal) innovation process nor a person or a department responsible for innovation (I11, p.1). The medium-sized companies tend to organise their innovation processes on a more formal basis. The general manager of one SME (when interviewed for the TNO Industry case: Chapter 7, Appendix 5, I10, p.3) argued that when SMEs need to adopt a more formal approach to innovation in cases where they received financial backing from government. Furthermore, a study conducted by the EIM (DE05, p.14) shows that 75% of all SMEs do not have a formal innovation strategy. SMEs often use the term 'product development' instead of innovation, although for them it has the same meaning (I06, p.1). The general belief at Syntens, that making innovation processes at SMEs more formal will enhance their innovativeness, is confirmed by Scozzi, Garavelli & Crowston (DE20; see also DE23) who look more specifically at the use of business modeling techniques in innovation processes.

To conclude, SMEs are a very diverse set of companies when it comes to innovation. For example, small firms mainly receive national subsidies for innovation, whereas medium-sised firms mainly receive European subsidies (DE04, pp.55-56). More specifically with regard to to looking to the future, one interviewee said that medium-sized firms look more to the future than small firms (I8, p.8). However, generally speaking, the innovation processes of SMEs have a informal nature and they are less innovative than large firms.

5.4 Futures research at Syntens NT

Syntens NT has put much effort into finding effective methods of futures research. In 2001 they visited many organisations (commercial and governmental) in Germany to learn how they were conducting futures research. (DI10). These visits proved an important inspiration for their activities in general, and for the development of the TW in particular (I08; I11).
With regard to the TW, they drew two conclusions (DI10):

1. Choosing the right level of detail when studying trends is very difficult. The TW addresses this issue (p.5).

2. Experts that are invited should have a broad vision and should not focus exclusively on the interests of the organisation they represent (p.6).

Cooperating with other institutes of futures research (e.g., Rathenau Institute, an independent Dutch organisation involved with technology assessment) is also a prominent task of Syntens NT (DI22, p.9). In 2003, it was involved in assessing studies by Booz, Allen & Hamilton carried out for the Ministry of Economic Affairs (I08; I12). There are also regular contacts between the Ministry and Syntens NT about the exchange of trend information (I08).[17]

In almost every office of Syntens there is (at least) one 'kennisverkenner'('knowledge-explorer') whose task and responsibility it is to spot and analyze new developments in one of Syntens' six areas of expertise. So, the futures researchers of Syntens NT focus on renewing and improving the *methodological* side of the TW, while the 'knowledge-explorers' update the *content* of futures research, that is to say, trends in specific areas of expertise.

Futures research at Syntens NT is carried out for and with SMEs which, from a futures research point of view constitute a rather special set of companies. Many large companies (e.g., KPN, Shell, DaimlerChrysler, Philips) are conducting futures research and have dedicated departments with futures researchers. Most of the SMEs Syntens works with, however, lack the financial and personnel resources to dedicate staff to carrying out futures research (I12, p.1). However, the fact that many of them do not adopt a systematic approach to futures research, does not mean that they do not look to the future at all. Interviewees from SMEs often talk about 'dreaming about where their company would be in the future', 'constantly looking for new things' or 'spotting new technologies' that could serve as input for new products and services (e.g., I07, p.12). SMEs look to the future in an implicit and informal way. They try to anticipate possible future developments and to asses how these developments could be a threat or an opportunity to their business. Because many SMEs equate looking to the future with predicting the future (which they consider to be impossible), they are somewhat reluctant (I07, p.7). The informal attitude among many SMEs makes it necessary for the futures researchers of Syntens NT to explain what looking to the future actually involves (i.e., more than just predicting it) and how it may benefit smaller companies. The TW turns looking to the future from an implicit activity into an explicit one. The systematic character of the TW is not always in line with the informal approach many SMEs adopt with regard to looking to the future and 'managing' innovation (see section 5.3). From the interviews it becomes clear that there is sometimes a fear that adopting a more systematic approach may take more time, which would be unwelcome in light of the speed with which developments take place in most industries (I07, p.11).

[17] Although one interviewee from the Ministry of Economic Affairs argued that the interaction between Syntens and his organization should be more intense (I02, p.1).

When asked how much effort SMEs generally put into looking to the future (and what the timespan is) and innovation, interviewees indicated that that depended on the economic climate (e.g., I19, p.4). Some argued that in bad economic times SMEs have to focus on solving the financial and economic problems at hand, which means that they have less time to pay attention to future developments (e.g., I16, p.3). Others argued that, when times are bad, SMEs focus more on future developments and innovation, realising that they need to look ahead and start up new business activities if they are to have any chance of surviving (e.g., I14, p.1). Conversely, when times are better, they are too busy taking care of their operational activities to look to the future and innovate (I19, p.4). In other words, as far as SMEs are concerned the relationship between innovative behaviour and the economic climate is a fairly ambiguous one. Research conducted by the EIM (DE21) indicates that large companies are more active in adjusting their strategy and business activities based on the economic climate than SMEs. A reason for this may be that the strategic skills of SMEs less well-developed that those of large companies (DE22).

5.5 The 'ToekomstWijzer'

Short history of the TW.

Syntens NT was established in the summer of 1999. Its manager Rene Hartman was asked by the management of Syntens to write a strategic plan for the future activities of Syntens NT. His first idea was to bring together different experts to build visions of the future (I08, p.2; see also DI10, p.6). Hartman was inspired by large Delphi-projects[18] in Germany and Japan in the 1990s, by studies of large companies about the future of computers, and by his educational background as an industrial designer. Hartman: "...as a product developer you just have to be focused on the future" (I8, p.2). Also, Hartman had worked in similar projects before.

The actual development of the ToekomstWijzer (TW) started in March 2000, but its initial names were different: 'Princess Day' and 'Veenendaal's Delphi method' (DI22, p.3). The development of the TW can be characterised as a trial-and-error process. For

[18] A Delphi-study is an expert-meeting that often consists of two phases. In the first phase, experts are consulted individually about a certain topic or problem. In the second phase, the results of the first phase are distributed among the experts, giving them the opportunity to revise their position. Subsequently, an overall opinion can be established. For a detailed description of the Delphi-method: Linstone, H.A. & M. Turoff (1975). *Delphi method: techniques and applications*. Reading: Addison-Wesley (DE27). For an overview and evaluation of Delphi studies in Japan: Cuhls, K. (2001). *Foresight With Delphi Surveys in Japan*. Technology Analysis & Strategic Management, Vol.13, No. 4, pp.555-569 (DE28).

instance, although the input of the first national TW was collected by experts who discussed and brainstormed in so-called 'e-groups' (an Internet community), the facilitators at Syntens NT decided to collect the input for the second national-TW themselves (I08, p.7). Also, the abundance of post-its and handwritten ideas for innovations which were stapled together in an apparently haphazard way made the early versions of the TW look slightly less than professional. To improve the game it was often played with the knowledge-explorers, which made it possible to test the game in a semi-controlled environment where mistakes and adjustments could be made.

The originators of the TW at Syntens NT emphasized that it was important for Syntens management to give their support in the first stage of the development (I08, p.3). The general manager of Syntens even participated in the first national-TW. And after the first meeting in the fall of 2000, when the budget of Syntens for 2001 had already been determined, management agreed on providing additional funds for further developmentof the TW. Other support came from a report written by Pieter Hovens of Syntens Limburg (ibid., p.7).

The methodology of the TW.

The approach of the TW can be characterised as an expert meeting that uses the interactivity between people with different backgrounds to investigate the consequences of future trends (e.g., socio-economic, technological) with regard to innovation. The people who developed the TW and who are responsible for its exploitation consistently refer to it as a 'game'. And although the TW is not a game in the sense that participants compete with each other, the idea is to to emphasise the fun element of the TW by characterising it as such. Many interviewees say that the TW is also designed to serve as a tool for 'networking' (I05, p.2; E03, p.1; I08, p.2), i.e., bringing together SMEs (and experts) to facilitate contacts between them (one interviewee even interpreted that as a kind of 'hidden agenda' (I15, p.1)). Furthermore, a special version of the TW has been developed for that purpose.

However, interviewees often define the TW differently. Some refer to it as a method designed to help SMEs (and other participants) communicate in a loose and almost informal way (E06, p.1). Others view it as a sort of Delphi-meeting (I15, p.1) or as a method that combines brainstorming and brainwriting (E07, p.1; DE10, p.13; I06, p.5).

Notwithstanding these different interpretations, it has a basic structure consisting of two rounds (DE10, pp.14-15):

Round 1:

1. Participants are divided into groups consisting of (on average) 10 persons (all grouped around a table), who are then divided into couples.
2. On each table a board is placed with five topics. Each topic contains a set of trends or propositions.
3. Each couple discusses the consequences of a (given) trend or proposition for a few minutes. After that the boards rotates, giving each couple the chance to discuss a new set of trends. This way, people can be inspired by and elaborate on what others have written earlier.
4. After all trends have been discussed, the couples select the most relevant ones.

Round 2:

1. Discussion within the whole group about the selection of trends and the possible consequences.
2. Discussion on the innovation opportunities that are associated with these trends and on what the consequences are.

There are different versions of the TW depending on the following factors:

1. A decision can be made to play either one or two rounds (depending on the time available).
2. Input: discussing about trends, propositions, themes, or scenarios.
3. The desired output: e.g., deciding at which time a future trend becomes important, what the most relevant trends are, or how to cope with certain trends.
4. The extent to which participants could contribute their own trends to the TW.

The TW is presented and structured by facilitators who are assisted by employees of Syntens. Often the facilitators work at Syntens or Syntens NT, and sometimes they are brought in from outside. In addition to focusing on SMEs, Syntens NT tries to 'sell' the TW to other regional departments of Syntens. This means that Syntens advisors need to be convinced to offer the TW to their clients, i.e., the SMEs they serve. It also means that in a number of cases Syntens NT communicates directly with SMEs concerning the TW, whereas in other cases the (regional) advisors of Syntens do the honours. Also, external experts are invited to TW meetings to participate. They are contacted by Syntens and Syntens NT. Figure 5.2 shows the various actors and their relationships.

Although the TW is carried out with employees from SMEs, participants of the TW-meetings often discuss trends that have been formulated in previous TW-meetings. In regional-, sectoral- or company-TWs, the trends that have emerged in national-TWs are often used (DE10, p.21), and adapted to the TW in question, for instance by taking into account the sector in which an SME operates or the specific question that the TW is intended to address. Often, the list of trends that are used in a TW is a combination of trends from the *national*-TW and 'new' trends that are suggested by advisors from Syntens, Syntens NT, and employees from SMEs.

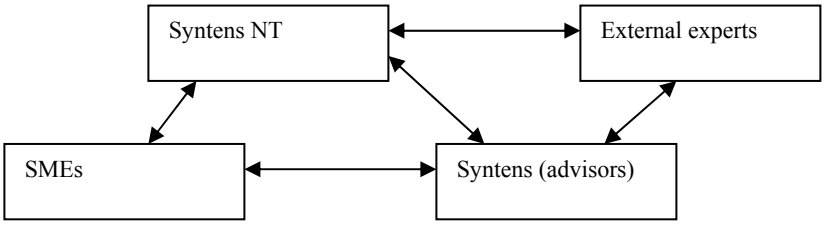

Figure 5.2 Actors involved in the TW.

In some cases, TW participants have sufficient time *during* a TW to suggest their own trends. In 2001, during the second national-TW, a few participants came up with their own trends and tried to assess what the consequences of these trends were with regard to innovation. In cases where SMEs do not have the opportunity to add their own trends but are asked to accept predefined trends the reaction of participants is not necessarily one of 'not-invented-here'. In general, participants accept the trends they have to work with (I08). If the proposition is not describing a possible development but a definite statement, a discussion may arise about whether the proposition is true or not (E11, p.2).

Levels of scope of the TW.

In addition to the various possible versions, the TW has five different levels of scope:

1. *national*-TW: often carried out with visionaries, employees from large companies and government organisations, and with a small group of SMEs.
2. *Regional*-TW: carried out with SMEs from a specific region (e.g., the province of Limburg) and attended by SMEs from that region and by employees from regional government organisations and less by well-known visionaries.
3. *Sectoral*-TW: carried out with and for SMEs operating in the same sector (e.g., the foodsector) and often attended by representatives from regional government and business organisations.
4. *Company*-TW: carried out specifically for and with a company and attended by partners of that company as well.
5. *Acquintance*-TW: carried out only to bring together SMEs and employees from other organisations to get to know each other.

The different types of TWs sometimes overlap. For instance, at a TW organised for RijkZwaan, a food company from De Lier, participants from other companies that were active in the same sector were also invited (DE08). And at a TW at the office of the Chamber of Commerce in Rotterdam, only SMEs from the foodsector located in the region

of Rotterdam were present (DI21). Also, the national-TW of 2002 used different sectors to structure the discusion about the scenarios and the possible consequences for innovation with regard to SMEs (DI04).

Link of the TW with other tools.
Often, the TW is combined with one or both of the following tools.
1. The AIDA-model
The TW is occasionally supplemented by the AIDA-model[19], an acronym for: Awareness (or: Attention), Interest, Desire, and Action. Syntens NT uses this model as a description of the phases an SME goes through before starting an innovation process. Firstly, the SME becomes aware of the importance of innovation. Then, the SME develops an interest in which innovation to produce. Next, the SME becomed truly convinced that it has to carry out that action, and finally, the SME has to take (further) action to realise the innovation. Figure 5.3 illustrates that the TW provides input to the Awareness-phase of AIDA.

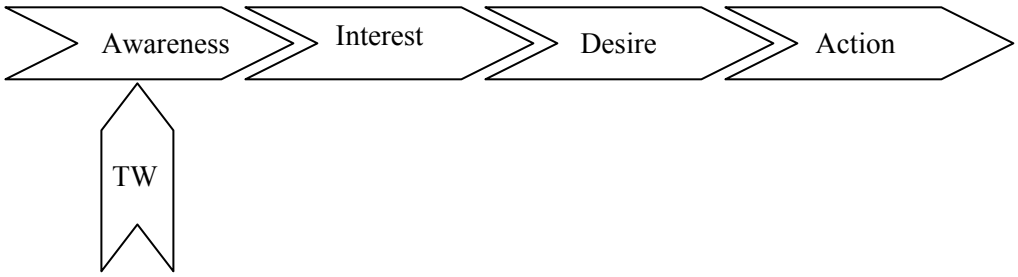

Figure 5.3 The TW connected to the AIDA-model.

The TW creates awareness about the importance of innovation and looking to the future, and provides ideas for possible innovations ("becoming inspired") (I12, p.2)).

The AIDA-model was originally not designed to describe the innovation process of a company. On the contrary, it is an example of a (classic) hierarchical advertisement model that aims at describing the buying behaviour of consumers (DE09, p.433), and is based on three psychological approaches: cognition, affection, and conation. It is, therefore, very doubtful whether the AIDA-model is suitable for describing the innovation process of an SME. There is a great difference between SMEs and consumers, and an innovation process (i.e., *developing* an innovation) is essentially different from a buying process (i.e., *buying* an innovation), involving as it does different motives and different actors. It would make

[19] The AIDA-model was originated by the psychologist K. Strong in 1925.

sense to opt in favour of a model that is designed specificially to describe the innovation processes of SMEs.

2. The TOM-model.
TOM is an acronym for Technology Organisation and Market, based on a model called TAO (Technology Application and Organization[20]) (I12, p.1). The model is based on the idea that, to develop a successful innovation these three elements need to be addressed in the innovation process. This is especially relevant with regard to for SMEs, because they often tend to focus on the technological approach to innovation. For the TW this means that participants are asked to assess what impact future trends, propositions, or scenarios may have on a possible innovation. The TOM-model helps participants structure their ideas for innovation.

3. The 'AntenneWijzer'.
The 'AntenneWijzer' (AW) is a method aimed at collecting and analyzing questions from SMEs at Syntens. By doing this, problems, needs and other issues at SMEs can be spotted (DI01, p.1; DI02, p.5; I16, p.3) at Syntens. By matching the 'inside' information of the AW with the 'external' information of the TW, new trends can be spotted at an earlier stage, which may enable the TW to address the needs of SMEs more effectively, a link that has thus far rarely been established (I12, p.1). A difference between the AW and the TW is that the AW looks at the past and the TW looks to the future (DI01, p.2).

A few facts and figures of the TW.[21]
Between 1999 and 2003, a total of 71 TWs took place involving about 2000 SMEs. Table 5.1 shows the various types of TWs per year.

Table 5.1: Different types of TWs in the period 2000 - 2003.

	2000-2001	2001-2002	2002-2003
national	1	1	1
regional	4	5	12
sectoral	8	6	8
company	2	2	7
acquaintance	5	1	8
total	20	15	36

[20] The TAO-model was invented by Jan Voûte (DE25).
[21] This sub-section is mainly based on DE10.

Table 5.1 shows a large growth in the number of TWs although in the period 2001-2002 there was a small decrease. In particular the regional and company-TW were organised more often.

The TWs took place in different regions of the Netherlands. Figure 5.4 shows the total number of TWs per region in the period 2000-2003[22]:

Figure 5.4 The geographical distribution of the TW.

Most TWs took place in the provinces of Limburg, Noord-Brabant, and Gelderland and much fewer in the northern provinces of the Netherlands. An important reason why so many TWs took place in the Limburg and Noord-Brabant is that the Syntens-advisors (e.g., Noud Bakels, Pieter Hovens, and Jeroen Thoolen) in that region were very active in promoting the TW among SMEs (DE09, p.22).

[22] Excluding the three national TWs and a few (informal) TWs that were carried out for special groups.

5.6 An example of a 'ToekomstWijzer'

This section describes the fourth meeting of the national-TW held in November 2004 (based on: DI06). The fourth national-TW was held on November 11, 2004 in Maarssen. The meeting lasted four hours and was attended by over 100 persons: employees from SMEs, experts, government officials, scientists, and so on. All employees were divided among eleven tables, each table representing a different industry. The industries were: agriculture, medical technology and caring, supplying industry, food, building, ICT, transport and logistics, knowledge-intensive services, consumer products, business-to-business, and general services.

The meeting started with three presentations. The first presentation was given by Herman Hovestad, general manager of Syntens. He welcomed all participants, emphasised the importance of the TW for both SMEs and Syntens, as well as the importance of innovation for the success of individual SMEs and for the Dutch economy as a whole. The second presentation was given by Dr Frank Ruff, a futures researcher at DaimlerChrysler in Berlin (see also Chapter 6). In his presentation he showed how DaimlerChrysler uses futures research in the development of new automobiles and other types of vehicles. He also described some future developents that were considered to be important by DaimlerChrysler. The third presentation was given by Vera Philippens, one of the organisers and facilitators of the TW. She explained the goal and agenda of the meeting, and presented an overview of five future developments ('forces') based on the STEEP-method: society, technology, ecology, economy and politics. The five forces were:

1. Societal forces, like the ageing population and the growing need of people to have intense experiences.
2. Technological forces, such as the increasing use of GPS (Global Positioning System).
3. ecological forces, such as the deterioration of the environment which urges society to take new measures.
4. Economic forces, such as the increase in cross-industrial cooperation.
5. Political forces, such as the 'war' between national governments and global terrorism.

In round one the various couples discussed the possible impact of each of these five forces on a specific industry. For instance, at the agriculture table niche products like small tomatoes and 'winter-strawberries' were considered important for the future. And at the food-table someone spoke about 'designer food', food made specifically for an individual who can track down 'his' food in the supermarket by using a ID-device placed on his wrist. After the discussions, each participant could write down the three ideas he or she considered the most promising.

In round two the three ideas that had the highest overall score were discussed further. This was done by placing them in a technological, organizational and market-related perspective (TOM, see section 5.5). Within each element of TOM a company must have a clear idea what the tips and obstacles are in further developing an innovative idea. For

instance, at the agriculture table one of the top-three ideas was 'robotization in the hothouse industry'. A tip was to communicate to the customer the special freshness that is made possible through the faster production due to robotisation. An obstacle could be not to make the robotised production process modular because that could prevent handling different crops.

The participants wrote small newspaper items about all of the ideas, tips and obstacles. Cartoonists visualised the ideas on large A-0 boards that could be viewed during the after-meeting drink. After one month all participants received a newspaper which contained a short summary of the meeting, the items that were discussed and the cartoons. After three months they received a more formal report that contained a broader summary of the meeting and the ideas that were generated as well as a response to those ideas by experts from each of the eleven industries.

5.7 Case conclusions

1. The place of the TW in the innovation processes of SMEs.
The TW is often used in the first phases of the innovation process for which Syntens NT uses the AIDA-model (see section 5.5). In other words, the TW is used for the *awareness* phase, which is the first phase of the innovation process according to the AIDA-model. Syntens NT employees consider the results of the TW to be too abstract to use after the awareness phase, when more specific information is needed (I12, p.2). The closer the process approached the action phase (the final phase in AIDA) the less the TW is used. To enhance the impact of the TW on the innovation processes of SMEs, its results should be more specific so that it can be used in the interest, desire, and action phases as well.

2. The quality of the TW.
Participants of the TW: The level and background of the participants are considered important factors with regard to the quality of the input to the TW, the level of satisfaction of the participants, and the quality of the output (E05, p.1). Experts from various fields participate in the TW. Although the *national* TWs are mainly visited by people with a vision, their expertise is not always directly aimed at the business of SMEs (I08, p.6). This may be one of the reasons why many participants think the results of the national-TW are too vague, and can therefore not be applied directly to SMEs and their business (E02, p.1; E04, p.1). One director of a company for which a *company*-TW was organised, was disappointed by the low level of expertise among his fellow participants. He felt that their level of expertise made it impossible to have a valuable discussion (I19, p.5).

A 'rule' of the TW is that at every table there should be participants with diverse backgrounds, to increase the likelihood of generating creative new ideas for innovation (E05, p.1). However, due to this diversity not all the participants will be experts in the

particular field that is being discussed at their table (E01, p.1). As a result, sometimes this proves to be a disappointment for the people that were experts in that particular field, who felt that there was little they could learn from the generalists at their table; often they would leave the TW feeling that all they had done was provide input to the discussions, without reaping any of the supposed benefits.

Facilitators of the TW: Not surprisingly, the quality of facilitators has a major impact on the quality of a TW-meeting as well (E05, p.1). One attendant of the RijkZwaan-TW was disappointed by the discussion in his group because of the poor quality of the facilitator (I05, p.1). At the TW of the Rotterdam food-industry, the facilitators fell behind schedule, and as a result the meeting ended much too late. By that time most participants had already left the meeting, leaving an insufficient number of participants to have a fruitful discussion, which did little to boost the enthusiasm of the remaining participants. On the other hand, the facilitators at the TW of Metaglas managed to keep on schedule, which allowed them to discuss everything that was on the agenda and provided the participants with ample time to provide input, and the meeting was a success.

Another important factor is the extent to which the facilitator sticks to his role as facilitator (I05, p.1). At the TW of the Rotterdam food-industry, an (external) facilitator started giving advice about issues outside the topic of the TW-meeting. Instead of discussing the possible consequences of future trends on the success of the SME, he was talking about operational problems (such as 'branding' and the difficult relationship of many SMEs with large suppliers) - a topic with which he was apparently more familiar.

Trends and propositions: Discussions in TW-meetings are stimulated through propositions or trends. The next step is to assess what the future consequences of those propositions may be for innovation. However, when we look at the scripts and results of the meetings, it appears that many of the propositions do not refer to future developments. Instead, they often present a specific *opinion*. Here are a few examples:

- "The consumer wants to know exactly what he eats" (DE08).
- "The retailer is the most powerful actor in the entire value chain" (DE08).

There are also examples of trends or propositions that do indeed refer to (possible) future developments. Here are some examples, two of which are from the same TW-meetings as the examples above:

- "Competitive pressures are growing because of the blurring of borders" (DI17).
- "The amount of growers will be halved within 10 years" (DE08).
- "Space, energy, and water are becoming scarce" (DE08).

If a proposition is used, the discussion between participants is often about whether that proposition is true or false, and not about the possible consequences of that proposition for innovation (I05, p.1; G, p.1). Also, if a proposition is not clear to the participants, the

discussion is about the meaning of the proposition rather than its implications. It is advisable to use only trends as an input to the discussion.

Another remark from interviewees is that many propositions or trends referred to consumer developments, while many SMEs operate at the beginning of the value chain (I05; I06). This does imply that the trends at the TW should only be about business developments. The 'complaint' that too many consumer trends are involved in the TW may have to do with the fact that many SMEs do not consider the consumer (in his role of end-user) an important link in their value chain. On the other hand, an SME called RijkZwaan is convinced of the need to involve consumer trends in the TW. They took part in a TW that focused on consumer-related developments. For this TW large retail companies were invited who had a great deal of information about consumers and who strongly argued that consumers play a vital part in the food value chain (I05, p.1; DE08).

Finally, TWs often do not focus on a specific sector, but also take into account developments from other sectors, based on the assumption that most innovations cross the boundaries of economic sectors (especially in the *national* TWs). Some participants argued that this multi-industrial element should receive an even greater emphasis (I12, p.2). However, it is an approach that makes it hard to discuss trends and their consequences in great depth. On the other hand, people who are invited to participate in the TW, and especially representants of the SME in case of a *company*-TW, are specialists on specific and relevant topics, which means that they are not really challenged by the trends and propositions provided during the TW (I19, p.5).

3. The impact of the TW on innovation.

All interviewees are more or less positive about the TW. Some said that *generally speaking* they appreciate that these kinds of methods are developed for, and used with SMEs, and that different SMEs are brought together to talk about the future and possible future directions for innovation (E07, p.1; I02, p.2; G, p.2). From the evaluation forms and the reactions of participants a picture emerges that is generally positive. The employees of Syntens NT are positive as well, although they indicated that improvements need to be made to keep the method up-to-date (I12, p.2; I04, p.3). This is especially relevant for the *national*-TW, which plays a crucial role in providing other types of TWs (regional, sectoral, company) with (new) trends.

However, the generally positive reactions do not necessarily imply that the TW has a positive impact at innovation processes of SMEs, or that it has any impact at all. Some employees of both Syntens and Syntens NT said that it has not resulted in specific innovations (e.g., I12, p.2). This is in line with their comment that the TW is mainly used to create awareness among SMEs, and to encourage them to look to the future and think about innovation. The positive reactions only referred to the first phase of the innovation process in which new ideas are produced (see also Figure 5.3). It was only in the case of the TW for RijkZwaan, that various activities were carried out afterwards (I11, p.2). Some

interviewees argued that the SME itself is reponsible for the follow-up (E06, p.1), while others said that Syntens should play a more active role (I12, p.2; I18, p.1), even though it does not have a "standardised approach" for that (I08, p.12). The fact that there is little or no follow-up to a large extent helps to explain why the TW does not lead to concrete innovations but only to ideas and plans for innovation. On the one hand, the TW is limited in its scope because its main goal is to make SMEs *aware* of thinking about the future and new directions for innovation (I04, p.2). On the other hand, it is this very approach that some SMEs find disappointing, because they fail to see how they can apply the results to their own company (e.g., E01, p.1; E04, p.1).

It is not easy to show to which extent the TW has improved the innovation process of SMEs. The alleged positive impact is difficult to measure because of the informal nature of SMEs, which means that, for instance, there are often no relevant documents about innovation processes. The following example illustrates this point (I10, pp.4-5). An advisor of Syntens adviced a manager of an SME to buy a *laser-based cutting machine*. The manager of the SME declined the idea. The advisor, however, did not give up and repeatedly informed the manager about the machine and about how it would benefit the company. After 18 months, the advisor visited the SME and the manager enthusiastically told to him that he wanted to show him something. He showed the Syntens advisor a laser-based cutting machine. "Good to see that you finally bought the machine." said the Syntens advisor. But the manager was surprised: "Did we ever talk about this? I don't think so." The moral of this story is that even if the preparations for a decision, as carried out by the Syntens advisor, are explicit and formally documented, the decision itself by the SME can take place in a very informal and spontaneous manner, without referring to the earlier work done by others.

To conclude, the TW is a frequently used method for and by SMEs that connects future trends in various industries and parts of society to possible ideas for innovation. It has an important function in making looking to the future a more explicit activity. It would benefit from a so-called business environment model that would give the list of future trends more structure. Given that many SMEs still confuse looking to the future with predicting the future and therefore fail to see the full potential, it may make sense to focus more on various future scenarios rather than future trends. The TW should become more ambitious and pay more attention to what happens next if it is to lead to more tangible results. This may make it a more valuable tool for SMEs, since they would have a clearer idea as to what the benefits may be for them. Last but not least, as with any method, the phrase 'garbage in, garbage out' also applies. The facilitators of the TW should be aware that providing vague formulations of future trends and inviting participants that are not really convinced of the value of these types of meetings can damage the usefulness of the outcome of the TW.

CHAPTER 6 – FUTURES RESEARCH AT DAIMLERCHRYSLER

In this chapter we describe and analyze futures research at the Society and Technology Research Group (STRG) of DaimlerChrysler. Although STRG uses many different methods of futures research, trend-analysis can be considered the core of its work. It very much advocates an 'outside-in'-approach in its work and sees itself as an important interface between DC and the outside world. STRG has quite a long history (it was established in 1979) and, with 40 employees worldwide, is one of the largest organisations that is specialized in futures research.

6.1 Structure of the case study

This case study was carried out in two phases:
1. Interviews and the collection of internal and external documents.
Interviews: We conducted in-depth interviews with two employees of the Science and Technology Research Group (STRG) of DaimlerChrysler (DC): Frank Ruff, head of the Socio-scientific Environment & Trend Research department of STRG, and Gerhard Mattrisch, manager at STRG. Both interviews lasted two hours. The interviews were transcribed and sent to the interviewees for feedback who both gave additional comments. The interviews took place on March 2003 at the STRG premises in Berlin, Germany.
Documents: Internal and external documents concerning, for instance, trends and scenarios, and futures research at STRG.
2. An analysis of the documents and interviews using the case analysis framework (see Chapter 1 section 1.2 for a description of this framework).
In this we use chapter the following references:

- Interviews: (I_number)
- Documents:
    - Internal: (DI_number)
    - External: (DE_number)

The references are listed in Appendix 4.
It must be noted that the research of this case has three limitations:

1. Only two people could be interviewed, both futures researchers at STRG.
2. For reasons of confidentiality we were unable to collect *recent* internal company reports.
3. We could not have a group discussion to discuss the results of the case, although the interviewees did comment on the draft version of this case study.

Nevertheless, this case does fulfil the case criteria and has two additional advantages:

1. Whereas the other cases operate on a national scale (e.g., KPN Research), apply futures research for SMEs (e.g., Syntens NT), or apply futures research (mainly) for external

2. clients (e.g., TNO Industry), DaimlerChrysler is a multinational and offers futures research for internal clients[23] and is therefore complements the other cases.
3. Few organisations have a department of this size dedicated to futures research (see also: DE07, p.43) and STRG has published much about their work externally.

6.2 Background of DaimlerChrysler and DaimlerChrysler Research & Technology

Organisation of DaimlerChrysler.[24]
DaimlerChrysler (DC) is an automotive company operating on a worldwide scale. It employs about 384,000 people, has manufacturing facilities in 37 countries, and is located on five continents (Europe, Asia, Africa, North-America, and South-America). Total revenues over 2004 were € 142 billion, with an operating profit of € 5,754 million. In 2004, about four million units passenger cars and 485,400 units commercial vehicles were sold. DC's products are sold in 200 countries. DC passenger car brands include Maybach, Mercedes-Benz, Chrysler, Jeep, and Dodge. Commercial vehicle brands include Mercedes-Benz, Freightliner, Sterling, Western Star, and Setra. DC is divided into five divisions and has its own research department called DC Research & Technology (see below), which also includes the Society & Technology Research Group.

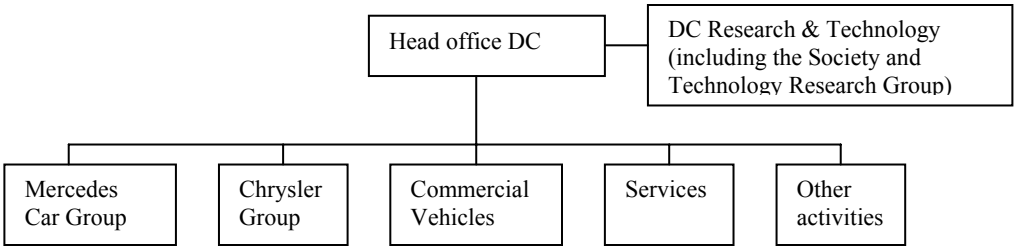

Figure 6.1 Organisational structure of DaimlerChrysler.

DC's its head office is located in Stuttgart (Germany), its official corporate language is English, and its shares are traded on all the major stock exchanges, including New York, Frankfurt, and Tokyo (DE06). The company has strategic partnerships with Mitsubishi

[23] Only a very limited number of projects was carried out for and with other companies and only under the strictest of conditions. See also section 6.4.
[24] Most data from this paragraph are from the 2003 and 2004 annual reports of DaimlerChrysler (DI10; DI11).

Fuso Truck and Bus Corporation, Mitsubishi Motors Company, and Hyundai Motor Company.

DaimlerChrysler started in 1998 after a merger between Daimler Benz, a German automaker and industry group, and Chrysler, a U.S.-based automotive company. The aim was "to create a global, diversified, manufacturer and distributor of automobiles, diesel engines, aircraft, helicopters, space and defense systems and other products and services" (ibid., p.3). Whether or not the company has managed to realise this objective remains to be seen, given the differences in culture, compensation policies, ownership structure, and the legal environment (DE01, pp.99-100; DE21, p.478).

Strategy of DaimlerChrysler.

In line with its goal of operating on a global scale, DC has made new investments in South East Asia and is looking at China for new opportunities to invest. DC has a multi-brand management approach in which the various brands are positioned distinctively. Because the company expects that customer needs and requirements will become more varied in the future, it is planning to develop more new models in the coming three years in an attempt to meet customer demand. Also, it aims at delivering cutting-edge innovations and is active in the development of new technologies like accident-free driving and alternative fuels (e.g., methanol and hydrogen technology, fuel cells) (DI10, p.4). With regard to the main three divisions the following can be said: within Mercedes Car Group the emphasis is on realizing top quality, optimising costs, and increasing revenues; the Chrysler Group is trying to raise productivity and introduce new types of cars; and as far as the Commercial Vehicles Division is concerned no drastic strategic changes are made because things are going well (DI11, pp.5-6). Generally speaking, it appears that DC is focusing on cost reduction as well as quality improvement (partly through innovation), which carries a certain amount of risk, given the fact that a more focused strategy is usually more successful.

DaimlerChrysler Research & Technology.

DaimlerChrysler has a research department called DaimlerChrysler Research & Technology (DC RT). In 2004, it employed 2,900 researchers divided among sixteen research labs, fifteen of which focus on technology, and one cross-sectional lab on future business environments and society: the Society and Technology Research Group (STRG). DC RT focuses on technology fields such as vehicle construction and man-machine interface, material technology, and intelligent transportation systems (DI10). Within these technology fields DC RT focuses specifically on reducing fuel consumption and vehicle emissions, enhancing road safety, and developing intelligent controls for relaxed and comfortable driving. Unlike at other automotive companies like General Motors and Ford, (I02, p.1), research and technology at DC is centralized as a corporate function. DC RT is represented on the board of management and carries out research for a diversity of vehicle

development units and central corporate functions (DE14, p.1). The manager of every research lab is represented on the board of management of DC RT. The (average) division of the budget for DC RT is 50% from corporate research and 50% from business units. Corporate research projects take two to four years. The business unit projects take less time because of the more explicit underlying business motive projects that demand quicker project results.

In addition to DC RT, about 26,000 employees contribute to innovation through their work at the six development departments of the Mercedes Car Group, Chrysler Group, and Commercial Vehicles. Some business units with several brands (e.g., Mercedes Car Group) have a cross-sectional strategic planning as well as units for functional strategies (e.g. product-, marketing-, and production-strategy). In 2002, DC spent a total of € 6,2 billion on new product and technology research and development. The boundary between research & technology and development is becoming thin and especially the technical scientists are more and more involved with development (I02, p.3).

6.3 Innovation and innovation processes at DC and DC RT

Innovation.
At DC, innovation is a joint process involving the development departments and DC RT, in which the development departments play a central role. Innovation projects within DC RT are evaluated on a regularly basis and in a formalized manner. Depending on their budgets and strategic importance, DC distinguishes three types of projects (DE12, p.260):

1. A-projects: projects that are evaluated before the head of DC RT, who is also member of the board of management.
2. B-projects: projects that are evaluated before the relevant director of a research lab.
3. C-projects: projects that are evaluated before a manager lower in the organisation.

Every project is reviewed at least once a year and some projects are evaluated four times a year (interim and post-project reviews). The evaluations (or reviews) take place before a committee and include the project members as well as the client. Although the emphasis is still on customer satisfaction, evaluating the client shows the extent to which the client has cooperated in a positive manner. This is called 'group-based project evaluation'. According to Frank Ruff, this approach enhances the objectivity of the project evaluations. He referred to the possibility of 'good project, bad customer', which the evaluation of the client is supposed to (partly) remedy (I02, p.3). However: "the higher the hierarchical level of participants, the more likely it is that the post-project review develops into a marketing event rather than an analysis of the finished project" (DE12, p.260). Post-project reviews of R&D projects within DC can be seen as opportunities for the organisation to learn, although in practice there are learning impediments that apply to DC such as "(T)he disinclination of team members to objectively reflect upon past actions and

their consequences, particularly their own actions" and the "(L)ack of time to deal with the past in a business that typically looks three to five years ahead" (ibid, pp.261-263). Nevertheless, the existence and execution of interim and post-project reviews underlines the structured and formalized way in which projects are reviewed.

Innovation processes.
The interviewees said that the innovation processes within most parts of DC are linear and use so-called 'quality gates', which can be seen as decision points in the innovation process. To illustrate the concept of quality gates Ruff (I02, p.2) Figure 6.2.

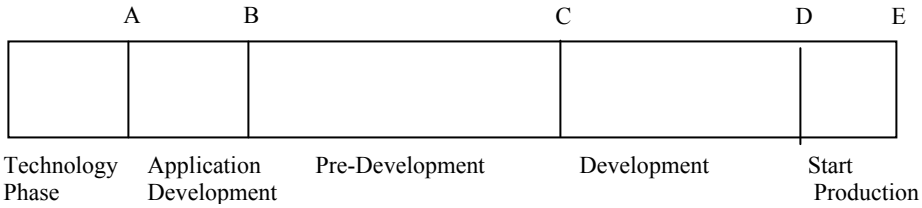

Figure 6.2 Innovation processes and quality gates within DC.

The innovation process is roughly divided into five stages involved in developing a vehicle from its technological concept to the final product. In the entire process a few binding decisions have to be made. Decision point C is the point-of-no return as far as the development is concerned. Point D is the start of production. The innovation process starts at the beginning of the development process and is triggered by either technological developments or market pull (i.e., expected future requirements). The areas representing the pre-development and development stages are larger than the other stages because they take up the most time and resources.

Gerhard Mattrisch drew another (simplified) picture of innovation processes within DC (I01, p.2):

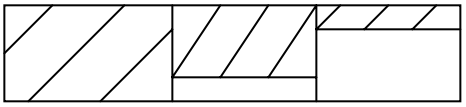

Figure 6.3 Innovation processes and ideas for innovation within DC.

He pointed out that not every idea for an innovation (the first fully dashed box) reaches the end of the process and that most ideas are excluded before the end of the process. In other words, the further an idea reaches, the more mature it is. The output of this innovation process can be a document, a prototype or a piece of software which in turn is

used as input to the product development process (see figure 6.2). This representation of the innovation process is almost identical to the classical *innovation funnel* in which at first there are many ideas for innovation, most of which are disapproved in the course of the process, leaving a small selection of ideas to be further developed into new products and services.
Although innovation processes within DC are relatively structured, there is no single innovation process. Brands like Mercedes, Smart, Chrysler, and Mercedes-Benz trucks each have their own (structured) innovation processes. What is best for a premium-brand like the Mercedes passenger car does not necessarily apply to trucks or an 'early follower'-brand like Chrysler. The variations are due to the different characters of the branches of the vehicle business. From this it follows that there are sometimes three strategic planning levels: corporate strategy (e.g., all truck business worldwide), business division (e.g., Mercedes passenger cars), and functional strategy (e.g., Mercedes passenger cars, marketing strategy). STRG works for all levels.

6.4 Futures research at STRG

The Society & Technology Research Group (STRG) was established in 1979 (when it was called: "Umwelt, Verkehr und Zukunft") and in 2002 consisted of 40 futures researchers. It is located in Berlin (35 employees) and Palo Alto, U.S.A. (5 employees), and has a network partner in Kyoto, Japan. Every year STRG hosts about 20 students who are mainly involved in corporate research projects. Although STRG employees call themselves 'scientists', they describe their activities as 'consulting on the basis of research'. Ruff does not approve of this term because in his view it is very broad and misleading (I02, p.1). The organisational structure of STRG in 2002 looked as follows (DI08, p.9):

STRG is divided into four sub-departments that are at the same time areas of expertise (socio-scientific systems and socio-scientific environment, and trend research) and research applications (future mobility/mobility trends and future requirements for vehicles and transportation systems). The Palo Alto office is considered a specific department of STRG and provides input to all research areas.

The employees of STRG are both future *process* experts and future *content* experts (DI08, p.11; I02, p.2). That is to say, on the one hand they know how to organize and facilitate workshops, how to apply methods, and how to conduct interviews. On the other hand, they have knowledge about the automotive industry itself. Mattrisch said that no other department within DC knows as much as they do about traffic forecasts (I01, p1). He also said that most of DC's business units would not accept the authority of a workshop facilitator unless he or she has the relevant knowledge.

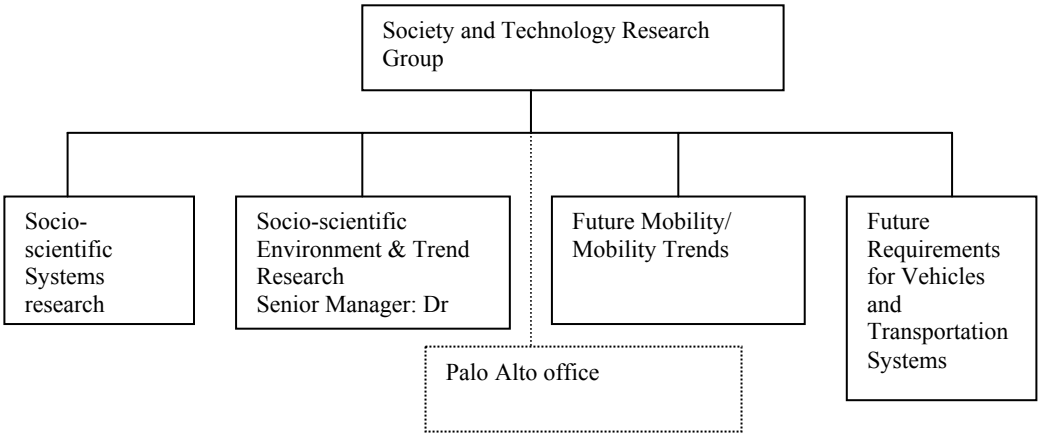

Figure 6.4 Organisational structure of STRG.

At STRG people with varying scientific and educational backgrounds are working together: engineers, psychologists, economists, communication experts, marketers, and even historians. Not a great deal of job rotation takes place. Employees stay at the same job longer than employees of other departments. Despite incentives from DC's head office, many futures researchers prefer to stay at STRG, which, according to Ruff, may have something to do with the fact that the employees prefer staying in Berlin rather than moving to Stuttgart where DC's head office is located (I02, p.2). He also said that futures research "is something you do with your heart" (ibid., p.2), which may make it difficult to persuade STRG employees to change jobs by offering them a higher salary or a better position.

In 2003, the budget of STRG was approximately € 7,3 million. In 2002, its workforce was reduced by some 20% because of the poor economic climate and resulting cuts in the research budgets at DC. STRG receives 50 to 60% of its budget from business units, 40 to 60% is funded by corporate research and 5 to 10% comes from external assignments. An example of a corporate research project is the development of a proto-type of a new car cockpit ('cab') in which STRG's role was to discover future needs with regard to the multimedia aspects of the car cockpit. The way the budget is divided is unlikely to change in the coming years, since there is no compelling need to increase the amount and extent of projects for external clients, because STRG is a department of DaimlerChrysler and primarily dedicated to its mother company. Ruff said that carrying out more work for external clients may cause the organisation to be outsourced (I02, p.2). The external companies are often suppliers of DC, and organisations that compete with DC or its

subsidiaries are excluded (DE14, p.1). However, STRG does stress the importance of occasional external activities because, as Mattrisch said, "it expands your mind" (I01, p.1). An example of such an 'expansion of the mind' is a joint project with a scientist from the protestant church in which the functional logic of companies is compared to strong brands like DC.

An example of a project for a business unit is the research into the functionalities of the 'driver's cab' (or cockpit) of the next generation of trucks that will enter the market in 2008-2010. Mattrisch drew the Figure 6.5 (I01, p.1).

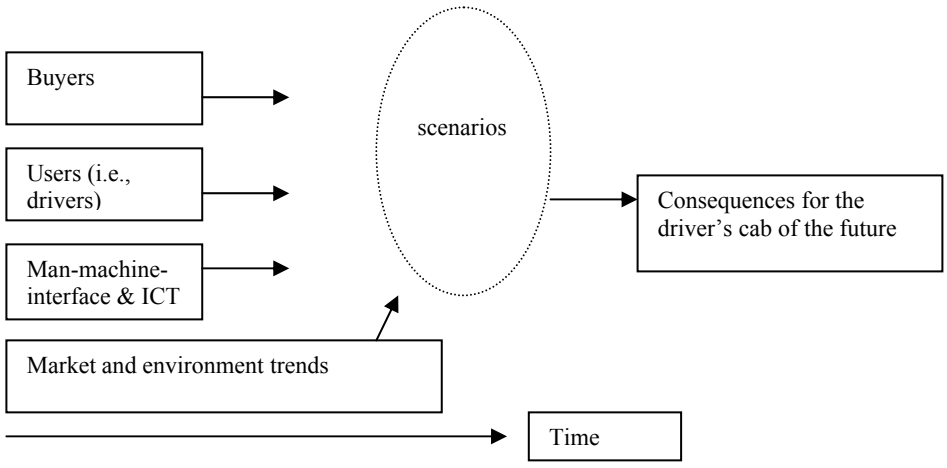

Figure 6.5 Scenarios for the driver's cab of the future.

Figure 6.5 illustrates that the scenarios combine elements like the needs of the (possible) buyers of the trucks, the needs of the drivers of the trucks (i.e., users), man-machine interface and information and communication technology (ICT) applications, and trends in the market and DC's wider environment, which often have a long time horizon. These elements together form different scenarios and based on these scenarios the consequences for the drivers cab in terms of services and design can be assessed.

An important element of STRG's view on futures research is that looking to the future does not start with technology or technology forecasts but rather with developments in the company's business-related and societal environment (I02, pp.1-2). STRG's old name was the 'Technology and Society Research Group', which was changed to the 'Society and Technology Research Group' because of the (growing) emphasis on the use of social

developments as an important input to looking to the future and to innovation (ibid., p.1). STRG holds the view that the importance of technological developments is often over-estimated and that too little attention is paid to the fact that people (i.e., consumers) need time to get acquainted with and adopt new products and services (ibid., p.1). According to STRG, the developments around UMTS, for which telecommunication companies have paid huge sums of money to get licenses, provide a good example of this over-estimation (I02, p.1; see also: DE20).

STRG strongly advocates the 'outside-in'-approach, which means that it is aware of the impact external developments have on the business, strategy, and organisation of DC. If the company is to respond adequately to future developments, it needs to monitor them closely. Also, STRG often looks at the value chains of other businesses to see how value creation takes place within and between those businesses (see also: DE13, p.17; DE14, p.2; DE16; DI08, p.5). STRG applies (working) principles such as interdisciplinarity, systems-orientation, methodological pluralism (i.e., using and combining many different methods of futures research), and interactivity (DE07, p.44).

Because parts of futures research are sensitive or confidential DC founded its own group of futures researchers (I02, p.1). Nevertheless, external consultants are sometimes hired and employees in other places within DC are doing futures research as well (e.g., DE10; DE11). Ruff said that the (market) position of STRG within DC is better than that of external consultants, because they know the company and its processes better than competitors do, and because STRG does not work for competitors (unlike the external consultants) their knowledge is not used for potential competitors (I02, p.1; DE15, p.18; DI08, p.16).

Ruff drew the figure presented below to outline STRG's (market) position vis-à-vis two comparable organisations involved in futures research (I02, p.1).

Figure 6.6 shows the amount of closeness (or distance) to the business (on the y-axis), and the amount of focus on the external environment of the organisation (on the x-axis). STRG is located near the application and business environment side. This means, in principle, that their work is close to both the products and services of DC and that they include other trends besides market-related ones, such as societal, technological, economical, and political.

STRG has a broad portfolio of methods of futures research ('products and services') (DI08, pp. 6-7) in which trend-analysis is the basis. For example, they use the scenario-method to identify potential future developments, early warning systems to recognize future markets before competitors do, and target group analysis and projection to describe action and decision patterns and lifestyles of customers. In addition to these methods, Ruff mentioned a confidential method for the evaluation of innovation by looking at customer needs in which method and content are linked. The reason that this method is not made public is that STRG believes that it gives the company a competitive advantage.

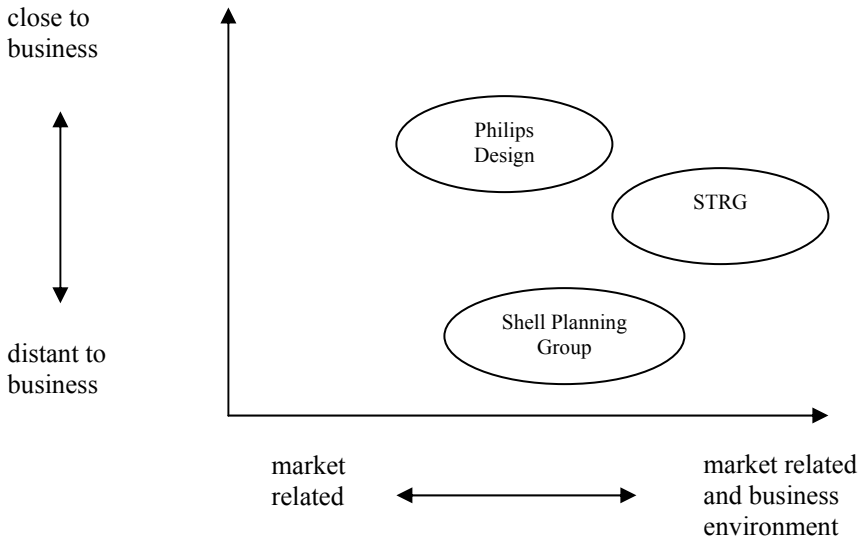

Figure 6.6: The position of STRG vis-à-vis other futures research organisations.

The futures research conducted by STRG results in various types of futures studies, such as market and business sector analyses, international business environment analyses, and future based product and innovation assessments. On a more regular basis, STRG provides annual reports about strategically important developments and it issues a newsletter issued four times per year about recent research findings.
The activities of STRG cover six research areas :

1. Regional Perspectives: several geographic regions are examined in order to identify business opportunities.[25]
2. Innovation, Value Chain and Organisation: "STRG analyzes the interdependence between products, services, and internal structures of DC with the media, as well as the societal and technological environment" (DI08, p.11).

[25] Research conducted by STRG often has an international character: 1) research into lead-markets: U.S.A., U.K., and Germany are regarded as the basis, while other countries in West-Europe are seen as variations, 2) emerging markets: South-East Asia, China, Latin America, Eastern Europe, and Russia. Not all projects are of an international nature, however. Some 50% is regional or domestic and the other 50% involve a variety of countries.

3. Society, Lifestyle and Consumption: consistently monitoring DC's broader environment, looking at the way people may live in the future, their lifestyles and customer behaviour.
4. Mobility, Transportation and Traffic: 1) identifying the opportunities and risk associated with new mobility concepts, 2) researching new manufacturing systems and logistical networks.
5. Environment, Energy, Resources: examining potential business strategies in relation to the demand for high environmental standards.
6. Methodologies: deployment of effective and proven innovative methods in addition to established procedures.

The time horizon of the research conducted done by STRG varies, but on average is relatively long (DE15, p.8). Although projects for business units have a time horizon of five to thirteen years ahead, this can vary per business unit. Corporate research projects have a time horizon of ten years. Although most of its work has a long time horizon, STRG distinguishes between long term, mid-term (three to six years) and short term (one to three years). With regard to for business unit-projects the time frame is set by the customer of these projects, and as far as corporate research-projects are concerned, STRG decides what the proper time frame is by itself. The relatively long time horizon is determined in general by the long lead times involved in the development and production of automobiles. For instance, technology development, which precedes the manufacturing of a new car (see Figure 6.2), takes five years within DC.

In general, STRG's activities can be characterized as outside-in, interactive, with interests in many different areas and designed to be applied in the various regions of the world where DC is active. Also, the activities take place in close interaction with customers. Ruff said that often contacts with customers take place on a weekly basis, and that considering the quick rotation of jobs at other departments within DC the futures researchers of STRG are often a constant factor in research projects (I02, p.2). STRG has a broad range of methods of futures research at its disposal, although the interviewees emphasize that the choice of method is not the most important one in the process of futures research. STRG's work serves as a means both to test existing ideas and to think about new ideas.

6.5 Examples of futures research at STRG

This section briefly describes three examples of projects at STRG (based on: DE18, pp.12-15, 19-25).

1. The future automobile market of China.

This project was carried out in 2004 and addressed the question "whether China will remain the powerhouse of global automobile market growth and what the market drivers

are" (ibid., p.12). The project consisted of three parts. In part one so-called 'macro-scenarios' were built. In these scenarios various factors in politics, traffic and transportation, society, industry, and other fields were identified. The scenarios varied with regard to the projected level of growth of the Chinese automobile market (low growth, steady growth, high growth). Since the macro-scenarios were too abstract to be used in the decision-making process, it was decided to build 'mobility scenarios' and 'market scenarios' to make the scenarios more specific. For instance, the market scenarios described various (future) possibilities with regard to market entry with specific products and setting up manufacturing or assembly activities in China (ibid., p.13).

The project yielded two results: 1) the macro-scenarios could be used to establish specific management objectives because they had various levels of detail, and 2) as a result of this multi-level analysis of the Chinese business environment several 'hidden' risks were identified that made it necessary for DC to approach the Chinese market with much caution.

2. Innovative ideas for vans.

This project, which aims at finding innovative ideas for vans to improve the current portfolio, consists of five steps:

1. Assessing processes and situations with regard to transport (e.g., loading and storage of goods).
2. Interviewing experts on transport about future developments and how these may effect customer requirements like safety and transport functionality. The *future* requirements were then ranked and compared to the existing portfolio, making it possible to determine 'search fields for innovation' (or blind spots).
3. To fill in the gaps in the portfolio, creativity workshops were held with participants from engineering, marketing and sales, facilitated by the futures researchers from STRG. The workshops were structured by using the 'Theory of Inventive Problem Solving' to "research existing solutions in related technology fields and tool-box approaches to search for solutions" (p.20).
4. In the fourth step the list of new (innovative) ideas for portfolio change were evaluated and prioritized against future customer requirements: "The result is a *future- and customer-oriented prioritization of innovative ideas"* (p.20).
5. The fifth step was a "feasibility analysis" (p.20) which resulted in various different types of ideas; ideas that could be implemented immediately in the development process of the vehicle concept; attractive ideas that need further investigation; and, 'future visions' that "are transferred into research projects and the 'idea memory bank' of the business unit for the next product and innovation cycles" (pp.20-21).

3. Acceptance of new IT-applications.
STRG carried out a project for the Information Technology Management unit at the DC head office, with the aim of improving the roll-out and acceptance of new IT-applications used by the company's employees. It showed that implementing these services is often hampered by organisational and personal obstacles that are not taken into account because of the focus on technological aspects. To overcome organisational resistance, a 'future-oriented contextual scenario approach' was adopted. These scenarios described various future workspaces and user profiles. The scenarios were characterized by an 'outside-in'-approach and heavily emphasized the social, economic, and organisational aspects in the workplace environment. Of each scenario the "implications for organisational design, employees of different levels and information architectures were derived" (p.24). STRG identified three lessons learned from this project: 1) an evolutionary, adaptive strategy for choosing and implementing IT-solutions is preferred above long-term contracts that can cause costly 'lock-ins'; 2) the acceptance of an organisational innovation such as an IT-application strongly depends on social and employee-related factors, which is quite a new insight for a technology-oriented industry like the IT-management; and 3) IT-strategies must have technological and business administration goals, as well as organisational and work sphere-related goals.

6.6 Case conclusions

1. The place of STRG in the innovation process.
Despite the wide range of methods, tools, and interest in methodological development ('Methodologies' is one of their research areas; see also: DE07, p.47), the futures researchers of STRG do not see the methods of futures research or the innovation process as the most important factors of their work. Mattrisch said that the choice of the method is not important but that it is more important to have the right skills and experience, and the commitment and willingness of your clients (I01, pp.1-2). He also said that: "Often there is underestimation of social-psychological effects of groups who normally do not work with each other", which means that the *process* of doing futures research (together with clients) is as important as the outcomes or results of the future study.

Although based on this one would be tempted to conclude that at DC and STRG, innovation, the type of innovation, and the innovation process do not relate directly to the method of futures research being used, that is not quite true. The interviewees said that the methods of STRG are used in the first phases of the innovation processes of DC, and that their work is also regularly used for marketing and product planning. Also, the time horizon of their futures studies is in line with the long lead times of product and service development within DC in particular and within the automotive industry in general. More specifically, Mattrisch stated that futures research is required for radical innovations more

than for incremental innovations, and that for incremental innovations market research is sufficient (I01, p.2), because there are no long lead times for incremental innovations.

2. The quality of the STRG.
STRG positions itself clearly as an 'interface' between DC and its environment. This is reflected in the 'outside-in'-character of its work and in its perspective on innovation at DC, where the service element is becoming more and more important vis-à-vis the product element. However, Ruff said that the topics they addressed should be broader than just automotive, for example mobility or multimedia (I02, p.4). He said that futures research should not take place in a mono-culture because then it loses its attractiveness. In his view, futures research crosses boundaries and brings in new topics and perspectives (ibid.).

In addition to his claim that the choice of method is not (all that) important (see case-conclusion 1), Mattrisch also said that the choice of method is determined mainly by which and how many resources (e.g., money, time, people) are available, and he emphasized that the client plays a major role in this because he is financing the project (I01, p.1). Time and money are not always abundantly available within DC, so STRG sometimes adopts a more 'quick-and-dirty' approach, such as the 'quick scenario method' which is also used by consultancies like Global Business Network. This way of working costs less time and money and produces results more quickly. Also, it matters whether a project is a single task or continuous or regularly activity (with an update of, for instance, every year). For ongoing projects STRG develops models, whereas for individual projects that are often used to formulate a decision that can not be revised without major additional investments, they are less inclined to use or build a separate model. A similar development can be seen in the construction and use of scenarios. Here, there has been a shift away from individual and detailed scenarios for business units, towards the construction of a set of *corporate* scenarios that can be customised for different business units. The business units no longer have the time and money to finance and instruct full-blown scenario studies.

3. The impact of STRG on innovation.
It is difficult to clearly point out what the (positive) influence of the work of STRG is on innovation at DC, because innovation at DC is carried out by many departments and suppliers (see DE03; DE08). This makes it difficult to tell what the specific contribution is, let alone whether it is positive or negative. However, Ruff mentioned CAR2000+, a project in which STRG evaluated car concepts with an emphasis on car mobility (I02, p.3). It developed the idea of a fancy two-seated car suitable for urban mobility. The project was taken further by other departments, which worked together with Swiss company Swatch (who earlier cancelled a cooperation with Volkswagen) and developed the well-known 'Smart'. The interviewees mentioned other examples of impact on innovation:

- DC invests a great deal of money in the development of fuel cells[26], based on STRG's prediction that environmental issues will become increasingly important in the future.
- Studies of STRG have referred to issues that in some way or other played a role in new car concepts. Examples are: there is growing need for comfort on the part of car drivers, comfort is becoming more and more sophisticated, driving hours are becoming longer, society is ageing, there is a growing importance of lifestyle in the marketing of new products and services, and the signalling of an excess usage of gadgets in cars.
- Ruff also mentioned that STRG gave advice to DC branches in Eastern Europe about the market for diesel and electronic locomotives, although that part of the organisation of DC has been sold to another company (I02, p.4). Also, it did some troubleshooting (as he called it) in Russia to advise the local account management to use more its political and personal networks to sell more products. Afterwards, sales did indeed increase.
- Ruff said that customers have a diverse opinion about the work of STRG (I02, p.3). According to him, clients say that it helps them in taking a new look at their daily work, changes their business perspective, and makes them consider 'areas of influence' that they had not considered before.

On the other hand, the interviewees mentioned some projects that had a much less positive impact:

- Although STRG was correct in signalling the issue of environment, it was wrong about the speed with which this issue would become important (I01, p.3). STRG argues that their error was caused by their expectation that the issue would be dealt with through market mechanisms rather than government regulations, which is what is currently happening.
- Another remark by Ruff was that many clients tend to ignore the advice that is given to them, which he considers a professional risk (I02, p.3). Also, STRG often needs to emphasize that the effects of its work are long term. Sometimes knowledge is lost on the way, and the result may be that certain things that might have been foreseen are not in fact predicted or explored. An explanation for this might be that job rotation at clients of STRG is high, which means that the futures researchers of STRG are often a constant element in projects (see also section 6.4).

To conclude, futures research at STRG is carried out very seriously. Its futures researchers use a broad portfolio of futures research methods, they posses the skills to apply those methods, and they have positioned themselves very strategically as the DC's

[26] For instance, see: Fuel Cells Bulletin, *Fuel cell car, bus fleets launched by* DaimlerChrysler, December 2002, p.1 (DE04); Fuel Cells Bulletin, *Millenium Cell DaimlerChrysler formalize the next phase*, February 2003, pp.6-7 (DE05); Renzi, S. & R. Crawford, *Powering the Next Generation Automobile: DaimlerChrysler's Venture into Fuel Cell Technology*, Corporate Environmental Strategy 7, 2000, pp.38-50 (DE09).

interface with its societal and business environment. The societal aspects of its work are very prominent and working for a multinational such as DC gives enough (financial) space to carry out the work. However, the enormous size of the 'mother company' also makes it difficult to have a sufficiently big impact on innovation at DC. In addition, STRG has felt the effects of the global problems facing the automotive industry in its budget. This makes its work more difficult, since satisfying its clients also means renewing its futures research method portfolio, for instance, by paying more attention to methods and tools that integrate or combine futures research and innovation.

CHAPTER 7 – ROADMAPPING AT TNO INDUSTRY

In this chapter we describe and analyse the use of roadmapping at TNO Industry. Its main clients are SMEs and for them roadmapping is carried out in two phases. First, a roadmap is made for the sector in which an SME operates. Second, the 'sector roadmap' is tailored to specific SMEs. The sector roadmap makes SMEs in the Dutch province North-Brabant aware of the need to innovate and of the technological and market opportunities that exist. A company roadmap is meant to be used as the start of an innovation process.

7.1 Structure of the case study

This case study was carried out in three phases:
1. Interviews and collection of relevant internal and external documents.
Interviews: we interviewed 20 people, seven from TNO Industry, three from Syntens, two from the roadmapping-project (see section 7.4), five from the steering-committee of the roadmapping-project, and three from clients of the roadmapping project. On average the interviews lasted one hour. With one exception, all the interviewees gave permission for taping the interview. The interviews were transcribed and sent to the interviewee for feedback (15 interviewees responded, five of whom with additional comments).
Documents: internal (e.g., report of meetings and scripts for meetings for the roadmapping-project) and external publications (e.g., DE01).
2. Analysis of documents and interviews with support of the case analysis framework (see Chapter 1, section 1.2 for the description of the case analysis framework).
3. A group discussion to present and discuss the conclusions of the case study. This group discussion was part of a project meeting at TNO Industry in Eindhoven and was held at December 15, 2003. Eight people attended this meeting; three from TNO Industry, three from Syntens, and two external consultants. Minutes were made of this meeting.
In this chapter we use the following references:

- Personal interviews: (I_number)
- E-mail questionnaire: (E_number)
- Documents:
    - Internal: (DI_number)
    - External: (DE_number)
    - Reports of attended meetings (RAM_number)
- Minutes of the group discussion (G)

The references of this case study are listed in Appendix 5.

7.2 Background of TNO and TNO Industry

TNO Industry is part of TNO, a Dutch-based research organisation that operates on a not-for-profit base. TNO 'produces' knowledge such as technical principles and processes, software, and patents. In 2004, TNO's mission was: "Utilising scientific knowledge to reinforce the innovative capability of business and government". Although TNO occasionally makes products for testing purposes, that is only on a small scale, and as such the organisation does not compete with commercial organisations. Roughly 65% of its turnover comes from commercial organisations and 35% from government budgets. In 2004, it had a turnover of € 555 million, € 361 million of which was market-related and and € 261 million from government organisations. TNO is located throughout the Netherlands and employs almost 5,000 people. Figure 7.1 shows its organisational structure in 2004.

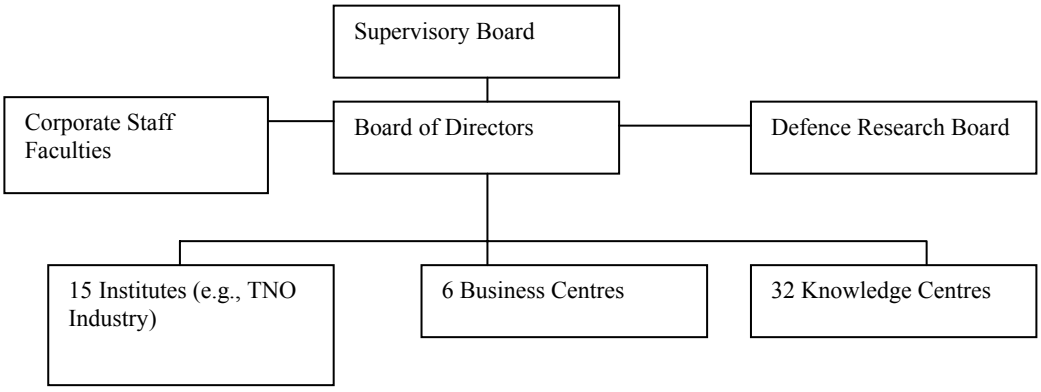

Figure 7.1 Organisational structure of TNO in 2004.[27]

[27] TNO was reorganised in 2005. The 15 institutes were merged into five core areas: Information and Communication Technology, Quality of Life, Defence, Security and Safety, Science and Industry, and Built Environment and Geosciences. TNO Industry is now part of TNO Science and Industry.

During this study in 2003, TNO Industry focused on product development, the development and application of materials, production processes and tools, and product evaluation and advice (DI22). The sub-department Product Development advises companies on their product development processes, designing and engineering of products, and producing 'null series'. The sub-department has knowledge in areas such as mechatronics, prototyping, ergonomics, and sustainability.

7.3 Innovation and innovation processes at SMEs

TNO Industry is applying roadmapping in the innovation processes of Dutch SMEs. These innovation processes are described in Chapter 5, specifically the 'ToekomstWijzer' of Syntens New Technologies. In this section the innovation processes are summarised and the extent to which these are applicable to this case study is explained.

Innovation.
The Syntens NT case showed that, because of the large diversity of (Dutch) SMEs and the limitations of existing research on their innovativeness, it is difficult to draw clear and general conclusions about innovation at SMEs. Nevertheless, it can be concluded that the innovativeness of SMEs (compared to larger firms) should not be overestimated and that innovation at SMEs takes place in a very informal and ad hoc way. This was confirmed by many interviewees from the TNO Industry case (e.g., I06, p.2; I16, p.1; I19, p.2). Also, one interviewee said that SMEs rarely innovate and that most of their innovations are 'opportunity-driven' (I07, p.2). Another interviewee stated that SMEs do not pay much attention to innovation, do not have an innovation strategy, and that their innovations occur mainly by chance (I05, p.1). Two interviewees said that if SMEs innovate it is because they feel forced to do so (I15, p.6; I16, p.1). These interviewees drew a distinction between *forced innovation* and *free innovation*. Forced innovation occurs because of external (market) pressures, such as changing market-demand and government legislation, or increasing competition. Free innovation is triggered by changing needs and wishes within the company (I15, p.6; I16, p.1).

Innovation processes.
The Syntens New Technologies case (Chapter 5) showed that innovation processes at SMEs are informal and unstructured, especially for the smaller firms, which was confirmed by nearly all interviewees from the TNO Industry case. SMEs do not have an explicit and formalised innovation strategy, nor do they assign responsibility for innovation to one or more employees.

Based on the interviews, two additional remarks about innovation at SMEs can be made:

- Some interviewees made a difference between first and second generation SMEs. First generation SMEs are entrepreneurs who started the firm. They are often very informal and intuitive with regard to innovation. Second generation SMEs (their successors) try to approach innovation more professionally (I04, p.9; I14a, p.9; I19, p.5). One interviewee said that managers of SMEs (i.e., the second generation 'owners') have a shorter time horizon than the first generation owners which means that less attention is paid to innovation (I20, p.6).
- When SMEs innovate they tend to view innovation more in terms of new products than in terms of the functionality of their new products or in the needs these new products fulfill (I01, p.7; I06, p.4; I08, p.7; I20, p.5). This indicates a technical view on innovation. Two interviewees considered it important that the roadmap should not only be about the new product or service but especially about its functionality (I01, p.7; I08, p.7).

7.4 Roadmapping at TNO Industry

A short history of roadmapping at TNO Industry.
In 1999, the sub-department Product Development (PD) of TNO Industry started with to apply roadmapping, after clients had begun to ask questions about *how* to innovate as well as about *what* to innovate (I14b, p.2). Also, clients were becoming more interested in future developments that migh affect their business (I05, p.3) and the products they were developing (I06, p.4; DE01, p.12), even though many SMEs consider the future as unpredictable and therefore do not bother to look to the future (I04, p.6; I14a, p.6). After a small study into other methods and tools (such as Technology Assessment, TAO[28], and the scenario-method) that might be of help to them, PD decided to build up knowledge about roadmapping. Roadmapping was considered to have the following advantages (over other methods): a managable method capable of offering unambiguous outcomes, realising focus in a diverse area, and visualising the connection between product, market, technology, and knowledge (I04, p.11; I14a, p.11). More specifically, the scenario-method was considered too far-fetched for SMEs (I05, p.5). A few employees of PD gained knowledge about roadmapping by taking a course at the PATO institute[29] and subsequently by writing a

[28] TAO is a Dutch acronym for 'Techniek, Applicatie, Organisatie' (in English: Technology, Application, Organisation). This model states that successful innovation occurs if these three aspects are addressed in the innovation process. See also footnote 6 in Chapter 5, section 5.5.
[29] PATO stands for Post Academisch Technisch Onderwijs (Post Academic Technological Education) and provides additional and refresher courses for technical engineers and computer scientists employed in businesses.

handbook (DI10). More practical knowledge about roadmapping was gained by building three roadmaps for SMEs (see below) (DI01; DI05; DI06). PD called their roadmaps *product*- or *business*-roadmaps. The (practical) knowledge that was obtained in these projects was laid down in a report and expanded with more theoretical knowledge about roadmapping (DI08).

Roadmapping at Product Development

In the interviews and publications of TNO Industry, different aspects of roadmapping are emphasised. One interviewee said that roadmapping is used to structure a discussion about a very broad and diverse topic (I03, p.5). Another interviewee said that roadmapping is an instrument to make an organisation's vision on the future visible (I17, p.1). Other interviewees said that the term roadmapping should be taken literally and that it means a path into the future consisting of specified steps (I04, p.11; I14a, p.11; I14b, p.3; see also: DI10, p.3). Lastly, one interviewee said that roadmapping is a collection of existing tools and methods in which different topics are visualised and related to each other (I06, p.9).

Roadmapping is often used by large companies to manage their innovation and develop an innovation strategy, and for those companies it is an ongoing process (I05, p.6.). The goal of PD is to apply roadmapping in the innovation processes of SMEs. Three roadmaps were made for SMEs, and although building these roadmaps served a commercial purpose it was also an opportunity for employees of PD to learn about roadmapping in practice. Several lessons were learned, one of which was that it is better to start by talking with the employees of a client organisation individually rather than by conducting a groupmeeting because of the risk of 'groupthink' (I06, p, 7), and that 'outside-in'-thinking is important (I05, p.8; I12, p.5). Also, it is important to know if a client organisation is a market-, product-, or technology-oriented company because that determines with regard to which topics the SME has less information and knowledge (I06, p.6). More specifically, technology-oriented companies find it difficult to imagine possible applications of a technology, whereas market-oriented companies pay too little attention to technology (ibid., p.6). Finally, all the relevant issues of the company and roadmap should be incorporated, so that all the relevant people are involved, which increases support for the roadmap (I14b, p.13).

Employees found it difficult to describe how roadmapping actually takes place, and one interviewee even called it a 'black box' (I14b, p.12). Making a roadmapping handbook was also considered very difficult given the size of a roadmap-project and the variety of SMEs (I06, p.9; I14b, p.12) and the diversity of definitions of roadmapping (see above). Nevertheless, there are two publications that describe how PD should carry out roadmaps (DE02; DI10). The first publication (DE02) describes in much detail how PD should do roadmapping. In this document roadmapping consists of the following four phases in which different activities are taking place:

1. Starting up the project:

- Determine the problem of the client. If the problem is related to developments about technology, product or market and to product development, then roadmapping may be a solution.
- Define the goal of the roadmap. For what reason has the roadmap been built and what purpose does the company want it to serve?
- Determine the central issue of the roadmap. For example, the whole organisation, a specific product-market combination, or a company's value chain.
- Determine the time horizon of the company.
- Form the project team and determine the project budget.

2. Collecting information:
   - Determine the relevant issues of the roadmap (e.g., company situation, product, technology, market, knowledge).
   - Decide the 'playing field' of the roadmap: which topics or issues are taken into account and which are not?
   - List possible sources of information.
   - Apply various methods to collect information, e.g., interviewing, document-analysis, observation and survey.
3. Processing the information to a roadmap:
   - Put the information in the elements of the roadmap: company, market, product, technology, knowledge.
   - Make a basic roadmap that contains all the information that has been collected and summarise this roadmap to a *main* roadmap by clustering the information.
   - Link the various elements of the (main) roadmap: how do the various elements influence each other?
4. Visualisation of the roadmap:
   - Assign a time frame to each element: how do developments in each element take place over time?

In 2001, PD made a document containing a smaller, more practical way of constructing roadmaps (DI10). This method consisted of three phases:

1. Start-up: acquire clients and subsequently get acquintant with the clients.
2. Roadmapping:
   - Inventory: what does the company do?
   - Ambition: what does the company want?
   - Feasability: what is the company capable of?
   - Action plan: what is the company going to do?
3. Evaluation: discuss new (unforeseen) developments, determine to what extent the roadmap has been implemented, and discuss whether it is necessary to rebuild the roadmap.

In each phase, several activities need to be carried out, such as: deciding which company experts and TNO experts will be asked to participate, which methods and tools can be used (e.g., interviewing, visualisation tool), how much time and resources can be devoted to each phase, and what the output is.

The second version of the roadmap process is much smaller and simpler than the first. Both versions have the same input-throughput-output structure and see the roadmap not only as a method in itself but also as a service that PD offers to its (potential) clients. Therefore, much attention is given to communication and interaction with the clients (and users) of the roadmap. However, it is not quite clear to what extent both procedures are fully carried out in practice which means that, there is indeed a certain 'black box' element involved with regard to the way roadmapping actually takes place. In itself, this does not have to be a problem, since a certain level of creativity is important for futures research and each SME is different and will therefore require a different approach. More specifically, DE02 suggests that SMEs to which roadmapping can be suitably applied have the following characteristics (DE01, p.16):

- The company is active in the construction or engineering industry.
- The company has its own development department, even is it is very small.
- The company is prepared to invest in development (i.e., innovation), not only in the roadmap project itself but also in the output of the roadmap.

Roadmapping for internal use

Roadmapping is not only applied to clients of PD but it is used internally as well. The main goal in using roadmapping internally is to decide which future issues may be of importance to TNO Industry (I02, p.1). One of the issues is portables and wearables (DI09). The roadmaps serve as input to the strategic plan 2003 – 2006 of TNO Industry (I12, p.4). Although every sub-department was stimulated by general management to draw a roadmap, not every sub-department responded. One interviewee said that it is not easy to build a roadmap since many innovators at TNO Industry have a strong desire to carry out their own (applied) research and they are not totally convinced that these kinds of methods can help them (I12, p.13). Furthermore, it turns out that, when economic times are bad, manager prefer to focus on their own business area and are unwilling to cooperate, which was urged by the roadmaps (I03, p.3).

Often, the *internal* roadmaps (with a time-horizon of six years) are preceeded by a trend-analysis (I02, p.9). The internal roadmap then functions as a way to focus and make decisions. The internal roadmaps can help innovators in systematically addressing all issues that should be taken into account in the development of new products and services. In doing so, it can be used as a tool to make decisions and the roadmap can make reaching a consensus easier (I02, p.12). The value of the roadmap increases when the 'playing field' of the roadmap is broad and very diverse (I03, p.1). Also, given the dynamics of science, technology and business, the roadmap should be adjusted at least every year. Sometimes

the roadmap is already outdated when it is finished. An important condition for a good roadmap is that the participating group is not too large (i.e., four to six persons) and that, unless 'key personnel' is involved, the quality of the input is low and no decisions can be made because the people responsible that are absent from the process (ibid., p.1).

The sector roadmap project

PD found it difficult to 'sell the roadmaps, because SMEs found it too expensive and time-consuming (I04, p.1, 10; I05, p.6; I06, p.3; I14a, p.1, 10).[30] Also, due to the confidential nature of the roadmaps it was not possible to show them to other SMEs to convince them to get on board. To counter these problems, it was suggested to build roadmaps at industry- or sector-level and then tailor them to the needs of SMEs operating in these sectors. It would then take fewer resources (time, money) to build a roadmap specifically for an SME. To build the initial *sector roadmap* (or 'sector *agenda*' as it occasionally was called) the Province of North-Brabant and the Brabantse Ontwikkelings Maatschappij (BOM)[31] were contacted to see whether they could finance that part. Syntens was also asked to join the project because of its extensive relationships with local SMEs that may be potential clients of the sector roadmap .

The project was called 'Branche agenda for Business Roadmapping' (BBR-project) and was part of a programme named 'Innovatieve Acties Brabant' (in English: 'Innovative Actions Brabant'). In the BBR-project the following actors are involved:

- PD: its role is to build the sector roadmap and to apply the experience and knowledge gained in former roadmapping projects for SMEs.
- Syntens: its role is to support TNO Industry in building the roadmaps and to contact SMEs that may be interested in using a roadmap.
- The Province of North-Brabant: it is the financer of this project which it has set out to improve the 'innovative basis in the region'(DE07, p.1).
- BOM: it is the overall project leader. PD and Syntens report to BOM and BOM reports to the economic deputee of the Province.
- The steering committee: a kind of advisory board that consists of managers of SMEs, people with experience in innovative projects and consultants in innovation. Their task is to advise both those who carry out and those who manage the project.
- Two external advisors (former employees of PD) who are responsible for the methodological aspects of the project.

  Figure 7.2 shows the actors in the organisational chart of the BBR-project (DE04, p.4).

[30] The building process of a roadmap takes five months on average, consists of three workshops, and costs ~ € 20,000.

[31] In English: Development Company of Brabant.

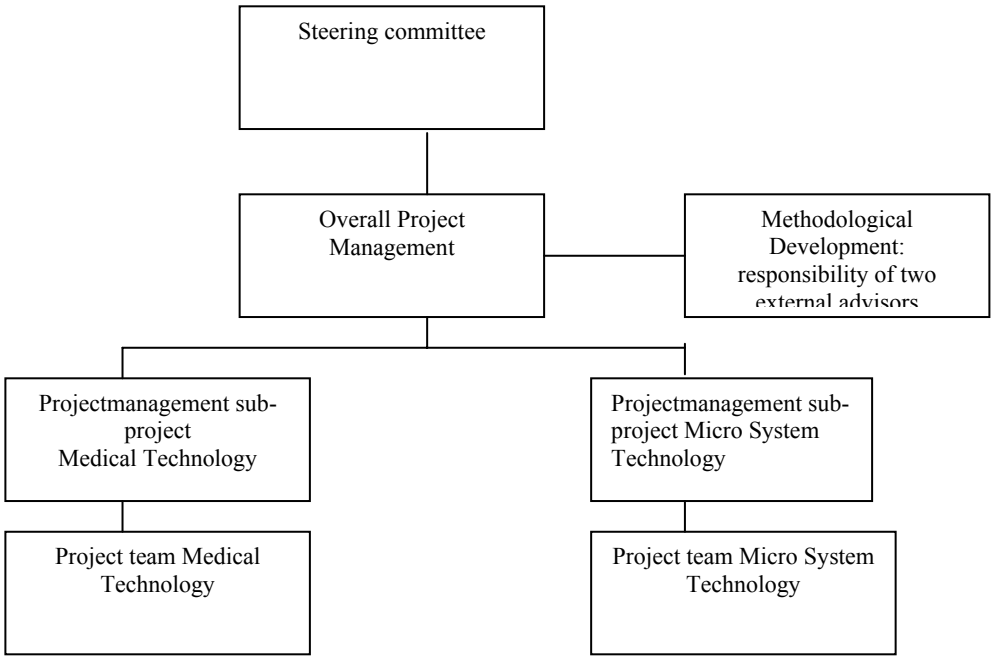

Figure 7.2 Organisational structure of the BBR-project.

The BBR-project has a number of goals. According to the main financer, its goal is to create awareness among SMEs that they have to change their way of doing business and prepare for changes in market, society, and technology (I09, p.1). The underlying motive for the BOM is that the economic situation in North-Brabant is bad[32] and that new business should be developed to rekindle economic growth in this region (I12, p.7). One interviewee of Syntens argued that the project should be considered a success if the sector roadmap makes it more easier to develop a business roadmap (I15, p.9) and another interviewee said that the project is a success if it really leads to innovation (I11, p.2).

Since it is not possible to study every sector, a choice was made to built roadmaps for 'microsystem-technology for the small mechanical en plastics processing industry' and 'medical systems and supporting tools' (DE07, p.1). Reasons for choosing these two

[32] However, one interviewee said that the economic situation is not that bad, which would make it less urgent for SMEs to make the necessary changes in their way of doing business (I09, p.1).

sectors is that many companies within these sectors are already operating in the province of Nothern-Brabant (I05, p.7). Several interviewees emphasised the need for a good and precise demarcation of the sectors (I07, p.8; I16, p.1), although doing this too early may result in a focus on the roadmap that is too narrow (I19, p.5).

It is considered important by many that various organisations from business and industry, and government and semi-government organisations are involved in the project (I09, p.1). They can play different roles within the project, such as providing input about certain (business) topics and offering access to other possible relevant actors.

The sector roadmap is based on three elements (DI02, p.6):

1. Needs: the needs of the end-user, such as the need for safety or comfort.
2. Resources: all that is needed to fulfill the needs, such as: technology, knowledge, financial capital.
3. Network: the value-system that links all the processes and actors involved in fulfilling the needs.

The building process of the sector roadmap consists of four phases (DI02, p.8):

1. Exploring the sector and determining which actors and issues to address.
2. Collecting and analyzing information about the network, the needs within the sector, and the resources available.
3. Confrontation and integration: determining the relationships between the actors of the network and describing how relevant developments will unfold over time.
4. Visualisation and description: making the elements, relationships and developments visible and accessable to the clients of the sector roadmap.

In this process, most attention and resources are devoted to phases 2 and 3, each about 30%, 15% to phase 1 and 25% to phase 4 (DI02, p.9). In every phase general tools are used, such as expert interviewing, brainstorming, and workshops. More specific methods are also applied: needs-function-parameter analysis (dividing needs into four different levels), DESTEP-analysis (analysing the developments in the societal and business environment of organisations: Demography, Economy, Society, Technology, Ecology, and Politics), stakeholder analysis, and technology application matrices.

7.5 Example of an application of roadmapping

This example (based on DE03) is about the medical industry, which is divided into telemedicine, preparation and analysis equipment for medical biotechnology, and medical imaging equipment for which different sector-agendas (or sector roadmaps) were made. This example focuses on telemedicine.

Sector roadmap telemedicine

Telemedicine uses information and communication technology to provide medical, paramedical and nurse care, and puts a physical distance between the care provider and the patient (DE03, p.9). The application of telemedicine is aimed at enhancing the quality and efficiency, and the accessability and availability of care, thereby maintaining the provision of patient-friendly care and enhancing the independence of elderly patients.
The sector-agenda for telemedicine consisted of the following steps:
1. List general developments and the most important actors (relevant for all three parts of the medical industry):
   - E.g., ageing society, patients become more critical towards care providers, indivdualisation, multicultural society, privatisation of care sector, rise of biochemics and genetics, robotics.
   - E.g., regional government institutions, Technical University of Eindhoven, TNO Industry, Syntens, regional manufacturers of medical equipment, insurance companies, family doctors, hospital physcians.
2. Build a value system for the telemedicine sector. This value system contains all the relevant actors, how they are linked to each other, how much power each actor has, and how much value each actor adds. The space available here is too limited to show the complete value system, but the following points are the most important parts of the system:
   - Equipment manufacturers add the most value and have a great deal of market power.
   - The government, insurance companies, patient organisations, the farmaceutical industry and equipment manufactures have the highest level of (market) power.
3. Describe more specifically the development of the market and needs of patients:
   - Telemedicine will first fulfill the needs with regard to care instead of cure (i.e., treatment).
   - Senior citizens will be the first users of telemedicine.
   - Saving time because patients do not have to visit hospitals for medical check-ups or treatments like dialysis.
   - Possibility of staying at home rather than at the hospital.
4. List characteristics of telemedical applications:
   - Telediagnostics-consultation: Data of measurements, static high resolution images.
   - Telemonitoring: Data of measurements, (mobile) measuring equipment, secured database system, 24/7 medical service.
   - Teletreatement: remotely controlled equipment (robotics), moving high resolution images in real-time.
5. Describe telemedical applications that demand specific technologies:
   - Information and communication technology: e.g., wireless technology, localisation systems, miniaturisation.
   - Measurement and analysis systems: e.g., sensor technology.
   - Security: voice recognition, iris/scanning, secure network connections.

6. Determine the implementation route of the available technologies by analyzing possible barriers:
   - 'Not invented here'-syndrome: manaufacturers and users in the medical sector are not always willing to share the necessary knowledge.
   - The financing model does not promote innovation (i.e., implementing telemedicine applications) because it does not finance implementation projects.
   - There is no actor who is responsible for the entire value chain (or system), which makes it impossible to mutually adjust ICT-applications of every actor.

Based on these six steps several recommendations were formulated to promote the development and use of telemedicine, such as enforcing knowledge sharing by a higher authority, appointing an actor who has overall reponsibility for the value chain, and demonstrating the effectiveness of telemedical applications through controlled evaluation research.

The business roadmap for Vitaphone.

The sector roadmap for telemedicine was made more specific for Vitaphone, a small company involved in developing the Cardiophone© that allows patients to contact a care provider immediately in case of an emergency. The Cardiophone© consists of a telephone with special functionalities, such as GPS (Global Positioning System), ECG (to record, store, and send data of heart rhythms) and a Telemedical Service Centre equipped with special software designed to diagnose, monitor and guide patients with chronic heart problems. For reasons of confidentiality the content of the roadmap can not be described here, so only the process and evaluation of the roadmap will be addressed.

For the roadmap, seven workshops and three interviews were held. First, all stakeholders (actors) are placed in an overall framework, after which the roadmap is constructed. The process more or less resembled the process of building the sector roadmap, although it is much shorter. The time-horizon of the roadmap is 2009 which is considered to be mid-term. The managers of Vitaphone are used to thinking within a shorter time horizon because technological developments in the medical industry take place at a high pace, although developments in the medical care are going slower (I13, p.13; I18, p.13). The role of the innovators of TN Industry is to facilitate the building process of the roadmap. The managers of Vitaphone appreciated the structure that the innovators brought to the (innovation and roadmap) process and the roadmap enabled them to look at their product from various perspectives (I18, p.12). The roadmap confirmed their idea that their sector is very complex and it showed them that it is better to convince physicians at hospitals of the added value of their product than to contact insurance companies (I13, p.1.). It took a lot of time to build the roadmap and the Vitaphone managers wished that they had done it one year earlier. They saw the roadmap not as a fixed thing but as a living document - "A rolling roadmap" (I13, p.14).

7.6 Case conclusions

1. The place of roadmapping in the innovation processes of SMEs.
The roadmap is positioned at the beginning of the innovation process (I02, p.6; I05, p.10; I19, p.6). The roadmap is clearly designed to generate new ideas for innovation and/or stimulate SMEs to innovate. The roadmaps can even be positioned before the actual innovation processes is started, in which case they serve at a more strategic or visionary level rather than at a specific innovation level. The roadmap is then used to decide in which field new products and services should be developed.

2. The quality of roadmapping.
Because to a certain extent a roadmap remains something of a black box, it is difficult to determine its quality. Despite the documents that show how the roadmap is built, it is not clear how the different steps in the building process are linked to each other. Also, the prescribed building process was not always followed in practice. Given a function of the roadmap – to make SMEs more aware of the importance of innovation – the roadmap should be convincing to SMEs, which some interviewees doubted (I01, p.12; I08, p.12).
Evaluations of users of the roadmap are also not a very good yardstick Given the different goals of the BBR-project some persons involved may be satisfied, whereas others are not. If the goal is to make SMEs aware of the importance and necessity of innovation, then the broad attention and distribution of the roadmaps is clearly a sign of a project that has succeeded. But if one is only satisfied if the roadmaps lead to innovation, then there is less reason to be satisfied or one should be patient and wait if any innovations (based on the roadmaps) will be developed in the future.

With regard to the role of the innovators of PD in the roadmap process, some interviewees said that they should have both knowledge of the process of roadmapping and of the issue that is addressed in the roadmap. One employee of TNO Industry, involved in roadmapping for internal use said that the facilitator should be knowledgeable on the roadmaps topic and as well as process skills (I02, p.10; I06, p.5). The general manager of Jentjens, one of the clients of the BBR-project, was somewhat disappointed about the project because he had expected more input from TNO Industry about the medical equipment market in addition to expertise about the process itself (I10, p.8).

3. The impact of roadmapping on innovation.
The roadmaps have not yet resulted in any innovations. The impact of the roadmaps of the BBR-project on innovation can be placed on a continuum. On one extreme there is the wish to have the output of the roadmap as a direct input to the innovation process, whereas on the other extreme the roadmap should make SMEs aware of the importance of innovation and inform them about the possible functionalities of new products and services (I01, p.7; I08, p.7). The sector roadmap is definitely close to the ‘awareness’-extreme. That

is to say, the roadmaps are mainly used to reach a consensus on what to innovate. From this perspective, it seems that the roadmaps help give direction to the innovation process as a whole and serve as a means to find out what it takes to develop an innovation. The roadmap should make it clear what resources are needed for the innovation and to what extent these resources are currently available.

The fact that the roadmaps have not resulted in an innovations is not considered a problem by everyone involved in the BBR-project. One interviewee said that he would be content if the two sector roadmaps are published externally and two SMEs want to use a roadmap for their company in particular (I05, p.9). Another interviewee said that it is difficult to illustrate the added value of roadmaps because most people attribute a (successful) innovation to the development trajectory and not to the visions that resulted from the roadmap (I06, p.11). Also, given the long lead times of innovation processes, there is a risk that SMEs focus their attention and resources on other daily projects because of, for instance, bad economic times (I07, p.5; I09, p.1; I20, p.15). And indeed: "There is a difference between building a roadmap and implementing one", according to one interviewee. Nevertheless, one member of the steering committee said that the BBR-project can be called a success if it really leads to innovations (I11, p.2).

One can doubt whether these various views on the goal of the project are supporting the impact of the roadmap on innovation. For instance, it is important for PD to be able to 'sell' its roadmapping method and develop it further, while for Syntens the main goal is actually to support SMEs with innovation, which means that it views the roadmap much more as an instrument rather than a goal in itself (I17, p.1). So, the variety in goals also seems to reflect the diversity in actors and stakeholders of the BBR-project.

One interviewee said that roadmapping is not necessarily connected to a specific type of innovation (I05, p.10), while another interviewee said that a roadmap is not suited for developing incremental innovations and that a certain type of technology should be the basis for innovation processes that are supported by roadmapping (I14b, p.6).

One of the functionalities of the roadmap is structuring the innovation process (I06, p.12). However, two other interviewees said that to them innovation is merely 'playing', and as such an activity for which using a roadmap may be too heavy a tool (I01, p.8; I08, p.8). Also, formalising the innovation process may lead to a situation whereby fewer radical innovations are developed. Two interviewees said that the more formal the innovation process is, the less radical the innovations developed by SMEs (I04, p.5; I14a, p.5). Developing a radical innovation can mean (according to SMEs) that the entire company is out upside down, which may endanger the existence of the company. SMEs find this too risky, which results in a rather flat risk-profile with regard to innovation (ibid.).

Roadmapping by TNO Industry is conducted in a quite extensive way. That is to say, many tools are used, much attention is devoted to defining which steps need to be taken to build a roadmap, and roadmapping is considered a service that is offered to clients (i.e., SMEs). The shift in demand from clients from 'how to innovate' towards 'what to innovate' not only is a reason to apply roadmapping, but also means that futures researchers at TNO Industry need to increase their knowledge with respect to the content (of the roadmap). This can be done by involving other experts from TNO Industry and other parts of TNO. Nevertheless, more insight also needs to be provided on how roadmapping is actually carried out. This not only means that it needs to be clear to what extent there are differences between 'the handbook' and 'the practice' of roadmapping, but also how the various steps of the roadmapping method are logically connected. Finally, with regard to the BBR-project it is good to involve many actors, since that will increase support for roadmapping, but it also means that roadmapping-projects need to serve many different goals that cannot always be aligned with each other.

CHAPTER 8 – SCENARIOS AND BUSINESS DEVELOPMENT AT PINKROCCADE

In this we chapter describe and analyse the use of corporate scenarios for business development at the Dutch IT-company PinkRoccade. The corporate scenarios are the output of a project called 'Foresight' and they are often specified into so-called 'business scenarios' that are used within the various business areas of PinkRoccade. The scenarios are used for business development, which not only includes searching (and finding) new business opportunities and concepts, but also for deciding how PinkRoccade should position itself within the different markets it serves. In addition, the corporate scenarios are used input to the strategy process of PinkRoccade.

8.1 Structure of the case study

This case study was carried out in three phases:

1. Interviews and collection of relevant internal and external documents.
   Interviews: In all we interviewed twelve employees. Three employees from head-office of PinkRoccade and nine employees from different business areas such as Healthcare, Finance, and Government. On average the interviews lasted one hour. The interviews were transcribed and sent to the interviewees for feedback (three interviewees provided additional comments). The interviews took place between January 2004 and March 2004.
   Documents: Internal and external documents about, for example, the Foresight-project and innovation and business development at PinkRoccade.
2. Analysis of documents and interviews using the case analysis framework (see Chapter 1, section 1.2 for a description of this framework).
3. A group discussion to present and discuss the conclusions of the case. This group discussion took two hours and was held at the PinkRoccade Public Sector premises in Amsterdam on April 15, 2004. Seven people attended the group discussion. Minutes were made of this meeting.

In this chapter we use the following references:

- Personal interviews: (I_number)
- Documents:
  - Internal: (DI_number)
  - External: (DE_number)
- Minutes of the group discussion (G)

The references of this case study are listed in Appendix 6.

8.2 Background of PinkRoccade

PinkRoccade.[33]

PinkRoccade is a Dutch IT-company that specializes in IT services and IT infrastructure management. PinkRoccade sells IT services and products, and it insources IT functions of large organisations. In 2004, PinkRoccade had a net turnover of € 703 million with a net profit of € 4.2 million and it employed 7,002 people.

The organisation of PinkRoccade consists of a head office and six relatively independent sectors or business areas: Infrastructure Services, ICT Management, Local Government, Finance & Healthcare, Industry, and Public Sector. In 2004, the business area Public Sector contributed the most to the net turnover: 33%, while the average share of the other business areas was 15%, with the exception of Finance & Healthcare (7%). The organisation and culture of PinkRoccade is relatively decentralised, although some employees said there is a growing wish to become adopt a more centralised approach by looking for synergies between the business areas (I06; I10). PinkRoccade also has a branch in the U.K. called PinkRoccade International Ltd., which in 2003 yielded 14% of both turnover and profit. Figure 8.1 shows the organisation of PinkRoccade in 2003.

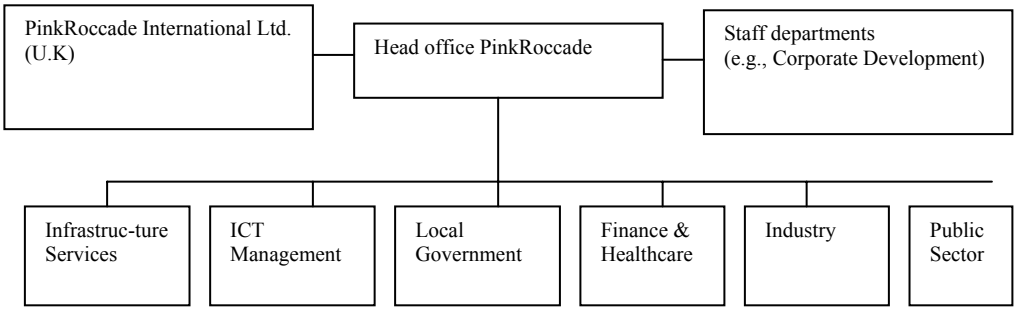

Figure 8.1 The organisational structure of PinkRoccade in 2004.

The history of PinkRoccade dates back to 1950 when the Dutch Ministry of Internal Affairs founded the State Central Mechanical Administration. From then on, PinkRoccade merged with many organisations linked to the government (e.g., the Government Computer Office ('Rijks Computer Centrum') in 1969) and it also acquired several IT departments of large organizations (e.g., the ICT department of a company called 'Bouwfonds' in 1992).

[33] Most data in this paragraph are taken from the annual reports 2003 and 2004 of PinkRoccade (DI12; DI13).

In 1993, Roccade (as PinkRoccade was then called) received a major boost when it merged with Pink Elephant (an IT services consultancy agency). In 2003, the Dutch government owned 25% of the total shares. The other 75% were owned by banks (25%) and other shareholders (50%). At the end of 2004, PinkRoccade was taken over by Getronics and it currently operates under the name of Getronics/PinkRoccade.

PinkRoccade Corporate Development.
PinkRoccade has several staff departments, one of which is Corporate Development (PR CD) which is responsible for the Foresight project (see section 8.4). PR CD consists of three employees, who are occasionally supplemented by employees from business areas. In general, its activities contribute to the corporate strategy of PinkRoccade by promoting synergy between the various business areas, and more specifically, through scenario-building with the specific aim of introducing long-term and outside-in thinking. PR CD is responsible for the Foresight-project, and it operates as a facilitator helping employees to tune the corporate scenarios to scenarios at business area (or sector) level, and to assess the consequences of the scenarios for business development and business cases.

8.3 Innovation and innovation processes at PinkRoccade

Innovation.
In its corporate strategy PinkRoccade aims at becoming an innovative company (DI12, p.4) and at realizing customer intimacy (DI11, p.4; I06; I03). Several interviewees stressed the need to connect innovation to the company's strategy (e.g., I06, p.6; I09, p.5). PinkRoccade has a Technology Board that is chaired by the head of Corporate Development and in which a few general managers of the business areas also participate. PinkRoccade has a close working relationship with forerunners in the IT market, such as Cisco, Microsoft, SAP, and Oracle, with regard both to the operation IT services and to the development of new IT-services (I06, p.4).

In spite of the company's stated desire to be innovative, one may wonder to what extent it manages to realize that ambition. For example, PinkRoccade has no patents or otherwise protected intellectual property, only a very small fraction of the total turnover is invested in innovation (I03, p.2; see Appendix 6), and only two business areas (i.e., Public Sector and ICT Management) have R&D managers (I03, p.1). One interviewee said that PinkRoccade mainly develops 'incremental service innovations' (I05, p.3). Another interviewee said that, although PinkRoccade is an innovative company, its decentralised nature prevents it from showing it to the world; sometimes the business areas do not inform each other about their innovative activities (I06, p.3).

Finally, within PinkRoccade the term 'business development' is used more often than the term 'innovation'. All the interviewees said that to them business development has the

same meaning as innovation, and that it should be viewed from a broad perspective, including product, service, and market innovation (e.g., I05, p.1; I06, p.4; I11, p.9), as well as incremental and breakthrough innovations (I09, p.6).

Innovation processes.
Formal innovation processes and methods are not abundantly present within PinkRoccade. Some interviewees did not interpret that as negative (e.g., I06, p.5; I10, p.4), because the independent business areas themselves are responsible for innovation, which in practice means that they may be involved in innovation in their own informal (or implicit) way. In other words, innovators at PinkRoccade have a great deal of freedom in deciding how to manage their innovation process, although one interviewee said that most innovators manage their innovation processes in similar ways (i.e., linear) (I05, p.3). The most formal part of the innovation process at PinkRoccade is the building of business cases for which there are different templates: "There are some templates available which contain certain criteria that have to be met but those are not general, they vary per business area" (I10, p.7). The decentral nature of PinkRoccade is clearly reflected by the fact that each business area has its own way of managing and carrying out the innovation process. However, not everyone was content with this situation and some interviewees expressed a wish to see more uniformity with regard to managing the innovation process because that may help PinkRoccade become more innovative (I03, p.2; I10, p.7).

8.4 Corporate scenarios at PinkRoccade: the 'Foresight'-project
During the 'dot.com'-crisis, in 2000, PinkRoccade went through some rough times. IT no longer was seen as the booming industry it had been and the the market changed from a 'seller's market' to a 'buyer's market' (I09, p.3). In 2002, PinkRoccade responded by initiating a project called 'Foresight', which was intended to make PinkRoccade more future-oriented, and to help employees 'to think outside the box' (or 'lateral thinking', as one interviewee called it (ibid.)). The project received much support from the board of directors of PinkRoccade, and specifically from its CEO, Henk Bosma. The project's motto was "Foresight, insight, action", to illustrate that its the goal was not only to change the way of thinking of employees of PinkRoccade, but also to produce specific business cases.
Presently, the Foresight-project group consists of three people, two of whom are working at Business Development, while the third one is working at a business area. In addition to Foresight, there is also a sub-project called 'ForeCast' where a select group of employees discuss developments (and their relationships) in areas like demography, economy, technology, and politics. The output of this group is used as input for the Foresight-project.
The Foresight-project group makes a clear distinction between the scenario *building* process and the scenario *planning* process. Building the scenarios took approximately six months. The scenario planning process, or the process of using the scenarios, has no

specific end date but in principle could go on as long as the scenarios are considered valuable by its users (i.e., employees from the business areas).

The scenarios were built 'in silence' (as one interviewee put it (I04, p.5)) to avoid too much time pressure. The project group reported to the board of directors of PinkRoccade on a regular basis. The scenario building process ended with a big workshop in which the scenarios were presented to and discussed with the the company's top-100 managers ('the Big Bang', as one interviewee called it (I04, p.5)). In this workshop much attention was devoted to the visualisation of the scenarios. For each scenario a kind of 'mood room' was built by students from the Amsterdam School of Arts, to express the various scenarios to the participants. In these 'mood rooms' different attributes, colors and even smells were used. Halfway through the workshop, the participants had a dinner that was based on the different scenarios. Each phase of the dinner was in line with the general character of one of the scenario's. After the dinner, each group was given a scenario and asked to decide what kinds of impact it was likely to have on PinkRoccade and its (future) business. The scenarios and the consequences were presented in a plenary session. Considerable time was spent 'confronting' opposing scenarios ('Bear vs. 'Gnu' and 'Beaver' vs. 'Elephant') because that enabled participants 'to think outside the box' (I04, p.6). After the workshop, the scenarios were worked out in further detail in five other workshops, each with a different theme (ICT, healthcare, public sector, security, and ageing).

The interviews that were conducted with PinkRoccade employees within the Foresight project (predominantly people in managerial positions) were an important input to the scenarios, since they gave a good overview of most of the uncertainties that are present within the top of PinkRoccade (DI01). The interviews were carried out by members of the Foresight-project group, and were recorded and analyzed. The interviewers addressed both external (of PinkRoccade) and internal issues or uncertainties. A qualitative factor-analysis[34] was carried out on the uncertainties to determine the issues that have the highest level of uncertainty that are expected to have the greatest impact on PinkRoccade and the IT-industry.

The scenarios are based on two dimensions: 1) a stable vs. a dynamic business landscape, and 2) big (societal) forces vs. small (societal) forces. By combining the two dimensions the four scenarios described below can be constructed.

[34] In a qualitative factor-analysis clustering is done by experts instead of by statistics (quantitative factor-analysis).

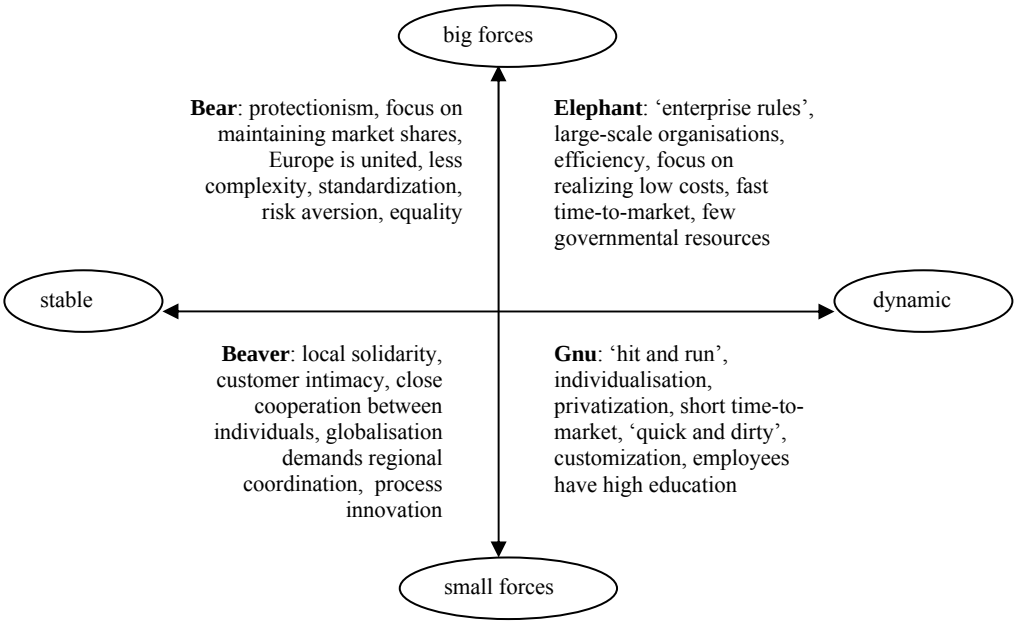

Figure 8.2 The corporate scenarios of the Foresight-project (DI03; DI06; I04).

The corporate scenarios are intended to serve as a general background or as 'business archetypes', as a central person in 'Foresight' put it (I04, p.4). The corporate scenarios are translated into *business* or *product/market/combination-scenarios* that are sometimes worked out more concretely into *industry*-scenarios (DE01, pp.45-46). The distinction between the types of scenarios is also reflected in the differences in time horizon. The time horizon of the (general) corporate scenarios (ten years from now) is different from the one used in the busines scenarios. From a business perspective the time horizon of corporate scenarios is fairly broad, making it difficult for users of the scenarios (both in the corporate departments and in the business areas) to narrow down the concerns and challenges of the corporate scenarios to the closer time horizon used by the product and business managers.
The corporate scenarios are business-to-business scenarios (I04, p.9). The main focus is on what the business landscapes of the future may look like. The scenarios are not completely in line with the notion that scenarios should be about possible future environments of the organisation. They also focus on new services PinkRoccade could offer in the future and on the organisation of companies and agencies within the scenarios. In other words, the scenarios take themselves into account, which means that there is insufficient emphasis on an outside-in perspective.

In the Foresight-project much attention is devoted to linking the scenarios to other management methods, such as SWOT-analysis and competition-analysis. An important tool is the early warning system, called 'event-analysis', which monitors (current) developments. The DESTEP-classification was used classify information concerning the developments. DESTEP stands for: Demography, Economy, Society, Technology, Ecology, and Politics. Since the scenarios are also structured on the basis of this classification, it is possible for the project-team to decide on a regular basis which scenario is 'dominant'. That is, to decide which scenario most resembles the current situation. By doing this regularly, a path running from the present and into the future can be established.

8.5 An example of an application of Foresight

In this section we describe a specification of the scenarios of the Foresight project for four business scenarios called 'Business scenario werk en inkomen' (in English: 'Business scenario work and income') (based on: DI06; DI07; DI08).

This project took place between Oktober and December 2002 and it was a joint effort between Corporate Development and the department Social Security of the business area Public Sector. The aim of the project was to determine the uncertainties in the field of work and income (e.g., what will be the role of various actors, such as government, employers, employees, citizens, and insurance companies?) and to create a greater outside-in awareness to determine possible market positions for PinkRoccade.

The first step was to determine the structural drivers for changes in work and income. The drivers were structured on the basis of the DESTEP-classification. A few examples of drivers were: increasing regional differences in the structure of the labor market (demography), individualization (society), more support for work above income (politics), technology fundamentally changes the nature of work (technology). The next step was to adapt scenarios to work and income (see Figure 8.3).

The business scenarios were used in a workshop in which the emphasis was on the position of health within social security. Therefore, the business scenarios were given different names: Corporate Health (Bear), Private Health (Elephant), Dynamic Health (Gnu), and Socio Care (Beaver). The workshop addressed the following issues:

- Presentation of the corporate scenarios and the business scenarios
- What topics are important in every business scenario?
- Which events may take place in each scenario in the next ten years?
- What are customers demands in each scenario?
- What services and products could PinkRoccade offer in each scenario?

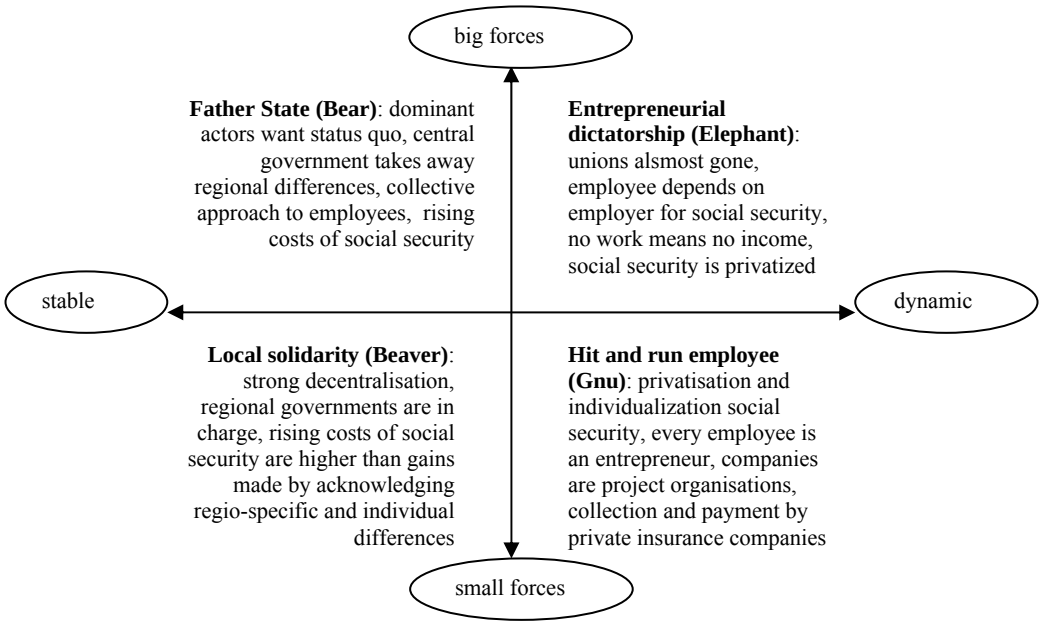

Figure 8.3 The business scenarios of work & income (DI06).

We now present a summary of the results of the workshop.

Corporate Health:
In this scenario there are many different actors (with different agendas) involved in health in relation to social security. There is no market mechanism and no innovation takes place. This 'industry' is characterized by mergers and acquisitions, with a focus on care provison and government price regulation.
For PinkRoccade the main business issues are: coping with actors that want to outsource and searching for economies of scale. Examples of services that PinkRoccade could offer are: shared service centra/ASP, consultancy, external integration, security.

Private Health:
In this scenario the sector is largely privatised, which means there is a shift in emphasis away from supply towards demand (i.e., customers are becoming much more important). The (traditional) health-insurance company becomes a 'health-broker'. However, there is also a social divide between people who can afford high-quality healthcare and people who cannot.

For PinkRoccade the main business issues are: improving communication, implementing international EPD (Electronic Patient Dossier), realizing efficiency, and a focus within companies on primary processes. Possible services that PinkRoccade could offer are: advising on implementation of IT-systems, insourcing of IT-systems, and the development of standard products.

Dynamic Health:
In this scenario innovation is triggered by patients and organized by the patients themselves on the basis of individual issues.

The main business issues for PinkRoccade are: coping with providers of healthcare that search for funding at banks, and the rise of insureance companies and/or venture capitalists. Examples of services of PinkRoccade: e.g., sector-specific marketing approach, patient organisations may become customers, extreme flexibility in providing services.

Socio Care:
In this scenario there is a new version of the 'AWBZ' (Dutch insurance arrangement for special health costs). Care is organised on a regional basis which allows for the development and use of a regional EPD.

The main business isssues for PinkRoccadre are: demand for a high quality basic care, the sharing of information within cooperations involved in care provision, and a desire to increase efficiency on the supply side. Services that PinkRoccade could offer are: support of information management and business consultancy.

This example illustrates that the Foresight-scenarios start from a broad societal perspective and are translated into concrete ideas for new IT services. What is missing is that it is not clear which decisions are made with regard to the development of new IT-services. No 'wind-tunneling' has been conducted, which means that it has not been decided which IT services have a chance of succeeding in each of the scenarios. Also, the risks of implementing a new IT service have not been not assessed.

8.6 Case-conclusions

1. The place of the (scenarios of the) Foresight-project in the innovation processes of PinkRoccade.
The scenarios of the Foresight-project are mainly used to generate ideas (I03, p.5) which is the early phase of an innovation process. Despite the connection with many other management methods (see section 8.4), no *specific* link is made to innovation (process) methods. Some interviewees said that different innovation methods were present (and used) in the different business areas, but that they were not explicitly linked to the

scenarios (e.g., I10, p.10). Also, no specific (or formal) method has been developed to *integrate* the scenarios and innovation processes. Integration takes place (only) during separate workshops in which the scenarios are used to generate new ideas for business development (i.e., innovation). However, during the group discussion one participant opposed this view (G, p.1). He argued that the various workshops provide a way to integrate scenarios and innovation. Other participants of the group discussion disagreed, arguing that it still did not constitute a specific method, but merely an *agenda* for a workshop to think about new ideas for innovation based upon a set of scenarios (ibid.).

The scenarios have been linked to other management methods but they are not linked to other methods of futures research, apart from the early warning system. A few employees suggested that that may be very helpful for using the scenarios (e.g., I03, p.3; I07, p.9; I11, p.6). One interviewee suggested that, since the scenarios aim at the long term future, it may be useful to use a short term forecast because of the low level of uncertainty (I11, p.6). This would also enhance the possibility that the scenarios are used for business development because it makes them less far-fetched and more urgent. One interviewee said that in a company like PinkRoccade, operating as it does in a very dynamic and competitive industry, scenario-thinking is almost considered "an abstraction of an abstraction" (I09, p.9), although "nothing is as practical as a good theory", he added. By linking the scenarios more to present and concrete issues, employees will find it less difficult to use them. Combining scenarios with a short term forecast and a roadmap (based upon regular applications of the early warning system) may provide the scenarios with a greater sense of urgency. In addition, other methods of futures research can also bring in more quantitative information and data to narrow the gap between the (corporate) scenarios and the specific business cases.

2. The quality of Foresight.

An important motive for the Foresight-project is to make PinkRoccade more future-oriented and to search for possible new products and services. It is considered important to convince employees that the hay-days of the nineties are over and that the future of the IT market has become much more uncertain and less advantageous than in the former decade.[35] The ongoing shift from a seller's market to a buyer's market is a clear example of this change (I09, p.3). However, some interviewees referred to reports produced by market research company Gartner claiming that in 2006 the IT market will grow again[36] and that IT companies have to prepare for when that happens (e.g., I07, p.7). So, although many considered the future of the IT industry uncertain and as such a suitable subject for

[35] However, in 2004, PinkRoccade was again fairly optimistic about the future of the IT market and described it as 'livelier' (DE02).

[36] Now, in 2006, with the benefit of hindsight, we can say that Gartner's prediction was quite accurate.

scenarios, the idea that better times are ahead serves as an incentive for developing new business cases and other plans.

In addition to making employees more future-oriented, the scenarios are meant to be used for business development as well. This also is very much in line with the wishes (or even demands) of many 'clients' (i.e., users) of the scenarios. These clients are business developers and account managers in the business areas with commercial targets. To realize this goal, additional information is needed to build a business case based on the scenarios. However, this information is often lacking. For instance, there is no information about the size and (possible) growth of the IT market (or parts of it) and that information is definitely necessary for making a business case (I11, p.7).

The difference between the two project-goals have to do with the different places within PinkRoccade's organisation where the scenarios are used. With regard to 'focus on the future'-goal, the focus is much more on the internal organisation of PinkRoccade. With regard to the other goal, there is a much more outward-looking attitude, since the scenarios are used to propose new business propositions or cases with the aim of expanding current markets or opening up new ones. It can be argued that, as far as the head office is concerned, the internal objective is the primary one, whereas for the business areas the outward-looking goal is considered more relevant. People who work in the business areas are in direct contact with customers, while the head office is further removed.

Although at the level of the business areas there is a desire to make the results of the scenarios as specific as possible and to incorporate market developments in the scenarios, the scenarios are not worked out with customers of PinkRoccade. Some interviewees employed in the business areas said that they felt that, before discussing any future plans with its customers, PinkRoccade first needed to work out what those plans were going to be (e.g., I08, p.5). In doing so, the company could use the discussions with its customers as a kind of assessment of the scenarios. Involving customers in the scenario process would mean that there would be a greater emphasis on the customer's perspective, and as a result the products and services of PinkRoccade would be described more in terms of how they add value to the business of their customers. The opinion that PinkRoccade should first have its own ideas right and clear is quite in line with the overall 'internal' nature of the Foresight-project, which became clear when we interviewed internal employees that were exclusively involved in the scenario building process. On the other hand, in deciding not to involve customers in the generation of business development ideas, the company misses an opportunity to use the experience that it gathered when using 'launching customers' (see also section 8.3) in its business development projects.

A member of the project group said that, with regard to the use of the scenarios, PinkRoccade's decentralised organisation is not always a plus (I01, p.2). A decentralised organisation makes the company more unstable, which does not have a positive impact on the follow-up of the scenario project and on the organisational embededness of the scenarios. This is especially the case for the management of the event-analysis information

that is used to update the scenarios. The information that is needed is often dispersed and it not collected on a systematic basis, because, rather than using a permanent project team, the company has to rely on a number of non-dedicated people at various points in the organisation.

Within PinkRoccade various time horizons are used. For the scenarios a time horizon of 10 years has been chosen, for the business scenarios the time horizon is five years and many business plans and business cases use a time horizon of two to three years. The time horizon of specific product development processes at PinkRoccade does not exceed one year. These differences are the result of the fact that the various departments within the company operate in different business situations. A problem is the gap between the time horizon of the corporate scenarios and the dynamics of the business in which PinkRoccade operates. In light of the relatively short time involved in the development of new IT products and services (about two years), one may well wonder whether the time horizon of the corporate scenarios is not too long. A member of the project group said that the corporate scenarios did not really have a fixed time horizon, despite the fact that some interviewees argued otherwise (I04, p.4). For him the corporate scenarios are mainly visions of business landscapes at *some* future point. Because the other types of scenarios (business, industry) are more directly linked to business development, the (shorter) time horizon becomes more important. Plans for business development often contain specific sub-plans for the investment in and market implementation of new IT- products and services, making it necessary to take a closer look at the time issue. Another problem is that it becomes more difficult to align the various types of scenarios since the different time horizons also mean that the scenarios have different levels of detail. A possible solution may be to link the scenarios to methods of futures research, such as roadmapping and back-casting, which are aimed at developments in a less distant future which are also better capable of incorporating quantitative data. Both methods are complementary to the scenario-method because they focus on how to reach a certain future (and can therefore be applied to short-term actions and decisions) whereas the scenario method predominantly focuses on establishing which (long-term) futures are possible.

3. The impact of Foresight on innovation.

The Foresight-project has not (yet) resulted in an innovation, although many business cases have been made. As a result of this the projects faces two risks. Firstly, there is a risk that the demand for scenarios may decrease because the IT market is (again) growing (see case-conclusion *The quality of Foresight*), which may be interpreted by employees as a sign that the market is less uncertain. Given the necessary lead time of the use of scenarios for innovation (i.e., building and applying the scenarios), many business cases will not be implemented. The *scenario-business-case-cycle* will then be cut short and the scenarios will not result in actual innovations. The second risk is formulated by many interviewees who are worried about the follow-up of the scenarios and their use for business

development (e.g., I07, p.8; I08, p.8). The interviews agree that, in order for the Foresight project to be successful, it is important that the project not be an on-off exercise. However, they are not in favour of setting up a dedicated department that focuses entirely on scenario-thinking, because that may reduce support for the scenarios at lower organisational levels. Having a separate department involved in scenario development would not have the desired results, because many employees would feel it would smack too much of company policy being forced upon them. "Thou shall is not done at PinkRoccade", as one interviewee formulated it (I01, p.2).

Another suggestion was given: to have a person responsible for facilitating, managing, and coordinating scenario-thinking within PinkRoccade (I07, p.7; I11, p.8). He or she would operate as a spokesperson or ambassador for the scenarios and as a central figure in the process of building and using of the scenarios. Therefore, social skills and a good knowledge of the internal organisation were mentioned as important characteristics of such a person (I01, p.3; I10, p.9). We could label this person a 'scenario champion' and he or she would be comparable to the 'product champion', a success-factor for innovation (DE03). The product champion is involved in the entire innovation process and as such has an important role in ensuring that an idea for an innovation is fully worked out up to and including its market implementation. The 'scenario champion' should play a role in every phase of the process of building and applying scenarios to innovation processed within PinkRoccade. Having a person in such a role would contribute very much to the use of scenarios in innovation processes at PinkRoccade.

However, having a 'scenario champion' is also risky because if that person would leave the organisation, the whole project may be in jeopardy (I01, p.3). In fact, the suggestion was made to a large extent because the current 'scenario champion' was about to leave the company's head office and move to a business area. In other words, it was not so much a cry for a 'scenario champion' as such, but also for a *new* 'scenario-champion'. Also, one interviewee emphasized the need to change the project group in the course of the process of building, applying, and maintaining the scenarios (I11, p.9). Building scenarios requires a different type of person than maintaining and updating the scenarios. The closer the use of the scenarios is to the development of new IT-services and products (i.e., business development or innovation), the more employees close to the business of PinkRoccade should be involved. This idea is based on the fear that the scenarios would not deliver specific results because the scenario builders may have a different interest and expertise than the eventual users of the scenarios (i.e., employees within the business areas). One of the tasks of a 'scenario champion' would be to invite the relevant expertise in every phase of the process.

To conclude, the PinkRoccade's Foresight project has resulted in a set of scenarios that are used not only for business development but also as input to corporate strategy. However, its impact on business development should not be exaggerated. To an extent this has to do with the company's informal approach to managing innovation processes which

makes it difficult to link the scenarios to innovation processes in a structural way. In light of the link between the scenarios and the company's corporate strategy, the need for which was brought up by several of the people we interviewed, and the support from the top of PinkRoccade to the Foresight-project, this is unfortunate. The impact of Foresight on business development (or innovation) at PinkRoccade would be much greater if there was a specific method to link the scenarios with the innovation process (and vice versa and) and if clients of PinkRoccade were to be involved, because that would make the business cases much more important.

CHAPTER 9 – ROADMAPPING AT PHILIPS MEDICAL SYSTEMS

In this chapter we describe and analyse the use of roadmapping at the business unit Cardio Vascular (CV) of Philips Medical Systems (PMS). Within their business, innovation is becoming more important and they put more resources into it. CV makes roadmaps on different topics (e.g., science, technology, market) that are combined into a product-roadmap. This product-roadmap is the second phase of the product creation process (i.e., their innovation process). CV is making a shift from developing separate (medical) products and services towards (medical) systems and platforms. Although these systems and platforms need more innovation time, the time-horizon of innovation is becoming shorter because more focus is put on the (current) market situation and the actions of competitors.

9.1 Structure of the case study

This case study was carried out in three phases:

1. Interviews and collecting relevant internal and external documents.
   Interviews: We interviewed eighteen employees: four employees from the marketing department, four from the clinical science and application department, three from the development department, one from the programme management department, four managers, and two employees from the NatLab of Royal Philips Electronics. On average the interviews lasted one hour. With one exception all the interviewees gave us permission to tape the interview. The interviews were transcribed and sent to the interviewees for feedback (16 interviewees responded, five of which with additional comments). The interviews took place between January 2004 and March 2004.
   Documents: Internal (e.g., internal presentations about the roadmaps) and external documents (e.g., a master thesis about roadmapping at Philips Medical Systems, and two articles about scenarios for IT-architectures).
2. Analysis of documents and interviews with support of the case analysis framework (see Chapter 1, section 1.2 for a description of this framework).
3. A group discussion to present and discuss the conclusions of the case. This group discussion took an hour and a half and was held at Philips Medical Systems in Best on July 1, 2004. Five people attended the group discussion.

In this chapter we use the following references:

- Personal interviews: (I_number)
- Documents:
  - Internal: (DI_number)
  - External: (DE_number)

- Minutes of the group discussion (G)

The references of this case study are listed in Appendix 7.

9.2 Background of Philips Medical Systems

Philips Medical Systems.

Philips Medical Systems (PMS) is an independent product division of Royal Philips Electronics and its core business is to develop and deliver products and services in the field of medical systems that are mainly for use in hospitals. The products and services of PMS have the following application areas (or functionalities): radiology, cardiology, oncology, surgery, critical care, women's health, information management within hospitals, and providing certain types of care outside hospitals.

In 2004, PMS employed 30,800 people and it had a profit from operation of € 34 million with sales of € 5.9 billion. PMS has locations on every continent and is divided into six business lines: Magnetic Resonance, Medical IT, X-ray, Computed Tomography, Cardiac Monitoring Systems, Nuclear Medicine, Ultrasound and Customer Services. Figure 9.1 shows the organisational structure of PMS in 2003.

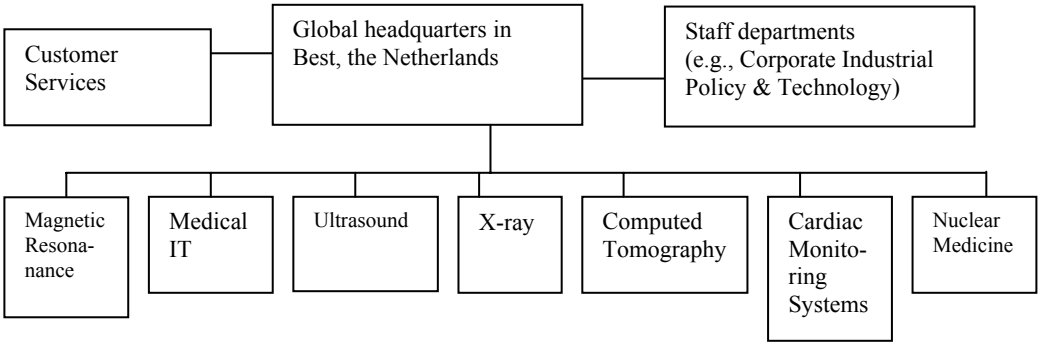

Figure 9.1 The organisational structure of PMS in 2003.

PMS operates in a business-to-business market, which mainly involves hospitals, where its main contacts are physicians who work with its products and services on a daily basis. Given the complexity of the products and services, these contacts are very important in determining the service that is required. PMS responds to this development by emphasizing its strategic ambition to realize both customer intimacy and product leadership (DE07, p.5). Due to the growing importance of healthcare worldwide, as well as the ageing populations

in Europe and the U.S.A. in particular, demand for healthcare products and services is growing.

More often the products and services of companies operating in this industry are combined, thereby creating separate platforms for providing healthcare. Within PMS this development is formulated as: "the transformation from the supply of specific, stand-alone clinical applications to a total patient 'care cycle'" (DE08, p.28). Furthermore, customers increasingly demand "full-range suppliers to provide total healthcare solutions" (DE089, p.29). In response to this, PMS regularly acquires (small) companies that help it become a full-service provider. For instance, in 1998 it bought ATL Ultrasound, in 2000 it acquired ADAC, involved in nuclear medicine and radio therapy planning, and in 2001 it took over Marconi Medical Systems, specialized in computed tomography (i.e., CT-scan) and magnetic resonance. Because GE and Siemens use similar strategies, the result of all these acquisitions is that the market in which PMS operates has become an oligopoly; PMS, General Electric, and Siemens together have a market share of about 85%. Nevertheless, small companies remain important for introducing new medical systems to the market, after which these companies are often bought by PMS, General Electric, or Siemens (DE01).

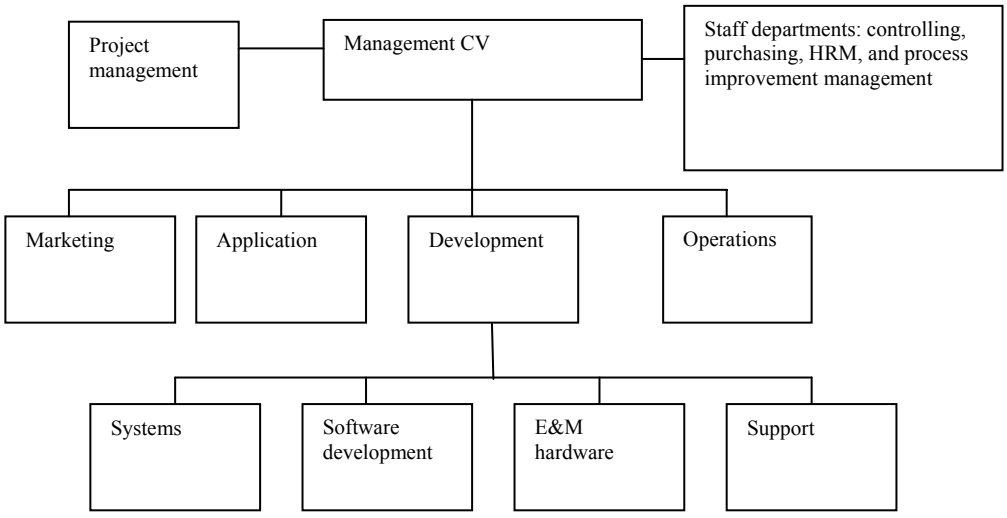

Figure 9.2 The organisational structure of CV in 2003.

Philips Medical Systems Business Unit Cardio Vascular.
Cardio Vascular (CV) is a business unit of PMS that develops and sells X-ray systems and platforms that are used to minimize invasive diagnostics and treatment of vascular and cardiac diseases. With regard to the functionality of its products a transition is taking place from diagnostics towards treatment. The products are made from (separate) components, with two-thirds software-related and one-third based on electrical engineering and mechanics. CV is "a company in itself" (I12, p.1) and it is profit-and-loss responsible. CV has its own development and sales departments and its development department employs about 482 people. Figure 9.2 shows its organisational structure.

9.3 Innovation and innovation processes at Philips Medical Systems and CardioVascular

Innovation at Philips Medical Systems.
According to its vision and strategy, PMS wants to be the most innovative company in the healthcare industry (DE07; DE08). It has close working relationships with NatLab, the central R&D department of Royal Philips Electronics as well as its own R&D lab in Hamburg, Germany. Although PMS is currently known as an innovator, that does not mean that it will automatically continue to have that image. It appears to be suffering from the 'law of diminishing returns'. That is to say, there is a risk that its comfortable market position will lead to complacency and a lack of incentives to stay alert and innovative. GE ands Siemens do have this incentive and are quickly catching up with PMS. So, there is a general feeling within PMS that its development speed has slowed down, and that as a consequence GE and Siemens are increasingly entering the market with new products before PMS does. One way to counter this problem would be to put more money into innovation, but because of these competitive pressures R&D budgets are often cut back (I12, p.8). However, it was recently decided to give additional funds to R&D (and to life-cycle management). Another way to shorten the time to market is by coupling innovation processes, in other words by carrying out different activities or stages of the innovation process in parallel or combined with other innovation processes (I05, p.7). Also, watching GE and Siemens has become more important. However, although that is in itself a valuable activity, PMS should not focus too much on its competitors otherwise, as one interviewee noted, PMS would become a market follower instead of a market leader (I08, p.10). A positive aspect is that many customers still have faith in PMS as an innovative company. One interviewee said that if a competitor of PMS introduces a new system or platform to the market, customers trust PMS to come up with a new and comparable system or platform soon (I07, p.2).

Innovation processes at Philips Medical Systems Business Unit Cardio Vascular

Innovation processes at CV are very formal, structured, and they are carefully watched and audited by organisations such as the Food and Drug Administration (FDA) in the U.S.A., and KEMA in the Netherlands (I05, p.6; I19, p.2). Its innovation process also has an ISO-certification and innovators at CV are obliged to use this innovation process (ibid.).

The innovation processes at CV is linear and can be regarded as an example of a 2nd generation innovation process[37] where market needs are used as a starting point. However, some interviewees said that technology (still) plays an important role in starting developing innovations (e.g., I19, p.3.). Lately, efforts have been made to introduce parallel innovation process so that the innovation process becomes more a 3rd generation innovation process. This does not mean that in every situation one can go back in the innovation process; once a certain phases, e.g., the research phase, has been passed, one cannot go back to it (I04, p.6). Furthermore, in the case of a new X-ray system, 2nd and 3rd generation innovation principles were combined. For example, the X-ray system itself was developed mainly in line with the 2nd generation while the workstation of the X-ray system (responsible for operating the system and producing 3-D imaging) was developed by 3rd generation innovation management.[38]

The innovation process at CV is called the Product Creation Process (PCP), although actually PCP is more than the innovation process, since it also contains the maintenance of current products. PCP has basically the structure illustrated in Figure 9.3.

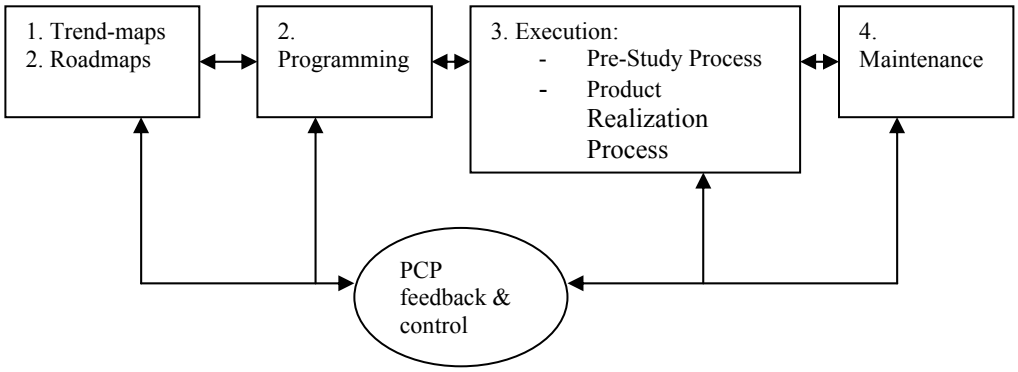

Figure 9.3 The PCP or innovation process at PMS/CV.

[37] See Chapter 3, section 3.3 for a historical overview of generations of innovation management.

[38] It is not uncommon for different ways of innovation to be used within Philips. In departments of Philips that operate in a high-tech business-to-business environment (such as PMS), customer intimacy is important (i.e., 2nd generation), while in a fast moving business-to-consumer environment a combination of consumer marketing intelligence and technology is required (i.e., 3rd generation) (DE09).

The PCP starts with trend-maps on topics such as clinical technology and market that are condensed into different roadmaps (e.g., product, clinical, technology). Based on those roadmaps, project plans for innovations are made that together form a programme. Then, the execution of the project takes place, which occasionally means that additional research is necessary to make more specific what will be developed (i.e., Pre-Study Process). After the innovation is implemented maintenance is needed. The arrows between the different stages of the PCP indicate that there is constant feedback between those stages to make sure that sufficient information is present to carry out an activity within the PCP.

The lead-times of innovation processes can vary from nine months (e.g., a new product release) to six years (e.g., a new system or platform) (I05, p.4). Given that many products have a life-cycle of ten years (during which systems are managed and supported) (I12, p.2), the time between the first idea for an innovation and the last day of its maintenance can take up to sixteen years.

Innovation at CV is a multidisciplinary activity that is always carried out in projects. To make sure that every aspect needed for innovation is taken into account during the innovation process, so-called KSF-teams are set up. KSF is an acronym for Key Success Factors.[39] The choice of these factors is the result of a trend analysis (I17, p.7). Each KSF-team has a principal and consists of representatives from the technology, marketing, and (clinical) application departments. The members of the KSF-teams are also part of the roadmap-teams and the product-managers play a role in every phase of the innovation process, which makes them a constant factor in this process (I02, p.5).

Users of products of CV (i.e., physicians at hospitals) play an important role in the innovation process. It often consults physicians to hear their views on the future of clinical applications and to receive more information about their current needs and problems with regard to the equipment they use. CV has two types of formal contacts with physicians (I03, p.2). One is a clinical network in which innovative hospitals participate that give feedback about clinical issues. For example, many hospitals from the top-50 hospitals in the U.S.A. are part of this network. The other is a medical advisory board whose members are physicians who can be regarded as 'forerunners' in their discipline. This board is invited once a year to stay for three days at CV to brainstorm about new ideas for medical systems and to assess existing ideas and prototypes. After the products are sold, CV uses field monitoring teams to see how the products are used (I03, p.2). The information from these teams is an input to the innovation process.

9.4 Roadmapping at Cardio Vascular

Various roadmaps are used at CV, such as clinical-roadmaps, research-roadmaps, and technology-roadmaps. These roadmaps are combined into a product-roadmap that

[39] Due to company confidentiality these KSFs cannot be listed in this case-study.

describes the development of various roadmaps over time. An important motivation for CV to work with roadmaps is the shift of its industry in terms of developing products towards developing systems and platforms which makes it necessary to pay more attention to how developments in products, clinical issues, market needs, and product components are linked (I12, p.3).

At a general level, the (product-) roadmap is preceeded by various trend-maps, such as a clinical trend-map and a market trend-map. First, the future clinical needs and the related clinical functionalities are described, after which technological developments are listed. The trend-map results in a kind of wish list or 'Pizza-list' (as some interviewees formulated it (e.g., I02, p.4)) that the roadmap should address. The KSF-teams are responsible for making this wish list and they are also part of the product-roadmap-teams. The various trend-maps describe what is possible and what CV would like to have with regard to its innovations. However, given the scarcity of resources within CV (e.g., budget, people) and medical equipment already installed at its customers, not all wishes can be fulfilled, which means that the content of the roadmap is (partly) the result of a negotiating process between employees of various departments of CV (I09, p.2). To some extent it turns the process of building a roadmap and its content into a compromise (I09, p.2). In other words, to a certain extent the roadmap is the outcome of a negotiating process between different stakeholders. Because the roadmap is also used to claim and divide financial budget and other resources, people have an interest in making their department or discipline as important as possible in the roadmap.

There are two outputs of the (product-)roadmap. One is a qualitative business case in which an estimation is made of how much money a new product yields. The other is a description that is used as the starting document for the project in which the product will be developed.

Figure 9.4 illustrates the context of roadmapping at CV.
Various types of trends lead to a list of functional features and KSFs that are put into the product-roadmap and the subsystem roadmap. Based on both roadmaps a programme is made containing project proposals for product development, subsystem development, or concept & feasibility roadmaps. Based on those programmes specific projects are formulated.

Roadmapping within PMS BU CV is an ongoing and iterative process involving much discussion and fine-tuning (I13, p.2). The roadmap itself is a 'living document' that is regularly updated with new information and insights (I12, p.10). So, in principle the roadmap changes along the road, although these changes become less significant as time goes on. However, in practice roadmap activities are often halted to give more space to the development activities (projects).

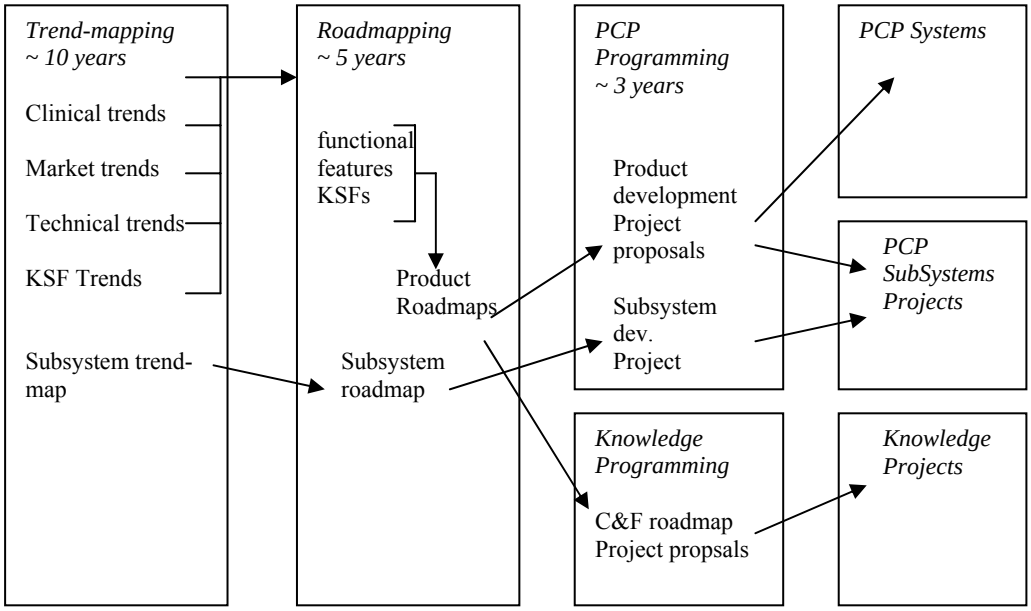

Figure 9.4 Trendmapping, roadmapping, and project programming at CV.

Employees of PMS involved with the roadmapping process are future *content* experts and not future *process* experts. In other words, they possess in-depth knowledge of a topic related to the business of CV and to future developments with regard to that topic. They know far less about the process of futures research and they are not actively involved in discovering and applying new ways of roadmapping. Only one employee of CV was trained in building roadmaps. Their roadmapping skills were further developed by their daily work in the field of roadmapping. The lack of knowledge about methods is not considered a problem as far as employees of CV are concerned (e.g., I06, p.3). They find it hard to imagine how greater knowledge of (new) roadmapping methods and tools could improve the quality of their roadmap, although some effort was put into improving the roadmapping process (DI03; DE04; DE05; DE06). They have more faith in improving the content of the roadmap itself than to improve the process of roadmapping.

And indeed, although frequently asked, the roadmappers found it difficult to describe precisely how they produce a roadmap. It appears that there is no fixed roadmapping method at CV, and every roadmapper has its own way of making the roadmap. Within CV there is no document that in some way describes the way roadmaps should be drawn up.

However, despite the variety of roadmaps at CV, a few general steps can be distinguished in building a roadmap (DI03)[40]:

1. Describe relevant trends (e.g., clinical, market) and determine which features should be part of the innovation that will be developed.
2. Describe technological trends and the technological options that can be derived from them.
3. Given the scarcity of the company's resources, priorities have to be set and decisions made about which features and technical aspects should be part of the innovation.
4. All information that is gathered and analyzed is put into a roadmap.
5. The components and the balance between resources and finances of the roadmaps are checked. Also, the roadmap is aligned with the overall vision of PMS.
6. The various roadmaps are consolidated at a higher organisational level.
7. If necessary, pre-studies are started to gain more knowledge and information about parts of the roadmap that are too uncertain or unspecific to put in the project plan that accompanies the roadmap.
8. The overall (strategic) product architecture is defined.
9. The development project is initiated.

The roadmap is not built by the same persons all the time, although the roadmap-team carries the overall-responsibility. Input is provided by different persons and teams. For instance, market trends are described by the marketers and the management of CV plays an important role in step three. The first two steps can be seen as market pull (i.e., describing customer needs) and technology push (i.e., listing technological options). The roadmap is not an activity in itself since its output serves as an input the project plan by which the innovation is actually developed. Also, it is possible to go back one or more steps. That is to say, if an aspect of the roadmap is not defined clearly enough to be executed, additional studies have to be carried out. Those responsible for the project plan consider this very important (I11).

9.5 An example of roadmapping at CV

This example has to do with a technology roadmap with topics like multi-modality and integration, and it is based on DI07.[41] Multi-modality is the combination of the results of different diagnostic (imaging) systems during the treatment. This can be done by combining or integrating different systems into one single system, or by integrating information from other systems into one medical system (for example, the integration of a

[40] Although these steps are taken from a roadmapping process from another business unit of PMS, they are almost identical to those of CV.

[41] Due to company confidentiality the content of the steps of the roadmap building process and the content of the roadmap can not be listed in this case-study.

viewing functionality into CT-scans in a cathlab). The roadmap building process involves the following twelve consecutive steps:

1. Describing strengths and weaknesses of multi-modality and integration.
2. Describing clinical trends with regard to multi-modality and integration.
3. Visualizing how clinical applications based on multi-modality are currently being used in clinical processes.
4. Creating an overview of market drivers that influence the need for multi-modality and integration.
5. Describing integration needs.
6. Describing multi-modality and integration needs.
7. Describing the current architectural scope (combination of systems and platforms).
8. Describing the future architectural scope.
9. Describing multi-modality innovations.
10. Describing the system architecture.
11. Describing the architectural concept idea.
12. Putting all the information that has been gathered into a roadmap consisting of four elements:
    - 12.1 products/services (components)
    - 12.2 product development (mainly integration activities)
    - 12.3 technology development (developing new technology and putting basic technology into the development of products and services).
    - 12.4 basic technology

The twelve steps of the roadmap building process are specifically related to each other. The first three steps and step seven describe the current situation. Step four to six describe developments in relevant areas thereby putting the current (static) situation in a more dynamic perspective. Step eight to eleven describe the 'end situation' of the roadmap, specifying to what kind of situation the trends lead. The roadmap presented in step twelve summarizes and synthesizes all the information, and makes the end situation and the trends visible. Figure 9.5 shows the structure of the roadmap.

The horizontal blocks at the bottom basically refer to processes in which knowledge is built up around multi-modality and integration. These lines can be seen as ongoing activities, the output of which is fed into the (development) of products and services (the block-figures above in the figure) that are more 'stand-alone' projects.

The roadmap illustrates that different issues (products/services, product development, technology development, and basic technology) are related to each other. One step serves as input to another step, whereby in some cases a delay occurs because another step has not yet been finished. The roadmap is not only about trends and a vision on the future but at the same time contains information about the innovation itself.

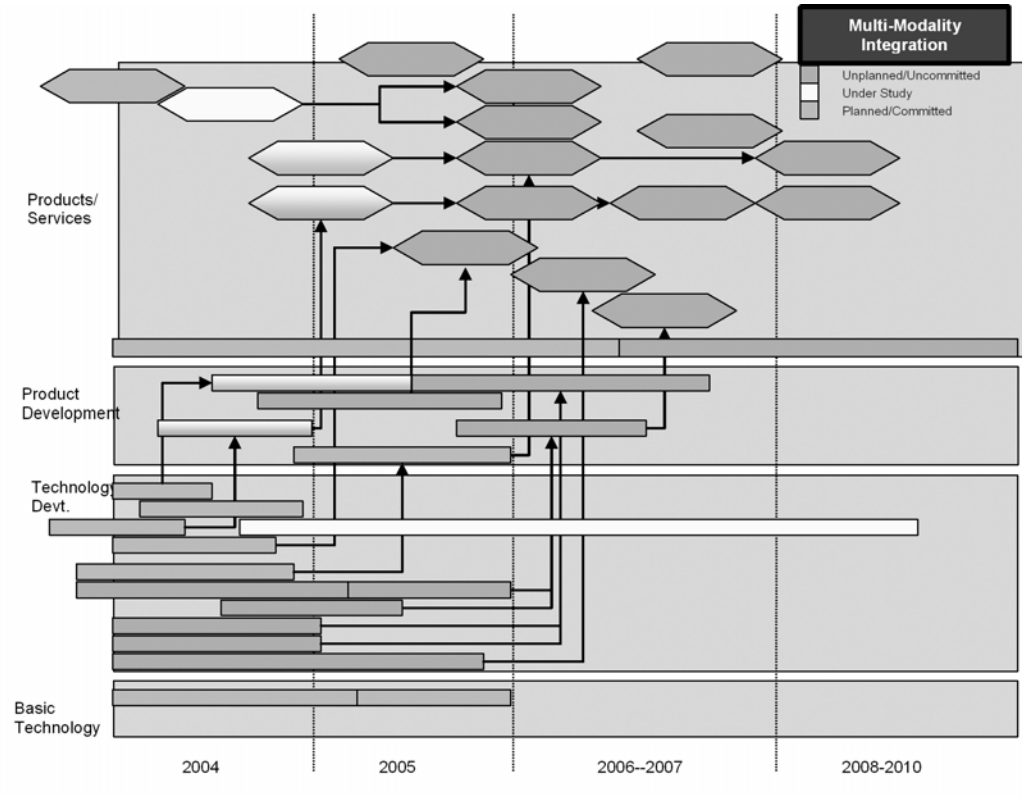

Figure 9.5 The structure of the multi-modality & integration technology roadmap of CV (DI07, p.20).

The steps that have been taken in this example are not entirely the same as the steps from section 9.4. That is, step 1 to 12.4 from the example can be considered a specific subset of the steps 1, 2, 3, and 4 of section 9.4. Step 3 is not taken into account, probably because in the example the focus already is on multi-modality, which means that less discussion is needed about which priorities have to be set.

9.6 Case conclusions

1. The place of roadmapping in the innovation process.
A product-roadmap not only contains a vision of future developments, it is also a plan that describes which products will be developed and how, and which input is therefore needed. This means that the study of the future and the innovation processes are largely similar. And indeed, according to figure 9.4 the (product-) roadmap is the second part of the innovation (or PCP) process at CV. This does not mean that there are no conceptual differences between the roadmap and the innovation process. Using a roadmap assumes that the future is fairly certain, whereas some interviewees said that the innovation process at PMS is rather uncertain (I04, p.5; I08, p.10). Also, if CV changes its innovation process from a 2nd into a 3rd generation innovation, its innovation process becomes less linear and the roadmaps will be changed more often. Given that many employees find it important that there should be a point after which the roadmap is no longer adjusted, the transition towards a 3rd generation type of innovation process will not be appreciated by everyone within CV.

2. The quality of roadmapping.
The interviews made it clear that two (related) factors influence the quality of the roadmap:
1) The time available to draw up the roadmap and to carry out the innovation process.
CV (and PMS as well) suffers from severe market-related and competitive pressures which, according to the management of CV, means that it becomes more important to develop new medical systems and platforms faster. Although this makes innovation at CV more important and forces managers to increase the budget for innovation, it does not mean that innovators and roadmappers get more time to develop new systems and platforms. Often they need to speed up their work and spend less time thinking about and figuring out new ideas for innovation. Also, the additional money is used to quickly incorporate 'new' features that competitors of CV have in their systems and platforms instead of spending the money on long term development. An advantage of the increasing pressure on innovators and roadmappers is that it prevents them for 'over-engineering'. Sometimes innovators and roadmappers look more at what might be possible from a technical perspective than at what the market (i.e., physicians at hospitals) requires (I19, p.2). A disadvantage may be that time pressure causes the roadmap to be insufficiently clear, which makes it more difficult for the project management department to work things out, which will again delay the innovation process.

2) The different time horizons present within CV.
Within CV different time horizons are used. That is to say, the different roadmaps and trend-maps have different time horizons. For instance, the product-roadmap has a time horizon of three to five years while the clinical-roadmap has a time horizon of ten years

and the spotted market developments range between one and three years. These differences in time horizons are not without problems and they are the result of a difference of opinion between the innovators or roadmappers on the one hand, and general management on the other hand. In general, the innovators have a much longer time horizon than the managers. This difference can for a great part be explained by the difference in targets. A manager has more heavy commercial and financial targets than an innovator and these targets are often only short term. Innovators have a different functional responsibility and are used to working in longer term projects. Also, as a result of market-related and competitive pressures, managers within CV (and within PMS as a whole) are more inclined to watch activities of competitors than innovators do. The result is that managers often want to change or shorten development plans immediately because a competitor has, for instance, already implemented a new X-ray system, while CV is still working on it. Many innovators are not happy with this tendency to shorten the time horizon (e.g., I09; I19). They claim that it does not have to be a big problem when a competitor introduces a new product into the market before CV does, because they can learn from the failures of this new product, and because customers are willing to switch to the portfolio of CV if that contains better products (I07, p.2). However, at the group discussion the general manager of CV said that this trade-off does not necessarily exist, and that if the short term is not properly managed there will not be any long term. Although he argued that it is important to find a balance between short and long term (G, p.1), it would appear that he also values the short term more than the long term.

3. The impact of roadmapping on innovation:

The types of innovations that CV develops have changed over time. CV (and other companies in its industry as well) develop fewer stand-alone products and services but more medical platforms and systems that can be regarded as combinations of products and services.[42] The systems and platforms have a more integral nature than the products and services. As far as using roadmaps for innovation at CV is concerned, this has two consequences: longer lead times of innovation processes, and the roadmap should mirror the integral nature of the innovation processes. The roadmap needs to contain many different types of developments, not only science, technology, clinical, and market but societal and legal issue as well. This broadening of the roadmap may cause difficulties because integrating existing developments (often described in a singular roadmap) is already a very difficult exercise.

The type of innovation does not only influence the roadmapping-process and the content of the roadmaps, there is also an influence the other way around. Despite the possibility of changing a roadmap it is assumed that there is much information, knowledge,

[42] Or, to put it differently, the products and services have become components of the systems and platforms.

and consensus about future developments in different fields (e.g., science, technology, market) and about the product, service, system or platform that will be developed. Leaving aside whether this amount of certainty is justified, the new product, service, system or platform will be very new and very different from its predecessor and can therefore be labelled a *radical* innovation. A roadmap depicts a development or evolutionary path towards a radical innovation. If CV wants to develop less radical types of innovations as well it would be advisable to use other methods of futures research besides roadmapping that are better capable of supporting the development of less radical or incremental innovations.

In conclusion, roadmapping is an important element of the innovation process at CV. Its innovation processes are structured and formal and much effort is put into them. Roadmapping at CV, by contrast, is a much more fuzzy process; the process of building the roadmaps is not clearly documented and it is influenced by negotiations between different stakeholders. Roadmapping at CV would benefit from a more formal approach (as is done with regard to innovation) because, given that there is sufficient expertise about the future present, the only room left for improving is in the process of building roadmaps. CV has enough future content experts, so one or more future process experts would be welcome. It also shows that both roadmapping and innovation are heavily influenced by developments in the industry of CV (and PMS) and by the organisational climate. Greater emphasis on a faster development of new medical systems means that innovation processes are to a larger extent carried out in parallel, and that sufficient resources are not always put into the roadmaps. However, roadmaps and innovation are also influencing each other. That is to say, using roadmaps has led to a change in the types of innovation: from incremental to radical innovation. The roadmaps leave ample room for more radical approaches to innovation, and by their 'evolutionary' nature favour radical innovations.

CHAPTER 10 – CROSS-CASE ANALYSIS, OVERALL CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

In this chapter we first cross-analyse the six cases (section 10.1) to formulate a set of overall conclusions (section 10.2). Then we discuss this research by assessing the validation of this research (section 10.3) and we close this chapter with recommendations on how to carry out futures research in innovation and by listing an agenda for future research in this field (section 10.4).

10.1 Cross-case analysis

In this thesis we addressed the following research question:

How do commercial organisations use qualitative futures research methods in innovation processes?

We answered this question at case level (the case conclusions) through a *within-case-analysis*. In this section we take it further by carrying out a *cross-case analysis* from six *perspectives* (taking into account the case conclusions as well) that are related to our research question, to come to a set of overall conclusions (see section 10.2):

1. Comparison between the use of futures research methods in the cases: scenarios, trend-analysis and roadmapping. We cross-analyse from this perspective because in our research question we specifically addressed the different (qualitative) methods of futures research.
2. Comparison between the different ways in which futures research and innovation are integrated in the cases. We cross-analyse from this perspective because in our research question we specifically addressed how the use of futures research in innovation is taking shape.
3. Comparison between the users (or clients) of futures research in the cases. We cross-analyse from this perspective because the use of futures research methods in innovation processes is carried for users (or clients) and because the cases can be categorized on the basis of the type of user.
4. Comparison between the place of futures research in the innovation process (case conclusion).
5. Comparison between the quality of futures research (case conclusions).
6. Comparison between the impact of futures research on innovation (case conclusion).

Perspective 1: Comparison between the use of methods of futures research.
In this thesis we have looked at three futures research methods: the scenario-method, roadmapping and trend-analysis. All six cases used one of these methods. Before addressing these methods separately, it must be noted that in the cases it is shown that these methods can be used in combination (see also: Masini, 2001; Bouwman & Van der Duin, 2003). For instance, the roadmaps used by Philips Medical Systems were preceded by 'trendmaps', trend-analysis at DaimlerChrysler often resulted in different scenarios, and the scenarios of KPN Research often contained roadmaps to make clear how certain new ICT-products and services can be realized. Especially trend-analysis seemed to be not only a specific method but also a kind of umbrella for all the various methods. For instance, trend-analysis at DaimlerChrysler meant not only looking at long term developments but it also entailed sketching out different possible futures and analyzing with which new products those futures can be realized. At a lower level of detail, we see that many tools, such as expert-interviewing, brainstorming and group discussions were used in all three methods.

- *The scenario-method*: this method was used by KPN Research and PinkRoccade. Their way of building scenarios was quite similar, which can partly be explained by the fact that the person who had the main responsibility for the scenarios at PinkRoccade had been part of scenario-project at KPN Research. Both types of scenarios were aimed at societal developments and they can be characterized as *corporate scenarios* that were made more specific to be used by separate business units of the two companies. However, there are also some differences. KPN Research had developed a specific method to combine the scenarios and the innovation process, while PinkRoccade combined the two only in an ad hoc manner (see perspective 2). KPN Research had interviewed many experts outside the organization, while PinkRoccade focused on its own experts. KPN Research used the scenarios in the innovation process together with clients, while PinkRoccade did not. Finally, PinkRoccade received support from the board of directors, while KPN Research lacked such support. With regard to innovation, both companies emphasised the importance of combining technological and market-related knowledge. Both companies had a strong technological basis but they were aware of the growing importance market and societal influences on technological development and innovation. That is also the reason why both companies developed their scenarios from a societal perspective.
- *Trend-analysis*: this method was used by both Syntens NT and DaimlerChrysler but they applied this method quite differently. Syntens NT mainly used it to generate new ideas or interesting fields for innovation within different industries. DaimlerChrysler directed its trend-analysis more specifically to the automotive industry, although it also took more general technological and societal developments into account. This means that the distance between futures research and innovation was smaller at DaimlerChrysler than at Syntens NT, despite the fact that Syntens NT used a specific

integration-method (see perspective 2) and DaimlerChrysler did not. In its trend-analysis, Syntens NT confronted different types of experts (and non-experts) with each other, while at DaimlerChrysler the experts involved were more homogenous (i.e., more focused on the automotive industry).

- *Roadmapping*: this method was used by TNO Industry and Philips Medical Systems. The difference in how the two companies used this method is mainly related to the goal for which they applied it. TNO Industry uses the roadmap to come up with new ideas or fields for innovation, while at Philips Medical Systems the roadmap is a direct input to project programming within which new medical systems and products are developed. Also, TNO Industry applied roadmapping to an industry or a part of that industry, while Philips Medical Systems developed its roadmaps around their portfolio and markets.

Perspective 2: Integration of futures research with innovation.
The level of integration of futures research with innovation can be described as a spectrum ranging from an ad hoc integration, via a so-called *integration-method*, to full integration between futures research and the innovation process:

- Ad hoc integration: the futures research method and the innovation process are separate entities that are combined occasionally in an *ad hoc* manner, for instance in a singular workshop.
- Integration-method: the integration between futures research and the innovation process is established by the development of a specific *integration-method* in which the method of futures research and the innovation process are integrated or combined.
- Full integration: the futures research method and the innovation process are fully merged with each other: looking to the future equals innovating.
  Figure 10.1 shows this spectrum.

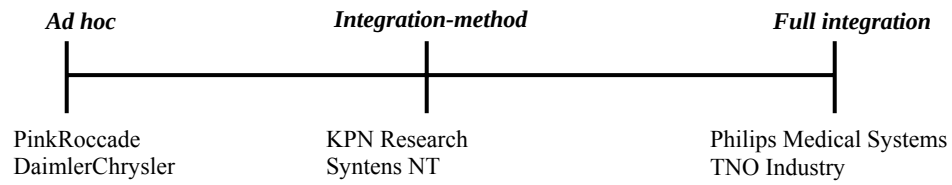

Figure 10.1 The integration of futures research and innovation: a spectrum.

PinkRoccade and DaimlerChrysler are the two cases in which futures research and innovation are integrated in an ad hoc way. In both cases studies of the future were not related directly to the innovation process although the goal of looking to the future was to

develop new products and services. The integration takes place 'afterwards' in, for example, separate workshops in which the consequences of the scenarios (PinkRoccade) or the trend-analysis (DaimlerChrysler) for innovation were assessed.

The *Innovation Chain* (IC) of KPN Research and the *ToekomstWijzer* (TW) of Syntens NT are two examples of an integration between futures research and innovation through a specific method. In both cases a method was developed that not only described how to conduct a study of the future but that at the same time described how this study can be translated into (ideas for) innovations. This does not mean that the entire study of the future was part of the integration method. In the case of KPN Research, the IC used an existing set of general scenarios that were specified to the topic of the IC, and in the case of Syntens NT the participants of the TW could bring in their 'own' trends, in addition to the existing trends that were proposed by the facilitators of the TW.

Two examples of a full integration of futures research with innovation process are provided by TNO Industry and Philips Medical Systems that both use roadmapping. The roadmapping-method is not only used to build a vision of the future, but at the same is meant to show how that future may be realized. The roadmap is indeed part of the innovation processes, as the Philips Medical Systems-case illustrates.

The level of integration does not relate directly to the other of the two futures research methods being used. Both the scenario-method and trend-analysis can be part of an integration method or not.

Perspective 3: Comparison between the users or clients of futures research.

The users of futures research can be very diverse and the cases were also chosen deliberately to capture that diversity. However, the users (or clients) of futures research can be divided into two criteria: 1) internal users and external users (i.e., users within and outside the organisation), and 2) SMEs and large companies.

Futures research is used for internal purposes at PinkRoccade, DaimlerChrysler and Philips Medical Systems, and for external purposes at KPN Research, Syntens NT, and TNO Industry. Our study indicates that the goal of futures was less specific when it was used for external purposes than it was for internal purposes. When it was used for external purposes, the goal was mainly to make users aware of the importance of looking to the future and of innovation, while its use for internal purposes usually implies a more specific goal, in other words, it should definitely result in specific ideas or plans for innovation that were a direct input to a product or service development program. In addition to this, external use involved adopting a wider perspective than internal use. Internal use usually meant that the research was geared more directly towards innovation whereas external use implied a greater emphasis on exploring fields of innovation.

The main difference between futures research at SMEs and at large(r) companies is that at SMEs employees look to the future in an implicit way, whereas large companies adopt a more explicit approach to doing futures research, as expressed in, for instance, the presence

of a dedicated futures research department. This can, of course, be explained by the fact that large companies have more (financial) resources at their disposal than SMEs. Also, with regard to innovation, we see that SMEs adopt a more informal approach than large companies, obviously for the same reason. Furthermore, an important motive and effect of the work by Syntens NT and TNO Industry is to make SMEs aware of the need for looking at the future and to show them how they can do so. The same is true with regard to innovation, where both Syntens NT and TNO Industry see it as their task to support SMEs by increasing awareness and by providing more structure to their innovation processes. Within large companies both futures research and innovation are embedded in a more formal culture. With the exception of PinkRoccade[43], futures research is an ongoing activity as far as larger companies are concerned, whereas for SMEs it is something they occasionally pay attention to, for instance by attending a workshop to which they are invited. Nevertheless, the continuity of futures research at larger companies also suffers from cyclical swings (see also below: *The impact of futures research on innovation*). DaimlerChrysler's futures research department was downsized in 2005 due to lower growth rates in the automotive industry, and KPN Research was completely outsourced to TNO in 2003. Futures research at PinkRoccade fell on hard times when the company was taken over by Getronics in 2005.

Perspective 4: The place of futures research in the innovation process.
Ad 1) In all cases futures research was used in the earlier phases of the innovation process that in all cases was linear. In these early phases the first ideas for an innovation were generated and the first specifications of those ideas were made. This means that the main function of futures research was to inspire innovators to generate new ideas for innovation and not to test the *future-proofness* of existing ideas (which is how world-famous trend watcher Faith Popcorn uses futures research; e.g., Popcorn, 1991). Also, the main function in those phases was to create awareness with regard to the importance of innovation and to generate some promising directions for innovation. This phase of the innovation process comes soon after the process of formulating an innovation strategy which precedes the (execution of) innovation processes. In that situation, an organisation has a top-down strategy in which the direction of innovation processes is determined by the corporate and innovation strategy. This is called an *rationalist innovation strategy* (Tidd, Bessant & Pavitt, 1997, pp.58-59). Given the inspirational function of futures research in the innovation process, futures research seems to be used by organisations that approach their innovation strategy process from a top-down perspective. Futures research is then used to formulate a (new) innovation strategy and to think about new innovations. To align the innovation strategy and innovation processes of an organisation it is important that the

[43] Although within PinkRoccade all interviewees expressed the need to conduct futures research on a continuous basis.

same study (or studies) of the future should be used. If that is not the case, management and innovators are working in different directions, as is shown by the KPN Research-case.

Perspective 5: The quality of futures research.
The quality of futures research is determined mainly by which function it fulfills in the innovation process and the evaluation by its users. If the goal is to enhance the awareness among clients of the importance of looking at the future in innovation, one should not be surprised that no actual innovations are developed. In cases where the stakeholders have different expectations, as in the TNO Industry case, the use of futures research in innovation processes was evaluated very differently.

To decide about the quality it is also important that futures research is carried out in a transparent way. In the cases of KPN Research, Syntens NT, PinkRoccade, and DaimlerChrysler it is quite clear how the input, throughput, and output stages of the process of futures research are linked to each other. Especially the Syntens NT case shows that bad input (i.e., vaguely defined propositions, a wrong mix of experts) can lead to disappointing results or output (and vice versa). Indeed: "garbage in, garbage out". But at TNO Industry and Philips Medical Systems the throughput stages of futures research is much more of a 'black box', which makes it difficult to make an accurate assessment of the quality. The difference between the two cases is that at Philips Medical Systems the output of futures research is much clearer than at TNO Industry.

Perspective 6: The impact of futures research on innovation.
The overall impact of futures research on innovation depends on what its goal is and on the extent to which people involved accept this goal. Also, the logical link between futures research and innovation (as described in Chapter 3, section 3.1) can at the same time have a weakening effect on the impact of futures research on innovation. That is to say, because of the long lead times of innovation processes (which makes futures research necessary), few people connect the use of futures research in the first phases of on innovation process and the actual implementation of a new product or service years later. The laser cutting machine example we mentioned earlier is a case in point. In the case of DaimlerChrysler it was said that given the many different internal departments and outside actors involved in the innovation process, it is hard to substantiate the actual contribution of futures research to the company's performance. And one of the people we interviewed in the TNO Industry case said that, generally speaking, most employees will attribute a successful innovation to the quality of the development process rather than the ideas that were generated at the start of the innovation process.

The long lead times of innovation cause another problem. Based on the relationship between general economic conditions and (macro-)developments in futures research described in Chapter 2, we assumed that organisations look to the future and innovate when business is going well. However, the cases indicate that many organisations find precious

little time to engage in futures research when business is booming, busy as they are satisfying customer demand. When we add to that the fact that most companies simply lack the resources when business is slow, the conclusion is that there will always be a reason to focus on the problems at hand rather than looking ahead. An explanation between this difference in the macro- and micro-level could be that, given the long lead times of innovation processes, the need for innovation and looking to the future might be countered because in the meantime the macro-economic conditions have improved or severe cutbacks in costs have been made. This can result in less need and attention for innovation and futures research because business is going well again.

10.2 Overall conclusions

Based on the cross-case analysis in section 10.1, in this section we formulate the overall conclusions of this thesis. Based on the overall conclusions we present a theoretical framework regarding the use of futures research in innovation and we give a short description of the cases projected into the framework. After that we review the overall conclusions on the basis of the theories discussed in Chapter 1, section 1.3, to assess to what extent they provide an explanation for these overall conclusions.

Overall conclusions.
1. Different interactions between futures research and innovation (based on perspective 2).
The lesson from the cases in this thesis is that the connection between futures research and innovation is rather implicit. Although most organisations realize that futures research is important, they find it difficult to integrate its results into the innovation process.[44] This also means that in most organisations futures research does not always have a clear and direct influence on the development of innovations. Of course, all this depends on how futures research and innovation are integrated (see the *Integration of futures research with innovation*-perspective). Given the differences in the extent to which futures research and innovation can be integrated, one should not automatically assume that an integration provides the best connection between futures research and innovation. Although at Philips Medical Systems futures research and innovation are closely linked, this link is much weaker at TNO Industry. Also, futures research and innovation seem to be connected much more closely at KPN Research and PinkRoccade than at TNO Industry. As a consequence, the use of futures research in innovation processes is rather diffuse which does not always make it easy to determine its impact on innovation.

[44] Indeed, not using the results of futures research in an innovation process or in any decision-making process is a classical problem of futures research (De Geus, 2005; Schoonenboom, 2003).

2. Futures research as a source of inspiration (based on perspective 4).
In all the cases described in this thesis, futures research is used in the early phase of the innovation process. This means that the purpose of futures research is to inspire innovators to generate new ideas for innovation, which is a common function of futures research (e.g., Abeln et al., 1996), and not to test the 'future-proofness' of existing ideas. Also, in this early phase futures research is intended to create awareness with regard to the need for innovation and to show promising directions.

3. Futures research and type of innovation (based on perspective 1) .
The scenario-method and roadmapping are linked to more radical innovations, and trend-analysis, because of its evolutionary nature, is more suitable for incremental (technological) innovations. For instance, at Philips Medical Systems a shift was made from developing singular innovations (a new product or a new service) towards more integrated innovations (a new system). This shift made the company decide to use roadmapping, because it enables the incorporation of various challenging aspects in the innovation process. As a result, Philips Medical Systems witnessed an internal shift towards developing more radical innovations. This is in line with Pearson's uncertainty map (Trott, 1998), where the fact that there is a higher level of uncertainty concerning the outcome of the innovation process and the innovation process itself means that an innovation is (more) radical. This uncertainty is higher when more new aspects are taken into account in developing the innovation, which also means that futures research should address this multitude of aspects. The cases show that roadmapping and the scenario-method are better able to take these aspects into account than trend-analysis.

4. Futures research, innovation, and the economic climate (based on perspective 3 and 6).
Many organisations find it hard to carry out futures research and innovation when business is going well and they are working hard to satisfy short-term customer demand. On the other hand, when business slows down, there is the immediate concern of trying to keep afloat, which more often than not leaves few financial resources to spend on futures research and innovation.

5. Futures research and innovating are human activities (based on perspective 1 and 5) .
The role of the futures researcher and the innovator are vital. Despite the wide range of methods of futures research and different innovation processes, the futures research and the innovator are of vital importance in applying these methods. The cases show that, in general, the futures researcher brings in the process skills and the innovator brings in information and knowledge about the issue involved. Usually, the futures researcher is a future *process* expert and the innovator a future *content* expert. The cases make it clear that at present there is either a lack of process skills with sufficient content knowledge, or there are sufficient process skills but a lack of content knowledge. The ideal futures researcher

possesses both sets of skills, but this is a very rarely the case. The KPN Research-case shows, for instance, that a situation in which process and content experts ignore each other is not helpful to integrating futures research and innovation. The PinkRoccade-case shows that attention should be paid to collecting all relevant knowledge of futures research (process and content) within an organisation at a central place to avoid having to rely too heavily on one individual.

6. Towards a theoretical framework for the iterative use of futures research in innovation.
Based on the above-mentioned overall conclusions, we suggest the (basic) theoretical framework described in Figure 10.2. The boxes are processes (applications) and the balls are the results of these processes.

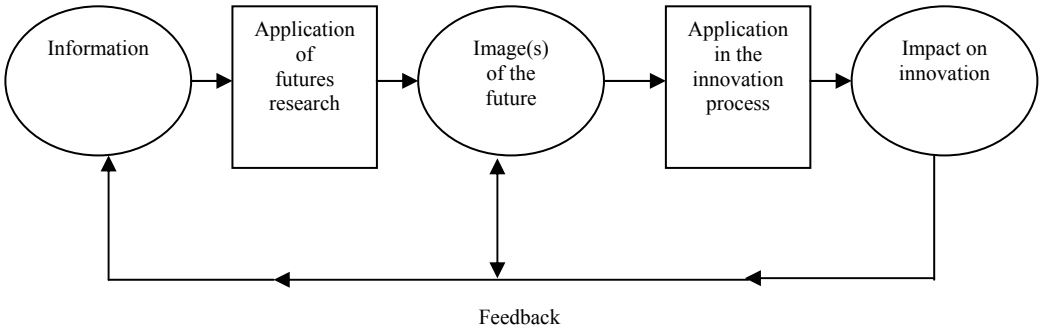

Figure 10.2 Framework for the iterative use of futures research in innovation.

Figure 10.2 should be read as follows. First, information is gathered about future developments through (expert) interviews, desk research, brainstorming workshops, and information from (international) websites. Next, this information is structured and analyzed by using a suitable method of futures research, which results in one or more images of the future. The result is used in innovation projects. This application should have an important impact on idea generation and idea selection with regard to innovation. Because old innovations propel new innovations, there is a feedback loop between the two. The cases in this thesis show that there is a weak connection between the left hand part and the right hand part of this framework.

As said, this framework is based on the overall conclusions outlined above. The elements or building blocks of this framework (the boxes and balls) can be considered the units of analysis of this research: *information* serves as input to the process of futures research; the *application* of futures research is the throughput of the process of futures research; the *image(s)* of the future, which can be considered the output of the process of

futures research, the a*pplication* in the innovation process, which is the use of futures research in innovation processes; and, the *impact* on innovation, which is the innovation and the result of an innovation process.

Figure 10.2 can be seen partly as a combination of Table 3.2 (from Chapter 3, section 3.2) and Figure 3.1 (from Chapter 3, section 3.3). What is new in this figure is that the *Application in the innovation process* has been added. This addition can be seen as the link between futures research and innovation. Also, two feedback loops have been added that make this framework an iterative one.

The overall conclusions play a role in the connection between the units of analysis. Overall conclusion 1 (*Different interaction*) is the link between *Image(s) of the future* and *Application in the innovation process*. Overall conclusions 2 (*Futures research as a source of inspiration*) and 3 (*Futures research and type of innovation*) link *Application in the innovation process* with *Impact on innovation*. The *Feedback loop* is related to overall conclusion 4 (*Futures research, innovation, and the economic climate*) since that influences the speed with which new studies of the future are set up again. Finally, overall conclusion 5 (*Futures research and innovating are a people's job*) is linking *Information* with *The application of futures research* and *The application of futures research* with *Image(s) of the future*.

Application of Figure 10.2 to the cases.

1. KPN Research: The information and the application of futures research as expressed in the corporate scenarios of the *Destination 2005-project* are constant. But the images of the future and the application in the innovation process (by using the *Innovation* Chain (IC)) change because clients have different needs and operate in different industries. Subsequently, the impact on innovation is also different, which means that (different ideas for) innovations are generated. The feedback loops from *impact on innovation* to *information* and to *images of the future* are not strong because the IC is applied only once for each client. Although the futures researchers at KPN Research may learn how improve the process of carrying out the IC, the knowledge they acquire does not benefit from the different impacts on innovation. Every result is so specific that it can not be used in other ICs. Therefore, the *information* and *image(s) of the future* are not adjusted by (new) *impacts on innovation*. So, *information*, *application of futures research*, *images of the future*, and *application in the innovation process* are closely related. However, the *impact on innovation* is relatively disconnected and there are no feedback loops.

2. Syntens NT: Except for the *application of futures research* and *application in the innovation process*, the other parts of the framework are partly or completely new in every workshop of the *ToekomstWijzer* (TW). In most TWs participants can bring in their 'own'

trends although the trends generated at national TWs often serve as a first input. Based on this new information participants transform this information into one or more new images of the future with the support of the IC-method. These (new) images of the future are then applied in the innovation process with the support of the IC, after which the impact on innovation is established. Compared to the KPN Research case the feedback at the TW is stronger, because the information generated during an IC is in many cases re-used in other TWs.

3. DaimlerChrysler: At DaimlerChrysler the elements of the framework are quite closely related, although they do not have a specific integration method (see perspective 2 of the cross-case analysis). The futures researchers of DaimlerChrysler are aware of the fact that to be successful with their work they should address every element of the framework. Often in their working situation the framework works from right to left. That is, decisions about the *information*, the *application of futures research*, and the *image(s) of the future* are motivated by the *impact on innovation* as formulated by their clients. This does not mean that their clients already have developed an innovation and look for an image of the future that justifies the development of their innovation. Rather, the desired type of outcome of the project (i.e., the goal of the project or the type of decision it should support) determines, for instance, the choice of the futures research methods or the type of information that is needed. The feedback loops are quite strong at DaimlerChrysler. Due to the size of their futures research department and their professional approach towards futures research, there is room to reflect on the methods and process of futures research, although because of internal financial problems and competitive pressures in their industry this room for reflection is shrinking. In addition to this 'internal' evaluation, much evaluation is conducted through different types of project reviews at a higher organisational level (see also Chapter 6, section 6.3).

4. TNO Industry: In the TNO Industry case the elements of the framework are very closely related and almost entirely overlap due to the use of roadmapping. In this futures research method looking to the future and innovation are almost equalled (see also perspective 2 from the cross-case analysis). All this does not make their way of working very transparent. The framework applied to their situation makes it almost like a *black box* in which it is hard to determine which activities have led to a specific image of the future and innovation. Contrary to the Philips Medical Systems-case (see below) where they use roadmapping as well and where the working direction in the framework often goes from right to left, the working direction at TNO Industry is mostly from left to right. This can be explained by the fact that the outcome of the roadmapping-project is not to establish a specific innovation but rather to increase the awareness of the importance of innovation and to provide some possible directions for innovation. The output is then too abstract to

point out which future developments (that together make an image of the future) are needed to realize the innovation described.

Given that they have not carried out many roadmapping projects and that every roadmapping-project has been quite specific, there was not much feedback specifically with regard to the roadmap. With regard to the overall project of designing a method for roadmaps at industry level, there was much feedback (and review), for instance from the steering committee and overall project management (see Chapter 7, section 7.4, Figure 7.2).

5. PinkRoccade: The elements *information*, *images of the future*, and *application of futures research* are constant in the PinkRoccade. Their *Foresight*-project has resulted in a set of corporate scenarios based on mainly internal interviews. But the *application in the innovation process* and the *impact on innovation* are different in every project. That is to say, the different business units of PinkRoccade have applied the corporate scenarios of the *Foresight*-project to their specific industry and portfolio in different ways, resulting in a different *impact on innovation*.

In almost every application of the corporate scenarios of PinkRoccade employees of the Foresight-project team were involved, often as facilitators. As a result, they were able to learn from every application, although the individual outcomes were difficult to re-use due to the differences between business units (i.e., portfolio and industry). With regard to the corporate scenarios themselves, they were regularly updating these scenarios through the use of an *early warning system* which enabled them to update their trends and scenarios. However, after the *scenario champion* left there was a serious threat to continuity when it took (too) much time to find a replacement.

6. Philips Medical Systems: Similar to the TNO Industry case, the elements of the framework applied to Philips Medical Systems are very close. However, because different departments carry out different parts of the roadmap, it is easier to see how the entire process of using futures research for innovation takes place. Like in the DaimlerChrysler case, the working direction is from right to left because in the roadmapping-method an idea for an innovation is often formulated first, after which the necessary future developments that are part of an image of the future and that should take place, are sketched out.

Given that at Philips Medical Systems roadmaps are considered *living documents*, there is much room and freedom to adjust the roadmaps, which means that there is plenty of feedback. In addition, the different versions of the roadmap are often presented to higher organisational levels, which adds a vertical (hierarchical) dimension to the feedback.

Overall, we see that the proximity of the relationships between the elements of the framework varies. In some cases the elements are so close to each other that they overlap, which often makes the process of using futures research in innovation less transparent. If

the elements are brought close to each other by a method that integrates futures research and with innovation the level of transparency increases.

Overall, the feedback loops are not very strong because futures research in innovation is often only applied to independent projects. The feedback loops that are present often refer to the process of using futures research in innovation.

Assessing the overall conclusions on basis of the theories of Chapter 1, section 1.3.

1. Different interactions between futures research and innovation.
In their survey, Kärkkäinen et al. (2001) establish the link between futures research methods and innovation by focusing on hidden and future customer needs for product development. However, they conclude that "(T)he utilization of methods may not be very well-integrated in the current product processes of the studied companies, and their use can be unestablished and accidental" (ibid., p.402). Doctor, Newton & Pearson (2001) establish a link between futures research and innovation by discussing a set of (quantitative) methods that are used to assess (future) uncertainty in R&D.

The difference between these two studies is that Kärkkäinen et al. (2001) conclude that the link between futures research and innovation is often not present, while Doctor et al. (2001) try to make this link more explicit by reviewing (quantitative) methods that connect futures research to innovation. This difference may be explained by the fact that Kärkkäinen et al. adopt a more empirical perspective by looking at ways in which organisations use information about the future in their product development process, while Doctor et al. focus more on whether there are methods to bring the two elements closer together.

2. Futures research as a source of inspiration.
The article of Saul (2002) underlines this overall conclusion. He describes a scenario-project in which the participants of scenario-workshops were able to "consider possible new product and service offerings from a perspective that was systematically different from the present situation and the current suite of product offerings" (ibid. p.24). So, the scenarios were used as a source of inspiration.

Twiss (1992) describes the role of technology forecasts in different phases of the innovation process (see section 1.3, Table 1.2). In this table, Twiss confirms that futures research is at it most valuable when it is applied in the first phase of the innovation process, in other words the *idea generation*-phase. This is reflected by the fact that in most of the cases we examined futures research was indeed conducted in the first phase of the innovation process. We would like to add that Twiss does not specify what role it is futures research is supposed to play in this phase.

To conclude, both authors to a greater or lesser extent confirm that futures research is mainly used in the first phase of the innovation process, in which its purpose is to inspire people to think about new products and services.

3. Futures research and type of innovation.

Lemos & Porto (1998) address the evolution of technology forecasting to competitive intelligence, which takes into account more than merely technological trends. They explain this evolution by pointing at the increasing importance of consumers in technology and innovation management, in addition to products. So, a changing concept of innovation demands a new approach towards futures research. In line with Lemos & Porto, Johne (1999) argues that a (future) vision for developing market innovations needs to put emphasis on future market developments and a vision for product innovation should include more information about new technology and products. Lynn & Akgűn (2001) are more specific about the term 'vision' and they draw a distinction between vision clarity, vision stability and vision support. According to their research, vision clarity is positively associated with evolutionary and radical innovations, vision stability is positively associated with incremental and market innovations, and vision support is positively associated with incremental and evolutionary technical innovations. Okuyama & Matsui (2003) also use the term vision and distinguish different types of R&D management. They state that the third R&D generation can be called *Vision driven R&D* in which, among other aspects, the "target future needs or wants" play an important role (ibid., p.627). O'Connor & Veryzer (2001) investigate the role of market visioning in technology-based radical innovation. They show that to develop these types of innovation there has to be an awareness that a vision "…does not arise through a single creative leap, but develops over time and requires focus, discipline, energy, and the involvement of many people" (ibid., p.231).

To conclude, all authors see a relationship between futures research and innovation, albeit at different levels of detail. John (1999), Lynn & Akgűn (2001), O'Connor & Veryzer (2001), and Okuyama & Matsui (2003) relate the type of innovation to a specific type of (future) vision, whereas Lemos & Porto (1998) relate futures research and innovation at a methodological level of detail.

The authors discussed in Chapter 1, section 1.3 cannot be related to overall conclusion 4 (*futures research, innovation, and the economic climate*) nor to overall conclusion 5 (f*utures research and innovating are a people's job*). A reason for this may be that all the authors are either looking at the relationship between futures research and innovation from a methodological, organisational or innovative perspective, while overall conclusion 4 is more about the context in which futures research and innovation take place. An explanation for why they do not relate to overall conclusion 5 is that none of the authors looks specifically at futures researchers, the skills involved, and its role and position in the

organisation. They pay no attention to how futures researchers work together with other people (clients or colleagues).

The work of Du Preez & Pistorius (1999), Berloznik & Van Langenhove (1998), Barker & Smith (1995), and Tschirky (1994) cannot be related to the overall conclusions. What they have in common is that they pay attention to how futures research and innovation can be related to the strategic level of an organisation. In our research we did not take the strategic perspective into account much, although some interviewees held strategic position within the organisation and emphasised the importance of linking both futures research and innovation to the strategic level. In PinkRoccade there was a great deal of support for futures research from the CEO, and at Philips Medical Systems technical and product roadmaps were 'added up' to a strategic level.

Overall, we can see that the theory from Chapter 1, section 1.3 more or less confirms the overall conclusions, although the theories we presented cannot be fully compared to our research because they look at the use of futures research in innovation form a different perspective. That is to say, they either view futures research as a *black box* and pay attention to how it can be related to the overall corporate or innovation strategy, or they adopt a specifically instrumental perspective by investigating how one futures research method or aspect of a futures research (e.g., a (future) vision) can be related to the output of an innovation process (i.e., the (type of) innovation itself). In our research the emphasis is on factors (e.g., organisational, methodological) that are relevant in using different qualitative methods in innovation processes.

10.3 Discussion

In this section we discuss the research approach and conclusions by assessing the construct, and internal and external validity of the research.

Validation.

In general, validation means that a research method yields valuable data. That is to say, a validated research method is about "doing the right things", and measuring and researching the proper subject (Baarda & De Goede, p.166). It must be noted that validation can have a different meaning within a specific methodological perspective. Easterby-Smith et al. (2002, p.53) state that in social constructivism, to which this type of case-study research by and large belongs, validation means: "Does the study clearly gain access to the experiences of those in the research setting" (whereas in positivism validity has to do with the question whether the measures correspond closely to reality).

Three types of validation can be distinguished:

1. *Construct* (or conceptual or content) validation: correctly translating theoretical concepts into empirical variables which is related to using multiple sources of evidence (De Leeuw, 1996, pp.105-106; Braster, 2000, pp.62).
2. *Internal* validation: rightly determining causal relationships between theoretical concepts and the empirical reality which relates to building cases over time (Mason, 1996, pp.146-151; Jonker & Pennink, 2000, pp.71).
3. *External* validation: the possibility of generalizing relationships one has detected to other persons, places, times, and cases, which is related to making analytical or theoretical generalizations (Easterby-Smith et al., 2002, pp.54; Hillebrand, Kok & Biemans, 2001, p.642).

Construct validation.

There are some problems surrounding the construct validation of exploratory case study research because the goal of case studies, by their very nature, is not to come up with precise definitions of their most important concepts. Nevertheless, the two central concepts of our research, futures research and innovation, have been defined in Chapter 3, sections 3.2 and 3.4, because our goal is not to find out how people define these concepts but how the concepts relate to each other. Also, given that, on the one hand, innovation has many different meanings and, on the other hand, futures research is not a well-known concept among non-specialists, we considered it necessary to devote two sections to defining the two concepts for the sake of clarification. Moreover, a consequence of our definition of (qualitative) futures research is that certain studies into the relationship between futures research and innovation (processes) are difficult to use as a theoretical framework because they use, for instance, different methods of futures research than the one we have used. So, we have not tested those theoretical frameworks in advance in this research to answer the question how qualitative methods of futures research are used in innovation processes in commercial organisations. We have only used those theories to put the overall conclusions into perspective.

During the case study we did not encounter much problems, confusion or unfamiliarity with the terms futures research and innovation as we defined them. Some employees of SMEs used the term *forecasting* or *predicting the future*, but after we explained what we meant they understood the term 'futures research' and made it clear that that was what they meant. Nevertheless, many originally viewed the future only by predicting and see the future as an unpredictable phenomenon and therefore not worth giving much attention. SMEs would benefit from extending their definition from predicting to exploring the future, because it would make them more interested. Therefore, we advised Syntens NT and TNO Industry to give a broad definition of looking to the future in their projects with SMEs.

With regard to the term innovation, most interviewees held the same broad view on innovation as we defined it. SMEs spoke about *product development,* but after we asked

them what they meant it became clear that their definition of innovation matched the one we used. At PinkRoccade the term *business development,* which upon investigation turned out to have the same meaning as our concept of innovation.

Internal validation.

There are some difficulties in determining the internal validation of the case studies as well, because case studies (in particular exploratory case studies) do not have a main objective to explain. This means that procedures such as pattern matching, explanation building, and time series analysis cannot be used to assess the internal validation (Braster, 2000, pp.68-69). Nevertheless, although the case study as a whole does not have the intention to explain things (from a specific theoretical standpoint), it can indeed contain some smaller explanations, for instance regarding the time horizon or scope that futures researchers choose.

The following five points describe the internal validation of this research more specifically.

1. For each case study we conducted interviews with employees with different background, function, and position towards the case, to research the use of futures research in innovation from different perspectives. This allowed us to enhance the validity of the data obtained from the interviews because it prevents a one-sided view on the research topic. If we had interviewed only futures researchers there was a risk of the resulting view on specific cases being too positive. By interviewing other people who are involved in futures research and innovation as well (such as managers, innovators or clients of futures research), more comprehensive and, therefore, 'better' data can be collected. In every case except the DaimlerChrysler case we interviewed the clients or users of futures research to hear their side of the story. Since their (personal) relationship with the studies of the future and how they are used in innovation processes is more detached than the futures researchers and innovators, they could be more critical. And indeed some were (e.g., the general manager of Navos, a client of the 'ToekomstWijzer' (TW) of Syntens NT) and some were not (e.g., innovators at RijkZwaan, a client of the TW of Syntens NT). Furthermore, every interviewee also had the opportunity to review the transcript of the interview (i.e., a *member check* (Braster, 2000, p.65)), which gave them the opportunity to rephrase certain comments they made during the interview.
2. Each case-study, except the DaimlerChrysler-case, was concluded with a group discussion to which all interviewees and other employees related to the case were invited. The goal of these group discussions was to collect views, reflections and opinions of the attendants on the (preliminary) results and (preliminary) case conclusions, so that these could be further validated (*respondent validation* (Mason, 1996, p.151)). Most case conclusions were confirmed by the attendees although at the group discussion of the PinkRoccade-case one attendee opposed a view that was shared by the others, that the integration of futures research with innovation was taking place in an ad-hoc way. Also, at

the group discussion at Philips Medical Systems (PMS) one attendee opposed the commonly held view, that innovation receives fewer resources than it should receive.
3. We have researched the cases by using different qualitative research methods, such as interviewing, participative observation (i.e. attending workshops), and document analysis (desk research). This is *method-triangulation*, although in a modest form because for actual method-triangulation both qualitative and quantitative methods should be combined. However, given the amount of cases using quantitative research methods would probably yield not much valuable additional knowledge.
4. We have used in our research different data sources, such as interview, reports and internal and external literature. This is called *data-triangulation* (Braster, 2000, p.65). With regard to literature, both internal and external sources of literature have been used. Only using internal literature could result view on the research topics that was too subjective. We cannot automatically assume that employees will write highly critical internal reports (company documents) and external reports (report of employees in, for instance, journals or newspapers) about their activities and their company, because that is simply not in the company's interest. And even they did, it is highly doubtful that such material would be made available to the researcher. Using external literature may give more balance because external reports and views are often more critical.

It must be noted that triangulation has been under some criticism. Mason (1996, p.149) states that triangulation assumes that there is one objective reality and that validation can be endangered because the researcher uses more than one data source. In response, we would argue that triangulation in our research is not related to the observation of concrete and objective entities (such as a table or air temperature), but to a *social construction* of, for example, innovation processes, based on interviews, literature and participant observation. This means that an innovation process is interpreted as a (re-)construction by compiling different experiences, opinions, activities, and memories of the people involved. In other words, the methods and data used and collected in our study do not compete with each other about the best observation or explanation. On the contrary, they complement each other because they adopt a different perspective on the units of analysis, which enhances the information and knowledge produced by our research (Jick, 1979, p.604; Braster, 2000, p.65; Jonker & Pennink, 2000, p.71). Moreover, triangulation has been used before in researching the use of methods of futures research (e.g. Dammers, 2000; Dobbinga, 2001).

External validation

Carrying out case studies means that the first priority of a researcher is not to draw conclusions that are valid for the entire population he or she is researching. Rather, he or she is more interested in researching one or more cases in depth. Nevertheless, assessing to what extent the case conclusions and overall conclusions are relevant to other cases that have not been researched is in itself a good thing. Yin (1994) distinguishes between

statistical and *analytical* generalization. *Statistical* generalization means that the researcher takes a sample from a population and draws conclusions that are valid for the entire population. Statistical generalization is mainly suited for the positivistic perspective on science with a strong emphasis on quantitative data and research strategies. Since our research has a more social constructivist nature and uses qualitative data and methods, it is not possible to use statistical generalization because the sample (i.e. the amount of cases) is too small. It is better to use *analytical* generalization: "one (has) a collection of cases, draws conclusions from that and subsequently generalizes those conclusions on base of logical arguments to a population of cases, that has as many similar and relevant characteristics as possible with the researched cases" (Van Aken, 1994, p.23). This is also important in determining how many cases should be researched. When new cases provide little additional information and conclusions (or new theoretical improvements), one may very well argue that there is no need to include other cases. This is called *theoretical saturation* (Eisenhardt, 1989, p.545). Eisenhardt has stated that the optimal case population is between four and ten cases, arguing that fewer than four cases provide insufficient date to build a theory that is sufficiently complex, and having more than ten cases makes it too difficult to cope with the complexity and volume of data (ibid., p.545). In our research we have conducted six case studies.

Our research-'population' consisted of SMEs and large(r) companies. In principle, it would be difficult to extend the case conclusions of Syntens NT and TNO Industry (the organisations that serve SMEs) to other SMEs given the heterogeneity of these type of companies. Nevertheless, it is safe to assume that the informal nature of futures research and innovation processes is a common characteristic of all SMEs, which as a rule are too small to have sufficient (financial) resources to be involved in futures research and innovation more extensively and thus more explicitly. The argument that looking only to those SMEs that are served by Syntens NT and TNO gives a biased view because they are already potentially interested in the future and innovation does not hold, since even those SMEs have an implicit attitude towards futures research and innovation.

The large companies that we have researched (KPN Research, DaimlerChrysler, PinkRoccade, and Philips Medical Sytems) can be characterized as technology-oriented companies. This would mean that the case conclusions only hold for technological companies. Indeed it has often been said that futures research is only useful for companies who operate in industries that are driven by long-term technological developments or in which a physical infrastructure plays an important role. Nevertheless, we believe that our case conclusions and overall conclusions apply to other large companies as well, although we realize that to be certain about that we would need to investigate them. Technology nowadays plays such an important role in doing business that almost every company can be characterized as a technology-oriented company, not only companies who develop and produce new technology, but also companies that use technology in their operations and innovation processes.

Having said all that, we can state that, with the benefit of hindsight, our research would have benefited from the following three (additional) research activities:
1. Organizing a group discussion to validate the overall conclusions in addition to the case conclusions for which we have held group discussions at case level. A reason for not doing this was that we considered the cases too specific to organize a group discussion to discuss their conclusions. It would probably take too much effort for a set of *objective outsiders* to work through all the research material and the cases to form a valid and well-informed opinion about the conclusions. However, next time it may certainly be worth a try.
2. Taking a closer look at the strategic context in which innovation processes are managed and carried out. We have focused on the level of innovation processes, thereby implicitly underestimating the influence of corporate strategy on these processes. The KPN Research case and the PinkRoccade case both showed that corporate strategy can have a significant positive or negative impact.
3. Although our aim was to capture a diversity of cases, we feel it is worthwhile for a follow-up study to focus on a specific industry. This would make it possible to investigate cases whose context is identical, and even to compare cases with regard to a specific innovation.

10.4 Recommendations

We close this chapter by formulating four managerial recommendations on how to use futures research in innovation and by presenting an agenda for future research on this topic. The recommendations are based on the overall conclusions.

Managerial recommendations
1. Implement a future-audit.
Overall conclusion 2 views futures research as (only) a source of inspiration for innovation and overall conclusion 4 and 5 indicate that the use of futures research can be subject to market tendencies and individual circumstances. A so called *future-audit* may cope with both issues. A future-audit can be compared to a marketing-audit in which futures research should not only be used as a source of inspiration but also as a tool to test ideas for innovation. This means that new patents or ideas for innovation are tested to see whether they are in line with future trends or scenarios.

Also, given that the use of futures research is influenced by cyclic movements, the future-audit should become a fixed element of the innovation process, and be repeated several times as part of the iterative approach. It would enable organisations to conduct futures research without interference from other, potentially more urgent, matters.
A case in point is the Philips Medical Systems-case, where government regulation has a big impact on the innovation process. Establishing a future-audit also means that the use of

futures research no longer depends on the financial position of an organisation. A parallel can be drawn with Shell, where country managers are obliged to present more than one strategic and financial annual plan to be prepared for more than one future (usually the preferred one).

A future-audit would also facilitate two types of learning processes within the organisation (i.e., the feedback loops in Figure 10.2). The first one is an *operational* learning process in which futures researchers built up knowledge about future developments and innovations by constantly carrying our projects in which futures research and innovation are integrated. The second type of learning process is a *strategic* learning process in which more knowledge is gained about the process of integrating futures research with innovation and how this process (and its results) is linked to the overall (or corporate) strtagey of an organisations. In both cases it is very important that the lead time of the feedback process is reduced as much as possible, so that the method of gathering information about the future and the impact on the innovation process become an iterative process. As a result, futures researchers and innovators learn how to improve their interaction better and faster.

2. Make futures research more holistic.

In overall conclusion 3 it was argued that an innovation process leading to a radical innovation should take a higher diversity of future trends into account. And indeed, future developments are more often interconnected. Nowadays, trends form a complex network that has a major impact on innovation. Berkhout (2000) argues, for instance, that innovation has become a matter of combining the progress in four different worlds (science, technology, products, and markets) in a systemic manner. Futures research should mirror the integral nature of this concept and take trends and uncertainties in all of these four worlds into account. It must then master the problem of coping with the different dynamics and time-horizons in these worlds. For instance, markets change significantly faster than science. The futures researcher must "play chess on four levels at the same time" (Berkhout et al., 2006) by not only combining information and knowledge from these four different worlds, but also by balancing the different time-horizons involved.

3. Balance futures research and innovation.

Overall conclusion 3 (*Futures research and type of innovation*) shows that the type of futures research is related to the type of innovation. More generally, the type of futures research method and the type of innovation process should be in balance. Our historical view on both futures research (Chapter 2) and innovation (Chapter 3, section 3.4) makes this balance more clear, as shown in Table 10.1.

Table 10.1 shows the historical development of futures research and innovation processes after World War II and is based on the description of history of futures research from Chapter 2 and the description of innovation processes from Chapter 3, section 3.4.

The historical overview shows that futures research and innovation to a large extent have developed in parallel. In the 1950s, innovation had a strong technical orientation, and future technological developments received by far the most attention. In the 1960s, more attention was devoted to the market and societal aspects of innovation, which was reflected by futures research assessing the societal and market consequences of new technologies. In the 1970s, innovation processes were focused on combining market pull and technology push. In those days, futures research had an explorative nature, combining possible and probable market and technological developments. In the 1980s, innovation increasingly became a matter of cooperation between different organizations, and futures researchers also became more cooperative, as we saw in large Delphi-studies organised by national governments in which many different actors participated. From the 1990s onwards, the networks have grown out to become systems in which both innovation activities and futures research is taking place.

Table 10.1 The historical development of futures research and innovation processes.

	Futures research:	*Innovation processes:*
1950s – 1960s	Technology forecasting	Technology push
1960s – 1970s	Technology assessment	Market pull
1970s – 1980s	Explorative futures research	Coupled innovation processes
1980s – 1990s	Networked futures research	Innovation in networks
1990s – now	Systemic futures research	Innovation systems

This historical development should not be regarded as a 'historical inevitability'. The fact that we now find ourselves in the most recent period does not mean that organisations are obliged to apply only systemic futures research and operate in innovation systems. Both historical categorisations should also be viewed in a contextual way (Ortt & Van der Duin, 2006). That is to say, given the type of organisation, its type of industry, its strategy, its (innovation) competences, and so on, an organisation should pick out the type of innovation process and type of futures research with which it feels comfortable. For instance, at Intel and in its industry, where Moore's Law rules, both futures research and innovation should be approached from a technological perspective. But at Philips Consumer Electronics, for instance, consumer requirements should play a pivotal role in both futures research and innovation. So, it is important that organisations balance their futures research and innovation and that they apply the type of futures research that fits the type of innovation process.

4. The two sides of futures research.
Futures research is primarily aimed at exploring what the future of the outside world might look like. But there is another side to futures research. Given the expected external changes, it is important that an organisation also formulates its own ambitions on what it wants its position to be in that outside future. In other words, given the external changes, how does an organisation create its own future? By adhering to its own vision, it can make a better distinction between the short term operational matters and the organisation's future direction: operational matters do not interfere with realizing the vision of the organisation. We have seen that at the Philips Medical Systems-case both sides of futures research are present. This is because roadmapping is a method that combines both a view on the future and how the company is attempting to realize that future by developing new products and services (innovation). However, since Philips Medical Systems paid too much attention to activities of competitors and because the outside world was not fully taken into account (the needs of patients, the customer of their customer, were not researched) their view on both aspects had some limitations.

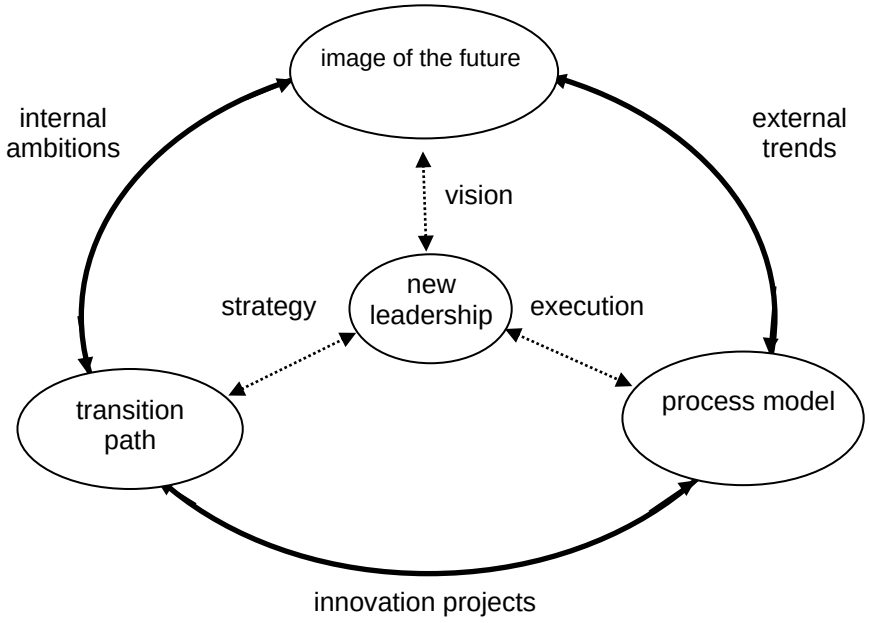

Figure 10.3 Futures research and innovation combined in an integral framework for leadership (Berkhout, 2005).

These two fundamentally different sides of futures research are illustrated in Figure 10.3 by the leadership concept of Berkhout (2005). This concept states that an image of the future is not only fed by external trends but by the internal ambitions of an organisation as well. Based on the future of its environment, the organisation develops its own vision. That vision is realized by carrying out a strategy along an innovation path that consists of various innovation projects. The innovation projects are carried out by using an innovation process model that is professionally managed (execution). The outcome of the innovation process will again influence the future, and vice versa.

The one side of futures research is located at the upper right hand side of Figure 10.3, where external trends influence the formulation of corporate visions. The other side is located at the upper left hand side of Figure 10.3. Here, the organisation defines its own ambitions for the future. Based on this vision, it formulates its strategy. Note that in this leadership concept the innovation process is strongly influenced by the internal ambition and strategy of the organisation. If the internal side of the image of the future is missing, it is very difficult to connect futures research with the company's innovation strategy. This is what we have seen in the cases. The KPN Research-case clearly shows that a disconnection between innovation processes and the innovation strategy makes the organisation less innovative and isolates the futures researchers. By relating the innovation process to the (innovation) strategy, innovators and futures researchers will have more support for their work. Both futures researchers and innovators will feel less (financial) pressure on their work caused by operational problems, and they can work with full dedication to realize the future goal which the organisation has set earlier.

We recommend that the external and internal aspects of futures research be incorporated when developing and innovation strategy and managing and carrying out innovation processes.

Figure 10.3 has been applied earlier in a project called *Een wereld om water. Naar een nieuwe aanpak voor de Nederlandse watersector* (*A world centered around water. Towards a new approach for the Dutch water sector*) (NWP/CUR, 2005). Due to the growth of the international water industry and increasing international competitive pressure, a new approach within the Netherlands towards this industry was needed, for which Figure 10.2 was used. Based on this concept a vision of the future was formulated, embedded in today's international context. Next, a strategy was formulated on how to travel along the transition path. In the strategy the formation of national innovation clusters plays an important role. An important aspect of the proposed innovation model is that there is a close relationship between technological capabilities and societal needs. The latter is very important for the water sector.

Agenda for future research

Scientific research is an endless quest for new knowledge. Evidently the research into the use of futures research in innovation process does not stop here. We consider the following topics in this field interesting and promising:

- Market research agencies not only carry out market research, they also advise their clients on issues regarding long-term innovation. How these market research agencies carry out these long term studies and how they advise their clients about innovation on the basis of their findings is still a *black box,* and given the major influence these types of consultancies companies have, this type of research can even be considered strategic.
- The qualitative relationships between futures research and innovation established in this research could be quantified. This would provide greater insight into the relationship between a specific futures research method and a specific type of innovation despite the fact that the outcome of such a research may be difficult to project onto other methods and innovations, and as a result may be limited.
- More attention to the strategic environment in which futures research and innovation takes place. Especially in organisations that have a top-down strategic process, the impact of the corporate innovation strategy on innovation processes, and subsequently on the use of futures research is interesting.
- Methods of futures research are not the only methods that organisations apply in their innovation process. Other (management) methods being used are competitor-analysis, market research, benchmarking, and core competence analysis. It would be very interesting to research how methods of futures research can be used in combination with those types of methods. Indeed, many interviewees argued in favour of combining futures research with, for instance, market research, to establish a connection between long term strategic considerations and short term considerations.
- By focusing on SMEs and large(r) companies, we managed to capture 99% of all companies. However, a subset of companies that is becoming more and more important with regard to innovation and starting up new business, are *techno-starters*. These types of companies are often located close to universities and research organizations and have a specific technology as a core competence and basis of their organisation. They too look to the future and innovate, and although it can be assumed that they do so as implicitly as SMEs (probably even more so), it may be interesting to see how these techno-starters perceive future developments and how they use that information in their innovation.

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APPENDIX 1: INTERVIEW PROTOCOLS, GENERAL CHARACTERISTICS OF THE ORGANISATION, FUTURES RESEARCH, AND INNOVATION PROCESSES

Appendix 1 consists of four parts:
1. Appendix 1A: interview protocols (innovators, futures researchers, and other stakeholders).
2. Appendix 1B: general characteristics of the organisation.
3. Appendix 1C: futures research: general information, information about the future study, and the good practices of the scenario-method, trend-analysis, and roadmapping.
4. Appendix 1D: information about innovation processes, i.e., the innovation indicators.

Appendix 1A: Interview protocols

Protocol intake-interview

1. General and practical issues:
1.1 Does your organisation have a commercial objective or does it support organisations that have a commercial objective?
1.2 Is innovation an important aspect of your strategy, or is your organisation trying to become (or stay) innovative?
1.3 Does your organisation explicitly use futures research in innovation processes?
1.4 Is it possible to gain access to internal documents?
1.5 Is it possible to interview futures researchers, innovators, and other stakeholders?
1.6 Is it possible to publish the case study (externally)?

2. The use of futures research in innovation processes:
2.1 Are futures research and innovation related to each other in your organisation? If so, how?
2.2 Is this integration institutionalised? If so, how? If not, why not?
2.3 How important is the use of futures research in innovation processes in your organisation?

3. Futures research:
3.1 Which methods of futures research do you apply?
3.2 How do you apply these methods?
3.3 For which goals do you apply futures research?
3.5 How is futures research related to other activities in the organisation?

4. Innovation:
4.1 How is innovation organised in your organisation?
4.2 Who in your organisation is (formally) responsible for innovation?
4.3 Does your organisation have a formal innovation process and strategy?
4.4 What type of innovation processes are used in your organisation?
4.5 How long does an innovation process take on average?

Interview protocol innovators

Innovation:
1. What type(s) of innovations does your organisation produce? For instance: radical, incremental, process, product, service, organisational.

2. Position of innovation in the organisation:
2.1 How is innovation organised in your organisation?
2.2 Do you cooperate with other actors in developing innovations? If so, who are they, what type of actors are they, and how are the responsibilities divided?
2.3 How can innovation in your organisation be improved?

3. Innovation processes:
3.1 Is there a formal innovation process method in your organisation?
3.2 Can you describe the (formal or informal) innovation processes in your organisation?
3.3 Which innovation processes or methods are used in your organisation?
3.4 How much time does an innovation process take in your organisation? Is this becoming shorter or longer?
3.5 How can innovation processes in your organisation be improved?

4. The use of futures research in innovation processes:
4.1 How, in general, is futures research used in innovation processes in your organisation? Do you have a specific 'method' for this? How would you describe this method?
4.2 How and with the support of which methods do you use futures research in innovation processes?
4.3 In which phases of the innovation process do you use methods of futures research?
4.4 What is the added value of futures research for you as an innovator?
4.5 Which successes did you have with futures research in innovation?
4.6 Which failures did you have with futures research in innovation?
4.7 What is your opinion about the importance of futures research for innovation processes in your organisation?
4.8 What is your opinion about the use of futures research for innovation processes in your organisation?

4.9 How can the use of futures research in innovation processes in your organisation be improved?

Interview protocol futures researchers

1. Types of methods of futures research:
1.1 With which methods of futures research are you familiar?
1.2 Which methods of futures research do you use in your organisation?
1.3 Do you develop (new) methods of futures research by yourself?

2. Place of futures research in the organisation**:**
2.1 How do the futures researchers relate to other employees in the organisation?
2.2 How many people are involved with futures research in your (part of the) organisation?
2.3 Which role does futures research play in your organisation?
2.4 Who are your clients?
2.5 How can the use of futures research in your organisation be improved?

3. Use of methods of futures research:
3.1 For which goals do you use futures research?
3.2 How and with which methods do you use futures research in your organisation?
3.3 What are your successes with futures research?
3.4 What failures have occurred in your organisation with regard to futures research?
3.5 How can the use of futures research be improved in your organisation?

4. Use of futures research:
4.1 Do you make use of external parties when you are conducting futures research?
4.2 Which time horizons do you use for your studies of the future?
4.3 With whom do you cooperate in conducting studies of the future?
4.4 Do you have examples of futures studies that are produced by your organisation?

5. Futures research and innovation:
5.1 How do you generally use futures research in innovation processes?
5.2 Which successes did you have with futures research with regard to innovation?
5.3 Which failures did you have with futures research with regard to innovation?
5.4 What is your opinion about the importance of the use of futures research in the innovation processes for your organisation?
5.5 How can the use of futures research in innovation processes in your organisation be improved?

Interview protocol others stakeholders

1. Innovation:
1.1 Which role does innovation play in the strategy? How are innovation and strategy linked to each other?
1.2 Who in your organisation is (formally) responsible for innovation? Is there someone in the board of directors responsible for innovation? Is there a CIO?
1.3 Is there a formal innovation strategy? Can you summarize that strategy (formal or informal)?
1.4 What type of innovations does your organisation develop?
1.5 How is the innovation strategy of your organisation evaluated?

2. Futures research:
2.1 How important is futures research to your organisation? What are your activities in that field? How are futures research and strategy linked to each other?
2.2 Which added value does futures research have for your organisation? How is futures research evaluated in your organisation?
2.3 Which aspects of futures research can be improved in your organisation?

3. Futures research and innovation processes:
3.1 How is futures research used in innovation processes in your organisation?
3.2 Which factors that play a role in the use of futures research in innovation processes in your organisation can be improved?

Appendix 1B: General characteristics of the organisation

1. Type of product or service the organisation produces (e.g., mass, custom-made, fast-moving, slow-moving).
2. Organisational position of the organisation (e.g., corporate, independent department, business unit, division, staff department)
3. General characterisation of the industry and of the organisation (e.g., dynamic level/time horizon of the industry, scale of production (big/small), capital-intensive or labour-intensive, distance to the end-user (B-to-B, B-to-C)).
4. Other characteristics of the organisation
   4.1. Central versus decentral
   4.2. Level of education staff
   4.3. Mobility of employees
   4.4 Amount of employees
   4.5 Turnover
   4.6 Profit

4.7 Countries in which the organisation is active
5. Strategic aspects of the organisation
5.1 Mission of the organisation
5.2 Vision of the organisation
5.3 General strategy of the organisation

Appendix 1C: Futures research

General information about futures research at the organisation

1. Organisational aspects of futures research:
1.2 Number of FTEs in the organisation dedicated to futures research
1.3 Number of projects in the organisation in which futures research is used
1.4 Own production, outsourcing, or combination

2. Methods of futures research:
2.1 Exploring methods, predicting methods, or both
2.2 Online or offline application of methods, or both
2.3 Level of interactivity in the application of methods
2.4 Methods and level of visualisation and communication
2.5 Place in the organisation where the responsibility for futures research is located
2.6 Goals of futures research
2.7 Tools used for futures research

3. General aspects:
3.1 Time horizon (in general)
3.2 Scope of the future studies (in general)
3.3 Types of information used

Information about the future study

Name of the future study:
Stage 1: Pre-foresight/ input:
1. Consultation/participation
2. Clients of futures research
3. Duration (research period) and costs (or available resources)
4. Goals or objectives
5. Rationales

Stage 2: Main foresight/throughput:
1. Communication flows
2. Futures researchers
3. Geographical coverage
4. Level of detail
5. Method
6. Organisation and management
7. Time horizon
8. Tools

Stage 3: Post-foresight/outputs and action:
1. Communication and visualisation
2. Decision-making
3. Dissemination
4. Implementation

Good practices of the scenario-method

This sub-appendix lists good practices of the scenario-method as can be found in literature (Schwartz, 1991; Van der Heijden, 1996; Van der Duin, Drop & Kloosterhof, 2001; Fahey & Randall, 1998). The good practices are categorised by the three stages of the process of futures research described in Chapter 3, section 3.2.

Pre-foresight/input:
1. Many different people, both inside and outside the organisation, have been interviewed.
2. A desk research (i.e., a literature-study) was carried out.
3. The (right) time horizon has been determined by deciding the moment at which there is too much uncertainty to produce a reliable forecast. (The time horizon varies per sector.)
4. Attention has been paid to a broad support for the scenarios in the organisation.

Main foresight/throughput:
5. Interactive workshops have been organised to collect information and opinions from clients and stakeholders.
6. The scenarios do not merely present various endings, but also various 'roadmaps' that show the evolution of certain trends in the various possible futures.
7. A great deal attention is paid to the visualisation and communication of the scenarios.
8. The scenarios and the decision-making process are linked to each other.
9. The scenarios are internally consistent.
10. Attention has been paid to the implementation of the scenarios in the organisation.

Post-foresight/outputs and action:

11. The number of scenarios is four.
12. The scenarios are described in sufficient detail for people who were not involved in the scenarios to understand them.
13. The scenarios are made both challenging and recognizable to users.
14. The scenarios can be modified to reflect the specific interests of the organisation and its sub-departments.

Good practices of trend-analysis

This sub-appendix lists good practices of trend-analysis as can be found in literature (May, 1996; Glenn, 1999; Van der Duin, Drop & Kloosterhof, 2001). The good practices are categorised by the three stages of the process of futures research described in Chapter 3, section 3.2.

Pre-foresight/input:

1. The concept of a trend is defined clearly.
2. The process and actions by which the trend-analysis is carried out are described.
3. The collection of information and data is defined.
4. The time horizon of the trend-analysis is defined.
5. Information and/or data is collected by using multiple and different sources (e.g., interviews, journals, Internet).
6. It is made clear how the trend-analysis is linked to the decision-making process.

Main foresight/throughput:

7. It is clear how the collected information is analysed.
8. To conduct the trend-analysis various supporting tools (e.g., GDR, content analysis) are used.
9. Trends are not only viewed in isolation, but their relationships and even their combinations are taken into account as well.
10. If possible, the trends are assigned a qualitative (conditional) probability (unlikely, likely, etc.).
11. The assumptions of the trends are clarified and validated.

Post-foresight/outputs and action:

14. Based on the trends that are spotted and analysed an all-encompassing picture of the future (or futures) is presented.
15. The consequences or impacts of the trends are assessed.

Good practices of roadmapping

This sub-appendix lists good practices of roadmapping as can be found in literature (Barker & Smith, 1995; Probert & Shehabuddeen, 1999; Farrukh, Phaal & Robert, 2003; Phaal, Farrukh & Probert, 2004). The good practices are categorised by the three stages of the process of futures research described in Chapter 3, section 3.2.

Pre-foresight/input:
1. Input for the roadmap is collected from various areas (market, technology, society) and provided by experts with different backgrounds.
2. The roadmap is embedded in a broader strategy and other types of decision-making processes.
3. There is a clear definition of the scope, focus, and unit of analysis of the roadmap.

Main foresight/throughput:
4. The process of building a roadmap has been clearly and extensively defined in different (linear or parallel) steps.
5. The roadmap has been constructed with the support of an interactive process.
6. The roadmap is approached both from the top down and from the bottom up, and/or from a technology push and market pull point of view.

Post-foresight/outputs and action:
7. The roadmap contains a clear and comprehensive vision of the future.
8. The various elements of the roadmap (e.g**.**, business, market, technology, products) are clearly linked to each other.

Appendix 1D: Information about innovation processes
This sub-appendix lists the innovation indicators as described in Chapter 3, section 3.3.
The indicators refer to the organisational as well as the project level.

Innovation indicators at the level of the organisation
1. Input innovation indicators:
1.1 Total innovation expenditure
1.2 Number of persons involved in R&D and/or innovation
1.3 Number of patents and patent applications

2. Throughput innovation indicators:
2.1 In which broad technological trajectories is the organisation active? (science-based, scale-intensive, information-intensive, specialised suppliers or supplier-dominated)
2.2 What are the technological competencies and where are they located within the firm?

2.3 How does the organisation identify potentially new technological competencies? (corporate visions, technical judgments, product-technology matrices, incremental trial, error and learning)
2.4 How are R&D and other innovation expenditures evaluated?
2.5 How are innovation strategy and corporate strategy linked?
2.6 Does the organisation use exploratory techniques to identify and predict future trends, e.g., brainstorming, scenario-analysis, Delphi?
2.7 Does the organisation seek to develop and maintain networks of formal and informal knowledge?
2.8 Does the organisation systematically search for new product opportunities? If so, how?
2.9 Does the organisation have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process?
2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this procedure used in practice or are there alternative 'short-cuts'?
2.11 Is there top management commitment and support for innovation?
2.12 Is there a clear shared sense of strategic vision and ownership of the business plan?
2.13 Does the organisation have a supportive climate for new ideas – or do people have to leave in order to carry them forward?

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years.
3.2 Percentage of annual turnover due to innovations.
3.3 Part of portfolio that has undergone an incremental change, a radical change, or that remained essentially unchanged.
3.4 Amount of sales of imitative and innovative products and services.

Innovation indicators at a project level

1. Cross-functionality
2. Integrating marketing and manufacturing with the product development process
3. Decision points or gates are also cross-functional
4. More holistic than just focusing on the development phase
5. Much more emphasis on up-front homework or pre-development work
6. Much stronger market orientation
7. Introducing parallel or concurrent engineering
8. Transparent decision-making process with clear Go/Kill criteria
9. Fluidity
10. Fuzzy gates
11. Focused
12. Flexible

APPENDIX 2: KPN RESEARCH

Match with case selection criteria

KPN Research: the former R&D organisation of Dutch (incumbent) telecom-operator, nowadays known as TNO Information and Communication Technology.
1. Company's objective: KPN Research is a department of KPN listed at the Amsterdam and New York stock exchanges. Making profit is an explicit goal in its mission and vision.
2. Role of innovation in the company: KPN Research is an R&D organisation that develops knowledge that is used specifically to develop KPN's ICT products and services. Innovation at KPN Research, i.e., constantly renewing their knowledge to support the innovation processes of their customers, is at the core of their strategy.
3. Explicit use of futures research in innovation processes: KPN Research has a specific sub-department called 'Future Scanning' that uses methods of futures research. This sub-department is part of the knowledge development side of KPN Research and is also an informal knowledge network. The 'Innovation Chain' (the specific method in which it uses scenarios in innovation processes) is a clear example of the explicit use of futures research in innovation processes.

General background characteristics of KPN Research
1. Type of products or services: Scientifically funded advice or consultancy applied in custom made projects. On average projects take about five months.
2. Organisational position of KPN Research within KPN: KPN Research is a staff department of KPN and is responsible for its own financial resources (profit- and loss-responsible)
3. General characterisation of the industry in which KPN and KPN Research operate: KPN Research operates in the telecommunication industry, which is very dynamic and (in principle) has a time horizon of about ten years due to its infrastructure-based nature. However, certain departments within KPN, such as KPN Sales, have a much shorter time-horizon (one to two years). The industry has a large production-scale, and is capital-intensive. KPN offers its products and services to both consumers and business. The customers of KPN Research are businesses.
4. Other characteristics of KPN Research
4.1 Central versus decentral: *quite decentral, there are few hierarchical levels.*
4.2 Level of education staff: *95% of all researchers holds an academic degree (often from a technical university), and about 10% of them also has a PhD.*
4.3 Mobility of employees: *used to be quite low (especially compared to KPN), but their mobility is increasing.*
4.4 Number of employees: ~ *400*.
4.5 Turnover: ~ *€ 40 million (2002).*

4.6 Profit/Loss of KPN: *huge loss in 2002*.
4.7 Countries in which KPN Research is active: *the Netherlands.*

5. Strategic aspects of KPN Research
5.1 Mission of KPN Research: *to develop new knowledge to support KPN and other customers.*
5.2 Vision of KPN Research: *'from money to knowledge and from knowledge to money'.*
5.3 General strategy of KPN Research: *developing new knowledge with regard to information and communication technology.*

General information about futures research at KPN Research
1. Organisational aspects of futures research
1.2 Number of FTEs in KPN Research dedicated to futures research: *~ 4.*
1.3 Number of projects in KPN Research in which futures research is used: *~ 30.*
1.4 Own production, outsourcing, or combination: *predominantly own production.*

2. Methods of futures research
2.1 Exploring methods, predicting methods, or both: *predominantly exploring methods.*
2.2 Online, offline applying of methods, or both: *mostly online.*
2.3 Amount of interactivity in the application of methods: *relatively high.*
2.4 Methods and level of visualisation and communication: *workspaces of the future, TV-journals, newspapers of the future.*
2.5 Place in KPN Research where the responsibility for futures research is located: *a sub-department called 'Future Scanning'.*
2.6 Goals of futures research: *vision building, input for the development of new products and services.*
2.7 Tools used for futures research: interviewing, creativity workshops, quantitative models, Group Decision Room.

3. General aspects
3.1 Time horizon (in general): *relatively long, i.e., 5 to 10 years. Can vary within KPN.*
3.2 Scope of the future studies (in general): *broad, taking into account as many aspects as possible.*
3.3 Types of information used: *reports of different consultancy companies (Forrester, Gartner) and (government) research organisations such as CPB, CBS, and SCP.*

Information about 'Destination 2005'

Name of the future study: *'Destination 2005' (in Dutch: 'Bestemming 2005')*
Stage 1: Pre-foresight/ input:

1. Consultation/participation: *rarely used, except for writing the scenarios of 'Destination 2005'*
2. Clients of futures research: *strategists, product managers, account managers.*
3. Duration (research period) and costs (available resources): *the scenarios take about 3 months to build, after which the scenarios are used for at least three years. The total project costs were approximately € 100,000.*
4. Goals or objectives: *presenting a vision of the customer of the future.*
5. Rationales: *building visions of the future, out-of-the-box thinking, and speculation about what possible future developments and ways they may affect business.*

Stage 2: Main foresight/throughput:

1. Communication flows: *relatively horizontal internally, and with clients: short, quick, and informal communication lines.*
2. Futures researchers: *both process and content experts, facilitating. Diverse backgrounds: economics, business administration, information science, industrial design.*
3. Geographical coverage: *Netherlands, Europe, society, telecommunication industry.*
4. Level of detail: *quite specific. The scenarios were extensively described with regard to topics like society, politics, economy, and technology.*
5. Method: *qualitative scenario-thinking supplemented with a trend-analysis.*
6. Organisation and management: *futures researchers played various roles, no special assignments attached to specific persons.*
7. Time horizon: *2005.*
8. Tools: *interviewing, brainstorming, desk research.*

Stage 3: Post-foresight/outputs and action:

1. Communication and visualisation: *website, four workspaces of the future, reports.*
2. Decision-making: *not used for specific decisions, but it serves as one of the input sources for the decision-making process and is often situated in the first phases of the decision-making process.*
3. Dissemination: *through presentations, articles, interviews, workshops.*
4. Implementation: *takes place by using the scenarios in projects, an interactive way of implementation.*

Good practices of the scenario-method with regard to KPN Research

Pre-foresight/input:

1. Many different people, both inside and outside KPN Research, have been interviewed: *yes, although the number of internal interviews was much higher than the number of external interviews.*
2. A desk research (i.e., a literature-study) was carried out: *yes, various reports were collected and analyzed.*
3. The (right) time horizon has been determined by deciding the moment at which there is too much uncertainty to produce a reliable forecast: *although this was not a separate point of discussion (the time horizon was set by the client), during the project it proved to be the correct time horizon.*
4. Attention has been paid to a broad support for the scenarios in KPN Research: *not really, because the link to the top of KPN was cut off.*

Main foresight/throughput:

5. Interactive workshops have been organised to collect information and opinions from clients and stakeholders: *no workshops have been organized. Information and opinions came from interviews and reports.*
6. The scenarios do not merely present various endings, but also various 'roadmaps' that show the evolution of certain trends in the various possible futures: *yes, each scenario also contains short a description of developments that have led to the scenario.*
7. A great deal attention is paid to the visualisation and communication of the scenarios: *yes (workspaces of the future, archetypes).*
8. The scenarios and the decision-making process are linked to each other: *not immediately, but the 'Innovation Chain' was lately specially developed for this.*
9. The scenarios are internally consistent: *yes.*
10. Attention has been paid to the implementation of the scenarios in KPN Research: *yes, to some degree.*

Post-foresight/outputs and action:

11. The number of scenarios is four: *yes*
12. The scenarios are described in sufficient detail for people who were not involved in the scenarios to understand them: *yes (e.g., economic, political)*
13. The scenarios have been made both challenging and recognizable to users: *yes, although many consider the scenarios also as (current) market segments.*
14. The scenarios can be modified to reflect the specific interests of the organisation and its sub-departments: *yes, the scenarios have been applied to many topics and departments.*

Information about innovation at KPN Research

The innovation indicators at an organisational level
1. Input innovation indicators:
1.1 Total innovation expenditure: *€ 40 million (total turnover)*
1.2 Number of persons involved in R&D and/or innovation: *~ 400*
1.3 Number of patents and patent applications: *~ 20 (estimation)*

2. Throughput innovation indicators:
2.1 In which broad technological trajectories is KPN Research active? *Science-based and information-intensive.*
2.2 What are the technological competencies and where are they located within KPN Research? *Broad knowledge about telecommunication networks, platforms, and devices. Central research laboratory.*
2.3 How does KPN Research identify potentially new technological competencies? *Through contacts with experts from universities and suppliers, desk research, applying methods of futures research in general, visiting conferences.*
2.4 How are R&D and other innovation expenditures evaluated? *Not comprehensively evaluated on a structural base, although projects are evaluated by and with clients. A few years ago Arthur D. Little has carried out an evaluation of the knowledge portfolio.*
2.5 How are innovation strategy and corporate strategy linked? *There is no CIO or CTO at the corporate level, there is no formal innovation strategy and there is a weak link between innovation projects (i.e., processes) and the KPN Research (innovation) strategy.*
2.6 Does KPN Research use exploratory techniques to identify and predict future trends, e.g. brainstorming, scenario analysis, and Delphi? *Yes, the 'Innovation Chain' and the Future Scanning department are clear examples of such activities. Also, although a trend-analysis was carried out for the innovation strategy of KPN Research, its quality was not very high.*
2.7 Does KPN Research seek to develop and maintain networks of formal and informal knowledge? *Yes, by maintaining relationships with universities and visiting conferences and trainings.*
2.8 Does KPN Research systematically search for new product opportunities? If so, how? *No, not very systematically.*
2.9 Does KPN Research have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? *No, not really. Some competing products were found by accident.*
2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this procedure used in practice or are there alternative 'short-cuts'? *No, not at KPN Research. KPN does indeed have such a process called TURN.*

2.11 Is there top management commitment and support for innovation? *Yes, although there is less support from KPN itself.*
2.12 Is there a clear shared sense of strategic vision and ownership of the business plan? *No, not really. Many researchers acknowledge this and acknowledge that that is a regrettable state of affairs.*
2.13 Does KPN Research have a supportive climate for new ideas – or do people have to leave in order to carry them forward? *Depends, only if it raises money at short notice.*

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years: *about 10.*
3.2 Percentage of annual turnover due to innovations: *about 25%.*
3.3 Part of portfolio that has undergone an incremental change, a radical change, or that remained essentially unchanged: *incremental: 50%; radical: 5%; unchanged: 45%.*
3.4 Amount of sales of imitative and innovative products and services: *unknown.*

Innovation indicators at a project level
1. Cross-functionality: *projects at KPN Research were often multi-disciplinary.*
2. Integrating marketing and manufacturing with the product development process: *many projects included both aspects.*
3. Decision points or gates are also cross-functional: *despite the multidisciplinary nature of many projects, this was not always the case.*
4. More holistic and looking beyond the development phase: *projects took place mainly in the first phases of the innovation (or development) phase.*
5. Much more emphasis on up-front homework or pre-development work: *yes, many projects emphasized the importance of thinking things through before starting to develop.*
6. Much stronger market orientation: *yes, customer needs played an important role in projects.*
7. Introducing parallel or concurrent engineering: *difficult to say, because most projects took place in only one phase of the innovation process, i.e., the first one.*
8. Transparent decision-making process with clear Go/Kill criteria: *not really relevant.*
9. Fluidity: *many projects did not use a fixed template so there was much room for being flexible (and fluid) with regard to the activities within a project.*
10. Fuzzy gates: *not very relevant since most projects only had one gate decision.*
11. Focused: *the link between (innovation) strategy and (innovation) projects was not very strong.*
12. Flexible: *see fluidity.*

Interviewees (in alphabetic order):
I01. Beelen, Dick van (AKZO Nobel; technology manager)
I02. Bosveld, Gerlof (KPN Research; general manager knowledge development department)
I03. Braber, Rob den (KPN Sales; account manager)
I04. Bruijning, Jeroen (KPN Research; knowledge development and strategy)
I05. Calbo, Frank (KPN Sales; account consultant)
I06. Elsendoorn, Victor (KPN Research; COO)
I07. Graaf, Sander de (KPN Research; innovator)
I08. Haas, Angelique de (KPN Research; innovator and futures researcher)
I09. Hage, Jaap (KPN Sales; account manager)
I10. Korte, Annemieke de (KPN Research; innovator and futures researcher)
I11. Langezaal, Rob (KPN Research; CEO)
I12. Lieshout, Barend van (KPN Research; head of Business Creation department)
I13. Ploeg, Bart van der (KPN Sales; account manager)
I14. Plugge, Albert (KPN Sales; account consultant)
I15. Prins, Marcel (KPN Sales; account consultant)
I16. Rippen, Frans (ABN Amro)
I17. Sibbel, Rene (ABN Amro)
I18. Smits, Cyprian (KPN Research; business creation)
I19. Stavleu, Hans (KPN Research; innovator)
I20. Vos-Biemans, Anja de (KPN Sales; account manager)

Participants of the group discussion (in alphabetic order):
1. Alves, Raymond (KPN Research; manager/innovator)
2. Bruijning, Jeroen (KPN Research; strategic advisor)
3. Haas, Angelique de (KPN Research; innovator & futures researcher)
4. Jansen, Luc (KPN Research; manager)
5. Korte, Annemieke de (KPN Research; innovator)
6. Kroon, Elisabeth (KPN Research; innovator)
7. Kruit, Marco (TU Delft; minutes secretary)
8. Maas, Aloys (KPN Research; manager/innovator)

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APPENDIX 3: SYNTENS NT

Match with case selection criteria

Syntens NT: a non-profit organisation linked to the Dutch Ministry of Economic Affairs and involved in supporting SMEs in developing innovations.

1. Company's objective: Syntens NT is part of Syntens, which is a non-profit organisation linked to the Dutch Ministry of Economic Affairs. However, we feel that Syntens NT is a suitable case within the framework of this research because the 'ToekomstWijzer', which has been developed by Syntens NT, is applied to *commercial* SMEs. Its method is used for commercial purposes and within a commercial environment, and not as input to innovation policy or processes at non-profit organisations.

2. Role of innovation in the strategy: Syntens NT and its mother organisation Syntens have as main their task to promote innovation among SMEs in the Netherlands. In this respect is important to note that Syntens not only supports SMEs that are already sufficiently innovative but that it also helps SMEs that are not (yet) innovative. With regard to the role of innovation in the strategy of Syntens itself, Syntens and Syntens NT themselves are not involved in innovations, but only supports and facilitates innovation processes and strategy among SMEs. Syntens views itself as 'an engine for innovation'.

The role of innovation in their own strategy (or policy) refers to the effort they put into renewing the ways in which they fulfil their task. From the interviews it became clear that Syntens NT is indeed trying to renew its own portfolio of tools and methods used to support innovation among SMEs.

3. Explicit use of futures research in innovation processes:

Syntens NT uses methods of futures research, such as trend analysis and, sometimes, scenarios. It is also responsible for the development and application of the 'ToekomstWijzer'.

General background characteristics of Syntens NT

1. Type of products or services: giving advice to SMEs about innovation.
2. Organisational position of Syntens NT: Syntens NT is part of Syntens which is affiliated to the Dutch Ministry of Economic Affairs.
3. General characterisation of the industry of Syntens NT: Syntens NT services Dutch SMEs, which make up 99% of all Dutch companies.

Other characteristics of Syntens NT
4.1 Central versus decentral: *quite decentral; Syntens has offices in all provinces of the Netherlands, and the advisors of Syntens NT can decide much by themselves without consulting upper management.*
4.2 Level of education staff: *many advisors have an academic degree, and often extensive business and technical working experience.*
4.3 Mobility of employees: *unknown, but given that Syntens is closely linked to a government organisation, it is unlikely to be very high.*
4.4 Amount of employees: *446 (in 2003).*
4.5 Turnover: *in 2003 Syntens had a budget of approximately € 40 million.*
4.6 Profit/Loss: *not relevant, Syntens NT is a non-profit organisation.*
4.7 Countries in which Syntens NT is active: *the Netherlands.*

5. Strategic aspects of Syntens NT
5.1 Mission of Syntens NT: *"Syntens supports successful innovation, it strenghtens the capacity to innovate of entrepreneurs in the Netherlands, and thereby contributes to sustainable growth" (DI14).*
5.2 Vision of Syntens NT: *see mission.*
5.3 General strategy of Syntens NT: *focus on innovation-intensive industries with an emphasis on techno-partners and 'fast growers'.*

General information about futures research at Syntens NT

1. Organisational aspects of futures research
1.2 Number of FTEs in Syntens NT occupied with futures research: *+/- 5.*
1.3 Number of projects in Syntens NT in which futures research is used: *+/- 30.*
1.4 Own production, outsourcing, or combination: *mostly own production.*

2. Methods of futures research
2.1 Exploring methods, predicting methods, or both: *exploring.*
2.2 Online or offline application of methods, or both: *online.*
2.3 Amount of interactivity during applying methods: *quite high; many discussions.*
2.4 Ways of and level of visualisation and communication: *reports, sometimes drawings, and fictitious newspaper articles.*
2.5 Place in Syntens NT where the responsibility for futures research is located: *not relevant.*
2.6 Goals of futures research: *to enhance the awareness among SMEs of the importance of looking to the future and use the information for innovation.*
2.7 Tools used for futures research: *brainstorming, TW-game board.*

3. General aspects
3.1 Time horizon (in general): *2010.*
3.2 Scope of the future studies (in general): *relatively broad; technological, market, economic, social, and industry-specific factors were taken into account.*
3.3 Types of information used: *desk research and input from experts participating in the national TW.*

Information about the 'ToekomstWijzer'

Name of the future study: 'ToekomstWijzer´
Stage 1: Pre-foresight/ input:
1. Consultation/participation: *many (external) experts were involved in the development of the TW as well as the TW-meetings.*
2. Clients of futures research: *managers and product developers from SMEs.*
3. Duration (research period) and costs (available resources): *it took about six months to develop the TW.*
4. Goals or objectives: *creating awareness among SMEs of the importance of looking to the future.*
5. Rationales: *creating awareness among SMEs of the importance of looking to the future for new ideas for innovation*

Stage 2: Main foresight/throughput:
6. Communication flows: *mainly between Syntens NT, Syntens, and SMEs.*
7. Futures researchers: *the facilitators from Syntens NT were mainly process experts, the knowledge explorers and external experts could be considered content-experts.*
8. Geographical coverage: *Netherlands, society, various industries.*
9. Level of detail: *trends were not defined in great detail, with the exception of some industry-related trends.*
10. Method: *qualitative, trend-analysis.*
11. Organisation and management: *facilitating mainly by employees from Syntens NT.*
12. Time horizon: *varies, but mostly five to ten years from the present.*
13. Tools: *brainstorming.*

Stage 3: Post-foresight/outputs and action:
1. Communication and visualisation: *a report was made of each TW, and sometimes ideas for innovation were visualised in drawings.*
2. Decision-making: *see implementation (above).*
3. Dissemination: *through meetings, reports, presentations.*

4. Implementation: *mainly the responsibility of the SME and sometimes supported by a Syntens advisor.*

Good practices of Syntens NT with regard to trend-analysis

Pre-foresight/input:

1. The concept of trend is defined clearly: *not very clearly, sometimes propositions were used that contained an opinion rather than the description of a possible trend.*
2. The process and actions by which the trend-analysis is carried out are described: *yes, every TW-meeting was prepared well by writing very detailed scripts.*
3. The collection of information and data is defined: *yes.*
4. The time horizon of the trend-analysis is defined: *yes*.
5. Information and/or data are collected by using multiple and different sources (eg. interviews, journals, Internet): *no, mainly from experts and some by desk research*
6. It is made clear how the trend-analysis is linked to the decision-making process: *no, the TW was mainly aimed at creating awareness.*

Main foresight/throughput:

7. It is clear how the collected information is analysed: *no, trends were not really analyzed but merely used as an input to a discussion.*
8. To conduct the trend-analysis various supporting tools (e.g., GDR, content analysis) are used: *yes, brainstorming and a game-board.*
9. Trends are not only viewed in isolation**,** but their relationships and even their combinations are taken into account as well: *no, trend were discussed separately.*
10. If possible, the trends are assigned a qualitative (conditional) probability (unlikely, likely, etc.): *no.*
11. The assumptions of the trends are clarified and validated: *no.*

Post-foresight/outputs and action:

12. Based upon the trends that are spotted and analyzed an all-encompassing picture of the future (or futures) is presented: *no, the trends were presented separately rather than in combination.*
13. The consequences or impacts of the trends are assessed: *yes very much so, discussing the possible consequences of the trends for innovation is at the core of the TW.*

Information about innovation at Dutch SMEs

The TW was applied in innovation processes of Dutch SMEs (see section 5.3). Therefore, in this appendix we pay attention to their innovation activities. Given the diversity of Dutch SMEs, the information about the *input*, *throughput*, and *output* innovation indicators is quite general and contains rough estimates.

The innovation indicators at an organisational level
1. Input innovation indicators:
1.1 Total innovation expenditure: *~ € 1063 million in 2001 (~ 25% of total number of persons involved in R&D) (DE03, p.108).*
1.2 Number of persons involved in R&D and/or innovation: *will probably be in line with R&D-expenditure: ~ 15,000 employees (DE03, p.113).*
1.3 Number of patents and patent applications: *in 2002 a majority of applications for Dutch patents came from SMEs and private inventors (DE15, p.32). In 2003 this percentage was a little over 70 (DE16, p.33).*

2. Throughput innovation indicators:
2.1 In which broad technological trajectories are SMEs active? *Information-intensive, specialised suppliers*.
2.2 What are the technological competencies and where are they located within SMEs? *Very diverse, but mainly related to small-scale technologies.*
2.3 How do SMEs identify potentially new technological competencies? *Often this is carried out informally; contacts with suppliers, business partners, and (business) customers.*
2.4 How are R&D and other innovation expenditures evaluated? *Not very often, rather informal.*
2.5 How are innovation strategy and corporate strategy linked? *Both types of strategy are often very informal, so the potential link will be as well.*
2.6 Do SMEs use exploratory techniques to identify and predict future trends, e.g., brainstorming, scenario-analysis, and Delphi? *Not formally.*
2.7 Do SMEs seek to develop and maintain networks of formal and informal knowledge? *Yes, but mainly informal networks.*
2.8 Do SMEs systematically search for new product opportunities? If so, how? *Not very systematically. Most ideas for new products come from technologies offered by suppliers and from customer demand.*
2.9 Do SMEs have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? *Not really a system, most innovation processes are informal.*

2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this procedure used in practice or are there alternative 'short-cuts'? *Often not, although the larger SMEs sometimes are involved in fairly major innovation projects that are managed quite formally.*
2.11 Is there top management commitment and support for innovation? *Depends strongly on the opinion of the general manager/owner.*
2.12 Is there a clear shared sense of strategic vision and ownership of the business plan? *Often only present at the general manager/owner level.*
2.13 Do SMEs have a supportive climate for new ideas – or do people have to leave in order to carry them forward? *Depends (again) often on the opinion of the general manager/owner.*

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years: *34% of all SMEs introduced new products and services in the past three years (DE05, p.5).*
3.2 Percentage of annual turnover due to innovations: *Difficult to estimate. It can be assumed that it is not more than 30%.*
3.3 Part of portfolio that underwent an incremental change, a radical change, or that remained essentially unchanged: *Unknown.*
3.4 Amount of sales of imitative and innovative products and services: *Unknown.*

Innovation indicators at a project level:
1. Cross-functionality: *Sometimes only the director/owner is involved, but if SMEs cooperate in innovation projects, more players form various functions are involved.*
2. Integrating marketing and manufacturing with the product development process: *See previous indicator.*
3. Decision points or gates are also cross-functional: *Only in cases were several SMEs innovate together.*
4. More holistic than just the development phase: *Given that SMEs view innovation as a new product or service that is available in the market, the innovation process is indeed holistic.*
5. Much more emphasis on up-front homework or pre-development work: *Not always the case; SMEs often start developing fairly quickly, without conducting the proper investigations, although in the more risky innovation projects SMEs do some up-front homework.*
6. Much stronger market orientation: *Depends on the position in the industry value chain.*
7. Introducing parallel or concurrent engineering: *Yes, if SMEs innovate together.*
8. Transparent decision-making process with clear Go/Kill criteria: *Given that innovation processes at SMEs are rather informal, this will not be the case. However, if innovation*

projects do not timely yield money, SMEs do not have problems with stopping an innovation process.

9. Fluidity: *Yes, given the informal nature of innovation processes at SMEs.*
10. Fuzzy gates: *No, often SMEs make a 'Go/No Go' type of decision.*
11. Focused: *Given the low number of innovation projects among SMEs, they will not think in terms of a portfolio of projects.*
12. Flexible: *Definitely, given the informal nature of innovation processes at SMEs.*

Interviewees:

Personal interviews:

I01. Bakels, Noud (Syntens Limburg, advisor)
I02. Bakker, Gerard (Dutch Ministry of Economic Affairs, directorate-general for Innovation, Market and Innovation, senior advisor)
I03. Barten, Marcel (RijkZwaan, chain manager Benelux)
I04. Berg, Erik op ten (Pioenconsult, creativity consultant)
I05. Doldersum, Jan (RijkZwaan, marketing support)
I06. Elstkamp, Peter (Syntens, Lelystad, advisor/team leader)
I07. Evers, Paul (Alko Research, general manager)
I08. Hartman, René (Syntens NT, Veenendaal, manager Syntens NT, futures researcher)
I09. Hovens, Pieter (Syntens Limburg, advisor)
I10. Leeuw, Erich de (Syntens NT, Veenendaal, futures researcher)
I11. Oosterveld, Liesbet van (Syntens Den Haag, advisor)
I12. Philippens, Vera (Syntens NT, Veenendaal, futures researcher)
I13. Simons, Bibi (Syntens Limburg, communication-advisor)
I14. Thoolen, Jeroen (Syntens, Arnhem, advisor)
I15. Till, Jaap van (Stratix, partner)
I16. Touw, Dennis van (Dutch Ministry of Economic Affairs, directorate-general for innovation, market and innovation, senior advisor)
I17. Vercoulen, Jan (former director Océ Research & Development, member of the management council of Syntens NT)
I18. Vermeulen, Simone (Syntens Rotterdam, advisor)
I19. Vos, Ronald de (Navos Klimaattechniek, general manager)
I20. Panne, Gerben van der (Delft University of Technology, faculty of Technology, Policy and Management; scientist, expert on innovation at SMEs)
I21. Jong, Jeroen de (Economisch Instituut voor het Midden- en Kleinbedrijf; researcher/consultant, expert on innovation at SMEs)

Respondents to the e-mail questionnaire:
E01. Kroon, Elisabeth (KPN Research, researcher)
E02. Niessink, Alfons (Syntens Arnhem, advisor)
E03. Paes, John (TechnoMed, advisor)
E04. Un, Stefanie (Philips Design, researcher)
E05. Welter, A (Hogeschool Zuyd, teacher)
E06. Kleeven, T. (Kleeven Control, manager)
E07. Soede, T. (iRV, consultant)

Participants of the group discussion (in alphabetical order):

1. Böttcher, Harriët (Syntens, advisor)
2. Cleine, Ben (Syntens, advisor)
3. Hartman, Rene (Syntens NT, manager Syntens NT, futures researcher)
4. Horst, Ruben van der (Syntens, advisor)
5. Hovens, Pieter (Syntens, advisor)
6. Niessink, Alfons (Syntens, advisor)
7. Nijhuis, Michiel (student at Delft University of Technology and Erasmus University; trainee at Syntens NT)
8. Philippens, Vera (Syntens NT, futures researcher)
9. Rademaker, Benno (Syntens, advisor)
10. Thoolen, Jeroen (Syntens, advisor)
11. Vermeulen, Simone (Syntens, advisor)
12. Witmond, Robert (Syntens, advisor)

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APPENDIX 4: DAIMLERCHRYSLER

Match with case selection criteria

DaimlerChrysler: a worldwide operating car-company with its head-office in Stuttgart, Germany.
1. Company objective: DaimlerChrysler (DC) is a commercial company listed on a number of stock exchanges, like Frankfurt, New York, London, Tokyo and Paris. The Science & Technology Research Group (STRG) is part of the Research & Technology department of DC. It is responsible for acquiring projects and it has a profit-and-loss responsibility.
2. Role of innovation in the strategy: One of the elements of DaimlerChrysler's strategy is to attain technological leadership in the automotive industry. As far as Research & Technology and STRG are concerned, innovation is a core activity and therefore an important part of their strategy.
3. Explicit use of futures research in innovation processes: STRG uses methods of futures research (their main method is trend-analysis) and is a separate department of the Research & Technology department dedicated to futures research.

General background characteristics of DaimlerChrysler

1. Type of products: passenger cars and other types of commercial vehicles (vans, light trucks, heavy trucks).
2. Organisational position of STRG within DaimlerChrysler: STRG is part of the DaimlerChrysler Research & Technology department.
3. General characterization of the industry of DaimlerChrysler and of DaimlerChrysler itself: the automotive industry is a global industry that very much depends on economic circumstances. Since competition is increasing and the human element (design, safety) is becoming much more important, being able to provide specific service elements and features is crucially important, in addition to just the technical qualities of cars. DC is a multinational company with a diverse portfolio. DC is the result of the merger between DaimlerBenz and the Chrysler Group.

Other characteristics of DC
4.1 Central versus decentralized: *relatively decentralized.*
4.2 Level of education staff: *very diverse, almost any educational level will be present.*
4.3 Mobility of employees: *unknown.*
4.4 Amount of employees: *365,000.*
4.5 Turnover: *€ 149.6 billion.*

4.6 Profit/Loss: *€ 5,8 million profit.*
4.7 Countries in which the case is active: *globally, on five continents.*

5. Strategic aspects of DaimlerChrysler
5.1 Mission: *to become the world's leading automotive company.*
5.2 Vision: *almost identical with the mission.*
5.3 General strategy: *achieving global presence, strong brands, a broad product range, and technology leadership.*

General information about futures research at DaimlerChrysler

1. Organisational aspects of futures research
1.2 Number of FTEs in the company dedicated to futures research: *40 - 60.*
1.3 Number of projects in the company in which futures research is used: *30-50.*
1.4 Own production, outsourcing, or combination: *predominantly own production.*

2. Methods of futures research
2.1 Exploring methods, predicting methods, or both: *predominantly exploring methods.*
2.2 Online, offline applying of methods, or both: *predominantly online.*
2.3 Amount of interactivity during applying methods: *quite high.*
2.4 Methods and level of visualisation and communication: *mainly reports (with many illustrations and figures) and presentations.*
2.5 Place in the company where the responsibility for futures research is located: *at the research department.*
2.6 Goals of futures research: *input for innovation and strategy development.*
2.7 Tools used for futures research: *interviewing, workshops, deskresearch.*

3. General aspects
3.1 Time horizon (in general): *short: 1 – 3 years; mid: 3 – 6 years; long: more than 10 years.*
3.2 Scope of future studies (in general): *broad, taking into account many different aspects.*
3.3 Type of information used: *reports of different consultancy companies, interviews, and information from government institutes.*

Information about the future study

Name of the future study: *'The future of the Chinese automobile business environment' (DE18, pp.12-14; see also section 6.5).*

Stage 1: Pre-foresight/ input:

1. consultation/participation: *mainly an internal SC-project team, some consulting was provided by external experts (expert interviews).*
2. clients of futures research: *DC headquarters.*
3. duration (research period) and costs (used resources): *unknown.*
4. goals or objectives: *to investigate whether the Chinese automobile market will remain a very important driver for the global automobile market and what factors play a role.*
5. rationales: *the enormous growth of the Chinese economy might cause surprising effects.*

Stage 2: Main foresight/throughput:

1. communication flows: *mostly within the project team.*
2. futures researchers: *from STRG and development departments*
3. geographical coverage: *China.*
4. level of detail: *developments in politics, traffic and transportation, society, industry structures and other fields.*
5. method: *trend-analysis resulting in different scenarios.*
6. organisation and management: *STRG was in the lead for this project.*
7. time horizon: *2015-2020.*
8. tools: *expert interviews, desk research and workshops.*

Stage 3: Post-foresight/outputs and action:

1. communication and visualisation: *not present.*
2. decision-making: *the results of the study were twofold: 1) scenarios at various levels (i.e., macro, mobility, and market) that could be linked to specific management objectives (DE18, p.13), 2) the analysis of the Chinese business market indicated there were several risks that had not been identified previously, resulting in a more cautious and incremental approach.*
3. dissemination: *this study was integrated in strategic plans at the headquarter by a workshop.*
4. implementation: *see dissemination.*

Good practices of DaimlerChrysler with regard to trend-analysis

Pre-foresight/input:

1. The concept of trend has been defined clearly: *not always in great detail, although determination of the time horizons is considered an important issue.*
2. The process and actions by which the trend-analysis is carried out are described: *yes but not very extensively.*
3. The collection of information and data collection is defined: *yes, part of the description of the process.*
4. The time horizon of the trend-analysis is defined: *yes (see 1.).*
5. Information and/or data are collected by using multiple and different sources (e.g. interviews, journals, Internet): *yes, they are often combined.*
6. It is clear how the trend-analysis is linked to a decision-making process: *not always.*

Main foresight/throughput:

7. It is clear how the collected information is analysed: *yes, often part of the description of the process of futures research*.
8. To conduct the trend-analysis various supporting tools (e.g. GDR, content analysis) have been used: *not always, depends strongly on the number of resources.*
9. Trends are not only viewed in isolation, but their relationships and even their combinations are taken into account as well: *this happens if trends are combined with scenarios.*
10. If possible, the trends have been assigned a qualitative (conditional) probability (unlikely, likely, etc.): *definitely not general practice*.
11. The assumptions of the trends are clarified and validated: *given the number of experts taking part in many studies, a certain amount of clarification and validation takes place.*

Post-foresight/outputs and action:

12. Based on the trends that are spotted and analyzed an all-encompassing picture of the future (or futures) is presented: *this often the case, especially when the trend-analysis is combined with scenarios.*
13. The consequences or impacts of the trends are assessed: *yes, most studies contain managerial and strategic implications.*

Information about innovation at DaimlerChrysler

The innovation indicators at an organisational level
1. Input innovation indicators:
1.1 Total innovation expenditure: *in 2002, the total budget of the DC/RT and the development departments was € 6.2 billion.*
1.2 Number of people involved in R&D and/or innovation: *about 2600 at DC/RT and almost 25,000 at the six development departments.*
1.3 Number of patents and patent applications: *4,700 patents applications annually.*

2. Throughput innovation indicators:
2.1 In which broad technological trajectories is the case active? *Scale-intensive, specialized suppliers.*
2.2 What are the technological competencies and where are they located within the firm? *General automotive technology (e.g., powertrain technology, vehicle construction and man-machine interaction, material technology), at Research & Technology and at the development departments.*
2.3 How does DC identify potentially new technological competencies? *Core task of Research & Technology.*
2.4 How are R&D and other innovation expenditures evaluated? *Extensive project evaluation in which clients are involved as well.*
2.5 How are innovation strategy and corporate strategy linked? *In various ways, for example: the director of DC/RT is a member of the board of directors of DC.*
2.6 Does DC use exploratory techniques to identify and predict future trends, e.g. brainstorming, scenario analysis, Delphi? *Yes, for example: trend-analysis, scenario planning, roadmapping, market research, early warning system.*
2.7 Does DC seek to develop and maintain networks of formal and informal knowledge? *Yes, STRG is member of various knowledge networks and its departments in Palo Alto and Kyoto also have that function.*
2.8 Does DC systematically look for new product opportunities? *Yes, using portfolio management, foresight and gap analysis.*
2.9 Does DC have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? *Yes, it is a formal process.*
2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this procedure used in practice or are there alternative 'short cuts'? *Yes, no short cuts.*
2.12 Is there top management commitment and support for innovation? *Yes, it is part of their corporate strategy.*
2.13 Is there a clear shared sense of strategic vision and ownership of the business plan? *Unknown.*

2.14 Does Dc have a supportive climate for new ideas – or do people have to leave in order to carry them forward? *Unknown.*

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years: *unknown.*
3.2 Percentage of annual turnover due to innovations: *unknown.*
3.3 Part of portfolio that has undergone an incremental change, a radical change, or that remained essentially unchanged: *unknown.*
3.4 Amount of sales of imitative and innovative products and services: *unknown.*
These output innovation indicators are extremely difficult to fill in. STRG gave the following two reasons for this:
1. Most of these performance indicators are very difficult to calculate. For example: how should one compare and count different kinds of 'innovations'? Is a newly designed headlight an innovation? How about a screw made from new material? And new production technologies, e.g., gluing together metal sheet? As a result of the difficulty involved in measuring these performance indicators, it also becomes difficult to measure other related indicators (e.g., share of portfolio, sales).
2. Some of theses indicators might have been estimated (e.g., in business consulting projects), but are probably hidden in confidential drawers.

Innovation indicators at a project level:
1. Cross-functionality: *yes, there is some cross-functionality though not much.*
2. Integrating marketing and manufacturing with the product development process: *not always, innovation process is relatively linear and often the stages are separated.*
3. Decision points or gates are also cross-functional: *see indicator 1.*
4. More holistic and looking beyond the development phase: *yes, innovation processes at DC include the entire process, from idea to market introduction.*
5. Much more emphasis on up-front homework or pre-development work: *yes, because innovation processes in the automotive industry are costly and time-consuming. STRG plays an important role here.*
6. Much stronger market orientation: *yes, the service element is becoming increasingly important, which means there is a greater focus on car users.*
7. Introducing parallel or concurrent engineering: *unknown, but not likely, given the linear nature of innovation at DC.*
8. Transparent decision-making process with clear Go/Kill criteria: *yes, is present.*
9. Fluidity: *limited.*
10. Fuzzy gates: *not present.*
11. Focused: *yes, a portfolio approach is adopted.*
12. Flexible: *rather limited.*

List of interviewees (in alphabetic order):
I01. Mattrisch, Gerhard (manager at STRG)
I02. Ruff, Frank (senior manager at STRG)

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APPENDIX 5: TNO INDUSTRY

Match with case selection criteria

TNO Industry: a Dutch non-profit research organisation that advices companies (mainly SMEs) on how to innovate.
1. Company objective: *TNO Industry is part of TNO, an independent research organisation. It obtains about 50% of its funding from the Dutch government and the other half from companies. Although it does not have a clear commercial goal, we feel that it does match the criteria of our research because its roadmapping activities are applied to commercial SMEs. Its method (i.e., roadmapping) is used for commercial purposes and within a commercial environment, and not as input for the innovation policy or processes of non-profit organisations. From this perspective, it is a case that resembles that of Syntens NT.*
2. The role of innovation in the company: *TNO Industry develops knowledge in various areas (e.g., roadmapping, new materials) that is used in innovation processes, which means that innovation is at the core of its activities and strategy.*
3. The explicit use of futures research in innovation processes: *TNO Industry has developed its own roadmapping method that is used in innovation processes. The roadmaps are described in reports and presented to clients (i.e., SMEs).*

General background characteristics of TNO Industry

Type of products or services: (technical) advice, patents, technical principles and processes.
Organisational position of TNO Industry: *it is one of the 15 institutes of TNO.*
General characterisation of the industry in which TNO Industry operates: TNO Industry serves large Dutch-based companies, which in most cases are SMEs, a group of companies that makes up 99% of all Dutch companies. TNO Industry occasionally also advises government organisations and carries out projects that are (partly) financed by government organisations.

Other characteristics of TNO Industry:
4.1. Central versus decentralised: *relatively decentralised.*
4.2. Level of education staff: *very high, most employees have an academic degree (e.g., MSc, PhD).*
4.3. Mobility of employees: *low, researchers are not always tempted to leave for a higher salary and TNO has a good reputation.*

4.4 Number of employees: ~ 500.
4.5 Turnover: *€ 555 million.*
4.6 Profit/Loss: *not relevant.*
4.7 Countries in which TNO Industry is active: *the Netherlands.*

5. Strategic aspects of TNO Industry:
5.1 Mission: *"Utilising scientific knowledge to reinforce the innovative capability of business and government".*
5.2 Vision: *see mission.*
5.3 General strategy: *see mission.*

General information about futures research at TNO Industry

1. Organisational aspects of futures research:
1.2 Number of FTEs in TNO Industry occupied with futures research: *~ 4.*
1.3 Number of projects in TNO Industry in which futures research is used: *~7.*
1.4 Own production, outsourcing, or combination: *mainly own production, although in some cases former employees of TNO Industry were hired as consultants. Sometimes external experts were invited to participate in the roadmap-workshops.*

2. Methods of futures research:
2.1 Exploring methods, predicting methods, or both: *roadmapping is predominantly a predictive method, although regular updates make it possible to adjust the roadmap to new (future) situations.*
2.2 Online, offline applying of methods, or both: *for the most part online.*
2.3 Level of interactivity while methods are being applied: *relatively high, clients are involved to a considerable extent.*
2.4 Ways and level of visualisation and communication: *to a limited extent, although the roadmap is visualised.*
2.5 Place in TNO Industry where the responsibility for futures research is located: *at the sub-department Product development.*
2.6 Goals of futures research: *as input to product development (i.e., innovation), as an input to the strategic plan of TNO Industry, and to create awareness about the future and the importance of innovation among customers of TNO Industry.*
2.7 Tools used for futures research: desk-research, attending conferences, expert-interviews, workshops.

3. General aspects:
3.1 Time horizon (in general): *three to five years from now (roadmapping).*

3.2 Scope of future studies (in general): *fairly broad, including technology, product, business, market, and industry-specific issues.*
3.3 Type of information used: *mainly qualitative information.*

Information about roadmapping

Name of the future study: branche-roadmap telemedicine and the business roadmap for Vitaphone.
Stage 1: Pre-foresight/ input:
1. Consultation/participation: *experts from TNO, experts on telemedicine and experts from Vitaphone were involved.*
2. Clients of futures research: *managers and product developers from SMEs and Vitaphone.*
3. Duration (research period) and costs (available resources): *it took about nine months to develop the sector roadmap and four months to develop the product roadmap.*
4. Goals or objectives: *creating awareness among SMEs of the importance of looking to the future as far as medical systems are concerned, defining opportunities in that area and more specifically for telemedicine, and information about how to realise those opportunities.*
5. Rationales: *creating awareness among SMEs of the importance of looking to the future for new ideas for innovation and giving concrete direction to innovation processes.*

Stage 2: Main foresight/throughput:
6. Communication flows: *mainly between TNO Industry, Syntens, and Vitaphone.*
7. Futures researchers: *the facilitators from TNO Industry were mainly process experts.*
8. Geographical coverage: *Netherlands, telemedicine.*
9. Level of detail: *various trends with regard to telemedicine were described.*
10. Method: *qualitative, roadmapping, trend analysis.*
11. Organisation and management: *facilitating carried out by employees from TNO Industry.*
12. Time horizon: *not clearly defined but it can assumed that the time-horizon is about five years from now.*
13. Tools: *brainstorming, expert-interviewing, workshops.*

Stage 3: Post-foresight/outputs and action:

9. Communication and visualisation: *a report was made of each TW, and sometimes ideas for innovation were visualised in drawings.*
10. Decision-making: *mainly the responsibility of the SME and sometimes supported by a Syntens advisor.*
11. Dissemination: *through meetings, reports, presentations.*
12. Implementation: *see decision-making (above)*

Good practices of roadmapping with regard to TNO Industry

Input

1. Input for the roadmap is collected from various fields (market-related, technical, commercial, societal) and provided by experts with different backgrounds. *Yes.*
2. The roadmap should be embedded in a broader strategy and other types of decision making processes. *Yes*
3. A clear definition of the scope, focus and unit of analysis of the roadmap. *Yes, much attention is given to the marking out of the sector and the issues involved.*

Throughput

4. The process of building a roadmap has been clearly and extensively defined in a number of (linear or parallel) steps. *Yes, steps have been defined.*
5. The roadmap has been constructed with the support of an interactive process. *Yes, interviews have been conducted and workshops organised.*
6. The roadmap is approached both from the top down and from the bottom up, and/or from a technology push and market pull perspective: *it started with the needs of the actors in the telemedicine value system, which were linked to technology options.*

Output

7. The roadmap contains a clear vision of the future: *yes.*
8. The various elements of the roadmap (society, business/market, technology, products/services) are clearly linked to each other: *yes.*

Information about innovation at Dutch SMEs

Because roadmapping by TNO Industry was applied in the innovation processes of Dutch SMEs (see section 7.3), in this appendix we pay attention to those innovation activities. Given the diversity of Dutch SMEs, the information about the *input*, *throughput*, and *output* innovation indicators is fairly general and contains rough estimates. Since the

Syntens NT-case (Chapter 5) also focused on innovation at SMEs, this part of the appendix resembles the innovation indicator part of Appendix 3.

Innovation indicators at an organisational level:
1. Input innovation indicators:
1.1 Total innovation expenditure: *~ € 1063 million in 2001 (~ 25% of total number of persons involved in R&D).*
1.2 Number of persons involved in R&D and/or innovation: *~ 15,000 employees.*
1.3 Number of patents and patent applications: *in 2002 a majority of applications for Dutch patents came from SMEs and private inventors. In 2003 this percentage was a little over 70.*

2. Throughput innovation indicators:
2.1 In which broad technological trajectories are SMEs active? *Information-intensive, specialised suppliers.*
2.2 What are the technological competencies and where are they located within SMEs? *Very diverse, but mainly related to small-scale technologies.*
2.3 How do SMEs identify potentially new technological competencies? *Often this is carried out informally; contacts with suppliers, business partners, and (business) customers.*
2.4 How are R&D and other innovation expenditures evaluated? *Not very often, rather informal.*
2.5 How are innovation strategy and corporate strategy linked? *Both types of strategy are often very informal, so the potential link will be as well.*
2.6 Do SMEs use exploratory techniques to identify and predict future trends, e.g. brainstorming, scenario analysis and Delphi? *Not formally.*
2.7 Do SMEs seek to develop and maintain networks of formal and informal knowledge? *Yes, but mainly informal networks.*
2.8 Do SMEs search for new product opportunities systematically? *Not very systematically. Most ideas for new products come from technologies offered by suppliers and from customer demand.*
2.9 Do SMEs have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? *Not really a system, most innovation processes are informal.*
2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this used in practice or are there alternative 'short-cuts'? *Often not, although the larger SMEs sometimes are involved in fairly major innovation projects that are managed quite formally.*
2.11 Is there top management commitment and support for innovation? *Depends to a large extent on the opinion of the general manager/owner.*

2.12 Is there a clear shared sense of strategic vision and ownership of the business plan? *Often only present at the level of the general manager/owner.*
2.13 Do SMEs have a supportive climate for new ideas – or do people have to leave in order to carry them forward? *This also often depends often on the opinion of the general manager/owner.*

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years: *34% of all SMEs introduced new products and services in the past three years.*
3.2 Percentage of annual due to innovations: *Difficult to estimate. It can be assumed that it is not more than 30%.*
3.3 Part of portfolio that has undergone an incremental change, a radical change, or that remained essentially unchanged: *Unknown.*
3.4 Amount of sales of imitative and innovative products and services: *Unknown.*

Innovation indicators at a project level:
1. Cross-functionality: *Sometimes only the director/owner is involved, but if SMEs cooperate in innovation projects, more players form various functions are involved.*
2. Integrating marketing and manufacturing with the product development process: *See previous indicator.*
3. Decision points or gates are also cross-functional: *Only in cases were several SMEs innovate together.*
4. More holistic, looking at more than just the development phase: *Given that SMEs view innovation as a new product or service that is available in the market, the innovation process is indeed holistic.*
5. Much greater emphasis on up-front homework or pre-development work: *Not always the case; SMEs often start developing fairly quickly, without conducting the proper investigations, although in the more risky innovation projects SMEs do some up-front homework.*
6. Much stronger market orientation: *Depends on the position in the industry value chain.*
7. Introducing parallel or concurrent engineering: *Yes, if SMEs innovate together.*
8. Transparent decision-making process with clear Go/Kill criteria: *Given that innovation processes at SMEs are rather informal, this will not be the case. However, if innovation projects do not yield money within a relatively short timeframe, SMEs have no qualms about stopping an innovation process.*
9. Fluidity: *Yes, given the informal nature of innovation processes at SMEs.*
10. Fuzzy gates: *No, often SMEs make a 'Go/No Go' type of decision.*
11. Focused: *Given the low number of innovation projects among SMEs, they will not think in terms of a portfolio of projects.*
12. Flexible: *Definitely, given the informal nature of innovation processes at SMEs.*

List of interviewees (in alphabetic order):
I01. Achthoven, Wilfred (business innovator at Altuition)
I02. Broek, Joelle van de (TNO Industry)
I03. Bruinsma, Nienke (TNO Industry)
I04. Dirks, Maarten (Effics)
I05. Duren, Gert van (TNO Industry)
I06. Eikelenberg, Nicole (TNO Industry)
I07. Heek, Rudolf van (TNO Industry)
I08. Hertog, Friso den (fellow of Altuition)
I09. Hoes, Onno (Deputy of the Province of Noord-Brabant)
I10. Jentjens, George (Managing director Jentjens)
I11. Lips, Dirk (CEO Libema)
I12. Lombaers, Jaap (TNO Industry)
I13. Oort, Andre van (General Manager Vitaphone)
I14. Oskam, Inge (Buro IO) *(interviewed twice: I14.a & I14.b)*
I15. Rietsema, Jan (Syntens)
I16. Schadewijk, Ton van (Syntens, advisor)
I17. Schraven, John (TNO Industry)
I18. Star, Erwin van der (innovator at Vitaphone)
I19. Wal, Gerbert van der (BOM/IAB)
I20. Westerbaan van der Mey, Cor (Syntens, advisor)

List of participants of the group discussion (in alphabetic order):
1. Dirks, Maarten (Effics)
2. Duren, Gert van (TNO Industry)
3. Eikelenberg, Nicole (TNO Industry)
4. Heek, Rudolf van (TNO Industry)
5. Oskam, Inge (Buro IO)
6. Rietsema, Jan (Syntens)
7. Schadewijk, Ton van (Syntens)
8. Westerbaan van der Meij, Cor (Syntens)

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APPENDIX 6: PINKROCCADE

Match with case selection criteria

PinkRoccade: a Dutch IT company.
1. The company's objective: PinkRoccade is a commercial organization listed at the Amsterdam stock exchange.
2. The role of innovation in the company: the corporate strategy of PinkRoccade is aimed at making the organization and its products and services more innovative. PinkRoccade has a corporate department involved in technology development, and almost all business areas have R&D or technology managers. One of the strategic motto's of PinkRoccade is: "Innovation in combination with continuity and security is the *raison d'être* of PinkRoccade" (DI11).
3. Explicit use of futures research in innovation processes: PinkRoccade has carried out a project called 'Foresight' in which corporate scenarios were built. One of the goals of this project was to produce new business cases and plans for innovation. The responsibility and project-management was mainly in the hands of Business Development, a department at headquarters.

General background characteristics of PinkRoccade

1. Type of products or services: IT advice, IT products and posting IT employees at organisations (i.e., customers).
2. Organisational position of Business Development within PinkRoccade*: located at headquarters, important role in strategy formulating of PinkRoccade.*
3. General characterization of the industry of PinkRoccade and PinkRoccade itself: in a very bad position, market does not grow, many lay-offs, and many (small) companies going bankrupt. The market has changed from a seller's into a buyer's market. However, most IT companies say that the bad times have almost past and they expected that in the coming years the industry will recover and that they will start hiring new and additional employees.

Other characteristics of PinkRoccade
4.1 Central versus decentral: *relatively decentral.*
4.2 Level of education staff: *rather high, many academics or higher vocational students.*
4.3 Mobility of employees: *average.*
4.4 Number of employees: *in 2004 the company employed 7,002 people*
4.5 Turnover: *€ 702 million (2003).*
4.6 Profit/Loss: *€ 4.2 million (2003).*

4.7 Countries in which the company is active: *mainly in the Netherlands and in the UK.*

5. Strategic aspects of PinkRoccade
5.1 Mission: *"PinkRoccade wants to be an innovative ICT-service provider, that on the basis of a solid knowledge of customer processes and a wide portfolio of skills and expertise actual contributes to the creation of business value by customers" (DI12).*
5.2 Vision: *see mission.*
5.3 General strategy of PinkRoccade: *developing new knowledge in the field of ICT.*

General information about futures research at PinkRoccade

1. Organisational aspects of futures research
1.2 Number of FTEs in PinkRoccade dedicated to futures research: *~ 4.*
1.3 Number of projects in PinkRoccade in which futures research is used: *~ 5.*
1.4 Own production, outsourcing, or combination: *predominantly own production*.

2. Methods of futures research
2.1 Exploring methods, predicting methods, or both: *predominantly exploring methods.*
2.2 Online, offline applying of methods, or both: *predominantly online.*
2.3 Amount of interactivity in the application of methods: *quite high.*
2.4 Methods and level of visualisation and communication: *not much. Methods that are used include: workspaces of the future, comprehensive first presentation of the scenarios.*
2.5 Place in PinkRoccade where the responsibility for futures research is located: *at business development (headquarter).*
2.6 Goals of futures research: *input for vision development and business development (new services and products).*
2.7 Tools used for futures research: *interviewing, creativity workshops.*

3. General aspects
3.1 Time horizon (in general): *2 to 5 years, for the scenarios it was extended to 10 years. Business dynamics differs per business area and therefore the time horizon.*
3.2 Scope of the future studies (in general): *broad, taking into account many aspects*.
3.3 Types of information used: *reports of different consultancy companies (Forrester, Gartner) and government research institutes.*

Information about Foresight

Name of the future study: Foresight

Stage 1: Pre-foresight/ input:

1. Consultation/participation: *no external consultation or participation was enlisted, only the employees from Corporate Development and from the business areas.*
2. Clients of futures research: *strategists, product managers, account managers.*
3. Duration (research period) and costs (used resources): *six months, ~ € 400,000.*
4. Goals or objectives: *to stimulate future-oriented action and to position PinkRoccade in its future markets (DI02, p.5).*
5. Rationales: *increasing uncertainty in the IT market and the Internet-crash forced PinkRoccade once again to explore the future, which meant paying more attention to its uncertainties. This uncertainty could be better addressed by scenarios than by forecasting models.*

Stage 2: Main foresight/throughput:

1. Communication flows: *much communication between business development and representatives of different business areas.*
2. Futures researchers: *predominantly content experts. Expertise on scenario-thinking was gained by a member of the Foresight-project at a former job.*
3. Geographical coverage: *Netherlands, Europe, society, IT industry.*
4. Level of detail: *society, Europe, IT market, IT technology.*
5. Method: *qualitative, scenario analysis.*
6. Organisation and management: *futures researchers have different roles, no special role assigned to individual people.*
7. Time horizon: *is not considered very important by the futures researchers of PinkRoccade, but the Foresight project aimed at 2010 (which at the time the scenarios were being built was about seven years ahead).*
8. Tools: *expert interviews, desk research, brainstorming.*

Stage 3: Post-foresight/outputs and action:

1. Communication and visualisation: *the scenarios have been given the names of different animals (bear, elephant, gnu, and beaver) and during the first presentation a specific building was build in which the different scenarios were reflected by different rooms. Also, there was a dinner during the workshop that consisted of four courses, each representing a different scenario.*
2. Decision-making: *see implementation.*
3. Dissemination: *mainly through a large workshop and through presentations for employees from the business areas.*
4. Implementation: *by defining a strategy based upon the scenarios and by adjusting the scenarios to the specific issues of the business areas to formulate new projects for business development. However, the scenarios were not very closely linked to implementation (and decision-making).*

Good practices of the scenario-method with regard to PinkRoccade

Pre-foresight/input:

1. Many different people, both inside and outside PinkRoccade, have been interviewed: *no, main focus was on interviewing employees (managers of different departments) of PinkRoccade. At the presentation of the scenarios a few external speakers were invited.*
2. A desk research (i.e., a literature-study) was carried out: *yes, different reports have been analyzed.*
3. The (right) time horizon has been determined by deciding the moment at which there is too much uncertainty to produce a reliable forecast: *yes, the time horizons of the scenarios were also adjusted to the organisational level at which they were applied.*
4. Attention has been paid to a broad support of the scenarios in the case: *Yes, a workshop was organised to present the scenarios and the scenarios were presented to business areas.*

Main foresight/throughput:

5. Interactive workshops have been organised to collect information and opinions from clients and stakeholders of the scenarios: *yes, but only with experts and stakeholders inside PinkRoccade.*
6. The scenarios do not merely present various endings, but also various 'roadmaps' that show the evolution of certain trends in the various possible futures: *not really, the scenarios are only pictures of possible future societies.*
7. A great deal of attention is paid to the visualisation and communication of the scenarios: *yes (names of the scenarios, rooms, dinner at the workshop).*
8. The scenarios and the decision-making process are linked to each other: *not formally but the scenarios have served as important input to the strategy process.*
9. The scenarios are (internally) consistent: *yes.*
10. Attention has been paid to the implementation of the scenarios in PinkRoccade: *yes.*

Post-foresight/outputs and action:

11. The number of scenarios is four: *yes.*
12. The scenarios are described in detail: *yes (economic, political, cultural, technological).*
13. The scenarios have been made both challenging and recognizable to users: *yes.*
14. The scenarios can be modified to reflect the specific interests of PinkRoccade and its sub-departments: *yes, this has also been done often.*

Information about innovation at PinkRoccade

The innovation indicators at an organisational level
1. Input innnovation indicators:
1.1 Total innovation expenditure: *not explicit in financial systems but an interviewee estimated it at 0.5 % of the company's total turnover, which is about € 2 million (I03, p.2)* .
1.2 Number of persons involved in R&D and/or innovation: *divided over several operating companies. Corporate: +/- 2 FTE. The Technology Board is responsible for portfolio and business development projects. Consists of +/- 10 persons, meets once per month.*
1.3 Number of patents and patent applications: *no patents or patents applications. Only registered trademarks.*

2. Througput innovation indicators:
2.1 In which broad technological trajectories is PinkRoccade active? *Information-intensive, specialized suppliers.*
2.2 What are the technological competencies and where are they located within PinkRoccade? *ICT infrastructure management: ~ 400 FTEs; ICT application management: ~ 3000 FTEs.*
2.3 How does PinkRoccade identify potentially new technological competencies? *Scenarios, foresight, contacts with customers and suppliers.*
2.4 How are R&D and other innovation expenditures evaluated? *Not evaluated.*
2.5 How are innovation strategy and corporate strategy linked? *Corporate development is responsible for establishing corporate strategy and is related to the Technology Board.*
2.6 Does PinkRoccade use exploratory techniques to identify and predict future trends, e.g., brainstorming, scenario analysis, and Delphi? *Scenario-planning, business intelligence, early warning system, event-analysis.*
2.7 Does PinkRoccade seek to develop and maintain networks of formal and informal knowledge? *Yes, within the company, facilitated by Internet, and also relationships with knowledge institutes.*
2.8 Does PinkRoccade systematically search for new product opportunities? *Yes, using portfolio management, foresight and gap analysis.*
2.9 Does PinkRoccade have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? *See above, make or buy decision is formal.*
2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this used in practice or are there alternative 'short-cuts'? *See above.*
2.11 Is there top management commitment and support for innovation? *Yes, there is. Its is a structural part of the corporate steering.*
2.12 Is there a clear shared sense of strategic vision and ownership of the business plan? *Not much. Focus is mainly on the short term due to the dynamic market in which*

PinkRoccade is operating. Nevertheless, the long term is becoming a more important agenda-issue.
2.13 Does PinkRoccade have a supportive climate for new ideas – or do people have to leave in order to carry them forward? *There is a so called Department Of Damned Good Ideas (DODGI) which is a web-enabled system that has as yet not been spectacularly successful.*

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years: *ASL, ITIL, Common KA and many other trademarked products.*
3.2 Percentage of annual turnover that comes from innovations: *unknown, estimations are not high.*
3.3 Part of portfolio that underwent an incremental change, a radical change, or that remained essentially unchanged: *not known. It is assumed that incremental change represents the highest portion.*
3.4 Amount of sales of imitative and innovative products and services: *not known, estimation is 2% per year (I03, p.2).*

Innovation indicators at a project level:
1. Cross-functionality: *not much since business development projects mainly take place within separate business areas.*
2. Integrating marketing and manufacturing with the product development process: *yes, different aspects of the innovation (such as market needs and organisational aspects) are taken into account.*
3. Decision points or gates are also cross-functional: *is limited because business development mainly takes place within separate business areas.*
4. More holistic and looking beyond the development phase: *yes, effort is put not only in idea generation but also in building business cases and implementation.*
5. Much greater emphasis on up-front homework or pre-development work: *yes, the scenarios are an example of this up-front homework.*
6. Much stronger market orientation: *is present, both the corporate scenarios and the efforts by PR CD to make PinkRoccade more focused on the market are proof of this growing market orientation.*
7. Introducing parallel or concurrent engineering: *not really present.*
8. Transparent decision-making process with clear Go/Kill criteria: *not really present given the general informal nature of the innovation process at PinkRoccade.*
9. Fluidity: *not really present given the general informal nature of the innovation process at PinkRoccade.*
10. Fuzzy gates: *not really present given the general informal nature of the innovation process at PinkRoccade.*

11. Focused: *although no formal prioritization methods are used, innovation is clearly in line with the overall strategy which makes it rather focused.*
12. Flexible: *given the informal nature of innovation at PinkRoccade, innovation processes are also quite flexible.*

List of interviewees:
I01. Blauwhof, Gertrud (PinkRoccade, advisor Corporate Development)
I02. Brake, Hans ter (PinkRoccade Healthcare, general management)
I03. Chang, Thiel (PinkRoccade Public Sector, manager Research & Development)
I04. Götte, Bart (PinkRoccade, advisor Corporate Development)
I05. Groenendijk, Ronald (PinkRoccade IT Management, manager Business Development)
I06. Hartveld, Gerdy (PinkRoccade, member of general board PinkRoccade Netherlands)
I07. Krol, Irene van der (PinkRoccade Public Sector, manager knowledge centre)
I08. Leppers, Ton (PinkRoccade Finance, consultant)
I09. Nieuwenhuis, Hans (PinkRoccade, manager Corporate Development/CTO)
I10. Oirschot, Robert van (PinkRoccade IT Management, managing consultant eStrategy)
I11. Rheenen, Ton van (PinkRoccade Public, senior business consultant)

List of participants of the group discussion (in alphabetic order):
1. Buis, Edwin (PinkRoccade Public Sector)
2. Chang, Thiel (PinkRoccade Public Sector, manager Research & Development)
3. Gotte, Bart (PinkRoccade, advisor Corporate Development)
4. Kampen, Alex van (PinkRoccade Public)
5. Krol, Irene van der (PinkRoccade Public Sector, manager knowledge centre)
6. Oirschot, Robert van (PinkRoccade IT Management, managing consultant eStrategy)
7. Rheenen, Ton van (PinkRoccade Public, senior businessconsultant)

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APPENDIX 7: PHILIPS MEDICAL SYSTEMS

Match with case selection criteria

Philips Medical Systems (PMS) is a company that operates in the medical systems industry and part of worldwide operating electronic company Royal Philips Electronics.
1. The company's objective: Philips Medical Systems is an independent business unit that is part of Royal Philips Electronics, a globally operating commercial company that is active in industries such as consumer electronics.
2. The role of innovation in the company: PMS' strategy is definitely aimed at innovation. Its employees often refer to their efforts in constantly renewing their product and service portfolio, and to their close working relationships with Philips' various R&D labs. One of the strategic motto's of Philips Medical Systems is: "Innovation in combination with continuity and security is the *raison d'être* of Philips Medical Systems" (DE07).
3. The explicit use of futures research in innovation processes: Philips Medical Systems uses trend analysis and especially roadmaps to envision the future and to develop new products and services for that future. Many people in Philips Medical Systems have a formal responsibility to build roadmaps and the roadmaps are part of their innovation processes.

General background characteristics of Philips Medical Systems

1. Type of products or services: Philips Medical Systems (PMS) produces systems that are used in the healthcare industry (e.g., hospitals).
2. Organisational position: PMS is an independent business area of Philips N.V. and is profit-and-loss responsible.
3. General characterisation of the industry: the market of PMS is an oligopoly; PMS, General Electric, and Siemens together have a market share of about 85%. Nevertheless, small companies are important for introducing new medical systems to the market, after which these companies are often bought by PMS, General Electric or Siemens.

Other characteristics of Philips Medical Systems
4.1. Central versus decentral: *relatively decentral; PMS and the business units have much freedom to decide on business issues.*
4.2 Level of education staff: *relatively high, almost all employees have an academic degree and many have a PhD as well.*
4.4 Mobility of employees: *unknown.*
4.5 Number of employees: *30,800 (in 2004).*

4.6 Sales: *€ 5884 million (2004).*
4.7 Profit from operations: *€ 34 million (2004).*[45]
4.8 Countries in which the case is active: *worldwide.*

5. Strategic aspects of Philips Medical Systems
5.1 Mission: *providing 'healthcare without boundaries"*
5.2 Vision: *realising "the transformation from the supply of specific, stand-alone clinical applications towards a total patient 'care cycle'" (DI09, p.28).*
5.3 General strategy: *combination of customer intimacy ("We take the time to earn your trust and build lasting relationships. […] By listening carefully to fully understand your issues. By making sure products work perfectly when they're introduced into your environment" (DI02, p.5)), and product leadership ("All share one focus: clinical excellence" (ibid., p.4)).*

General information about futures research at Philips Medical Systems

1. Organisational aspects of futures research
1.2 Number of FTEs in Philips Medical Systems occupied with futures research: *~ 5 FTE.*
1.3 Number of projects in Philips Medical Systems in which futures research is used: *Every development project is based on a roadmap and/or trend-map.*
1.4 Own production, outsourcing, or combination: *own production.*

2. Methods of futures research
2.1 Exploring methods, predicting methods, or both: *the roadmap is mainly predictive and the trend-analysis is mainly explorative.*
2.2 Online, offline application of methods, or both: *online.*
2.3 Amount of interactivity during applying methods: *not very high although the roadmap is a 'living document'.*
2.4 Ways of and level of visualisation and communication: *not present.*
2.5 Place in Philips Medical Systems where the responsibility for futures research is located: *at the technology board and the marketing department of Development of BU CV of PMS.*
2.6 Goals of futures research: *to plan the development of new medical products and systems.*
2.7 Tools used for futures research: interviews, contacts with physicians, desk research, workshops with customers.

[45] Very low operational profit in 2004 due to a big writing off on two recently acquired companies.

3. General aspects
3.1 Time horizon (in general): *varies per type of roadmap, but mainly ten years from now, the trend analysis often has a shorter time horizon.*
3.2 Scope of future studies (in general): *in principle broad but with an emphasis on clinical and technological issues.*
3.3 Types of information used: *both quantitative and qualitative information that comes from desk research, clinical experts, and visiting conferences.*

Information about Multi-Modality/Integration Technology Roadmap Cardio Vascular

Name of the future study: *Multi-Modality/Integration Technology Roadmap Cardio Vascular*
Stage 1: Pre-foresight/ input:
1. Consultation/participation: *input from market research agencies, physicians, and from literature.*
2. Clients of futures research: *not for external clients, only for internal use.*
3. Duration (research period) and costs (used resources): *3 months (estimation). Total costs unknown, mainly personnel costs.*
4. Goals or objectives: *to develop a vision about multi-modality and to achieve it.*
5. Rationales: t*o develop more in-depth knowledge about multi-modality and issues related to it.*

Stage 2: Main foresight/throughput:
1. Communication flows: *mainly between the various teams and occasionally with management.*
2. Futures researchers: *future content experts of PMS (e.g., the roadmap team, the product teams, the KSF-teams).*
3. Geographical coverage: *worldwide*
4. Level of detail: *relatively specific, especially with regard to the new systems and platforms, trends were also described in fairly great detail.*
5. Method: *qualitative, roadmapping, trend-analysis.*
6. organisation and management: *predominantly the content experts of PMS.*
7. Time horizon: *varies per type of roadmap, but between three and ten years from now.*
8. Tools: *expert-interviews, focus groups, desk research, SWOT-analysis.*

Stage 3: Post-foresight/outputs and action:
1. Communication and visualisation: *not much, only the roadmap is visualised and a few possible new systems and platforms (prototypes).*

2. Decision-making: *see implementation.*
3. Dissemination: *only internally, through presentations and by sending the report.*
4. Implementation: *roadmap is used as input to the Product Realisation Process.*

Good practices of roadmapping with regard to Philips Medical Systems

Pre-foresight/input:

1. Input for the roadmap is collected from various fields (market, technical, commercial, societal) and provided by experts with different backgrounds: y*es, but the emphasis is on clinical and technological issues.*
2. The roadmap should be embedded in a broader strategy and other types of decision making processes: y*es, the roadmap is the most important input with regard to decisions concerning which products and systems to develop and the roadmap actually also contains those decisions.*
3. A clear definition of the scope, focus and unit of analysis of the roadmap: *all are described and are part of the roadmap*.

Main foresight/throughput:

4. The process of building a roadmap has been clearly and extensively defined in different (linear or parallel) steps: *not entirely, the process is at times somewhat vague.*
5. The roadmap has been constructed with the support of an interactive process.: *not really, most contributors to the roadmap work separately from each other although the each version of the roadmap is reviewed extensively.*
6. The roadmap is approached both top-down and bottom-up, and/or technology push and market pull: *the roadmap approach is bottom-up and combines technology and market.*

Post-foresight/outputs and action:

7. The roadmap contains a clear vision of the future: y*es, the roadmap is explicit about what the product or system should be like.*
8. The various elements of the roadmap (society, business/market, technology, products/services) are clearly linked to each other: y*es.*

Information about innovation at Philips Medical Systems

The innovation indicators at an organisational level

1. Input innnovation indicators:

1.1 Total innovation expenditure: *unknown.*

1.2 Number of persons involved in R&D and/or innovation: ~ 10,000.
1.3 Number of patents and patent applications: unknown.

2. Througput innovation indicators:
2.1 In which broad technological trajectories is PMS active? *Science-based, information-intensive, specialised suppliers.*
2.2 What are the technological competencies and where are they located within PMS? *E.g., imaging, ultrasound, computed tomography. Mainly within the development and research departments of PMS but also within the NatLab of Philips.*
2.3 How does PMS identify potentially new technological competencies? *Through extensive contacts with physicians all over the world and by regularly organising workshops and attending conferences (see also innovation indicator 2.7).*
2.4 How are R&D and other innovation expenditures evaluated? *Corporate technology carries out some evaluation with the support of a consultancy agency.*
2.5 How are innovation strategy and corporate strategy linked? *The technology boards at business unit level and at corporate level.*
2.6 Does PMS use exploratory techniques to identify and predict future trends, e.g. brainstorming, scenario analysis, and Delphi? *Yes, roadmapping and trend analysis.*
2.7 Does PMS seek to develop and maintain networks of formal and informal knowledge? *Yes, there are extensive contacts with physicians all over the world and they regularly organise workshops and attend conferences.*
2.8 Does PMS systematically search for new product opportunities? *Yes, their formal and informal networks (see innovation indicator 2.7) are clear proof for this.*
2.9 Does PMS have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process? *Yes. The innvoation process in general is very formal and there are several moments when decisions about products and systems are made.*
2.10 Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this used in practice or are there alternative 'short-cuts'? *Yes. The innovation process has several stages and there are no alternative 'short-cuts'.*
2.11 Is there top management commitment and support for innovation? *Not always. The words of management about the importance and need of innovation, as expressed in annual reports and other corporate publications, are not always in line with each other.*
2.12 Is there a clear shared sense of strategic vision and ownership of the business plan? *Yes, employees know what PMS stands for and what it is trying to achieve.*
2.13 Does PMS have a supportive climate for new ideas – or do people have to leave in order to carry them forward? *Employees have much room for bringing in new ideas and carrying them out although due to market pressures this room is narrowed down.*

3. Output innovation indicators:
3.1 Number of innovations introduced over the past three years: *unknown, but given the lead times of new products and systems this percentage will fluctuate.*
3.2 Percentage of annual turnover due to innovations: *"whereas in 2002 some 40% of our sales were due to products younger than 2 years, in 2004 this number has grown to approximately 60%" (DI09, p.30).*
3.3 Part of portfolio that has undergone an incremental change, a radical change, or that remained essentially unchanged: *mostly incremental changes, radical changes such as the development of a new platform occurs only every seven years.*
3.4 Amount of sales of imitative and innovative products and services: *unknown but probably not constant (see innovation indicator 3.1).*

Innovation indicators at a project level:
1. Cross-functionality: *the KSF-teams are multidisciplinary.*
2. Integrating marketing and manufacturing with the product development process: *yes, both development and marketing are present.*
3. Decision points or gates are also cross-functional: *yes, these are present.*
4. More holistic, and looking beyond the development phase: *yes, the ambition is to develop an idea all the way to market introduction.*
5. Much more emphasis on up-front homework or pre-development work: *not always the case. The manager of project management said that sometimes not enough work is done before development which can slow down the innovation process because additional issues have to be solved.*
6. Much stronger market orientation: *yes, clients play an important role in the innovation process, although sometimes technical ideas are the starting point for innovation.*
7. Introducing parallel or concurrent engineering: *this is introduced recently on a small scale to speed up the innovation process.*
8. Transparent decision-making process with clear Go/Kill criteria: *yes, definitely present (see also above).*
9. Fluidity: *not very fluid, although to some extent there is parallel engineering.*
10. Fuzzy gates: *not present.*
11. Focused: *as a result of the shift towards more system and platform innovation more attention is paid to the entire set of innovation projects.*
12. Flexible: *the level of flexibility is low, with every innovation projects going through the same process.*

List of interviewees (in alphabetic order):
I01. America, Pierre (NatLab)
I02. Baars, Maarten (Business Segment Director Cardio)

I03. Babic, Drazenko (Clinical Scientist CV)
I04. Boosten, Marcel (Volumetric Imaging Technology Manager)
I05. Crooijmans, Wim (PCP Manager)
I06. Gijsbert, Geert (Clinical Scientist CV)
I07. Haas, Hein (Pre-development Manager X-ray)
I08. Hoornaert, Bart (IQ & Dose Technology Manager)
I09. Kets, Anke (Clinical Scientist CV)
I10. Koenraadt, Maryll (student Technical University of Eindhoven, at time of the interview: product manager at Philips Consumer Electronics)
I11. Kroon, Ron (Manager Projects PMG XRD Cardio Vascular)
I12. Meurs, Bert van (Marketing Manager)
I13. Mioni, Denis (Business Segment Director Vascular)
I14. Mulder, Rob (VP Corporate Industrial Policy & Technology)
I15. Obbink, Henk (NatLab)
I16. Pasman, Wim (Fellow Architect CIS)
I17. Reth, Eric von (Clinical Science Manager)
I18. Swinkels, Hans (Senior Project Manager)
I19. Wesselius, Jacco (Chief Technology Manager and Multi Modality Technology Manager)

List of participants of the group discussion (in alphabetic order):
1. Willem Vuisting (General Manager CV)
2. Pierre America (NatLab)
3. Denis Mioni (Business Segment Director Vascular)
4. Marcel Boosten (Volumetric Imaging Technology Manager)
5. Maarten Baars (Business Segment Director Cardio)

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APPENDIX 8 THE INNOVATION AUDIT OF TIDD, BESSANT & PAVITT

In this appendix we present the entire innovation audit of Tidd, Bessant & Pavitt (1997), parts of which we have used in the case analysis framework (Chapter 1, section 1.2 and Chapter 3, section 3.4). The goal of this innovation audit is to assess the innovative performance of an organization. The authors stress that the audit does not provide an absolute score on innovativeness, but that it will "give some underpinning to what will otherwise be rather subjective about the innovative performance of a company" (ibid., p.364). It is important is that an organization does not just score well on a selected number of issues, but that is shows a "good all-round performance" (ibid., p.359). Parts of this innovation audit are used in the case analysis framework. The innovation audit consists of four parts:

1. Does the organization adopt a strategic approach to innovation?
2. Has the organization established effective external linkages?
3. Are there effective implementation mechanisms?
4. Does innovation take place within a supportive organisational context?

Within each category several questions are formulated which the organization can use to audit its innovation management.

Does the organization take a strategic approach to innovation?

- What potential innovative advantages (disadvantages) derive from the national (local) environment - science base, input prices, workforce skills, market demand, support industries, competitive rivalry?
- What action is being taken to benefit from foreign systems of innovation - foreign investment, joint ventures and alliances, suppliers and customers, licensing, reverse engineering, public research?
- How do we compare to the competition - product, price, quality, delivery, level and composition of R&D, patents and publications, other benchmarks?
- How do we learn from the competition - R&D and reverse engineering, licensing, hiring, information collection?
- How do we maintain our innovative advantage over the competition - secrecy, accumulated tacit knowledge, product complexity, complementary assets, learning curve, standards, patents, lead times and product support?
- In which broad technological trajectories is the organization active - science-based, scale-intensive, information-intensive, specialized suppliers or supplier-dominated?
- What are the implications of the above for the tasks of innovation strategy - internal links between R&D, design, production and marketing, external links with suppliers and customers, links with university research and training, radical versus incremental innovation, potential for product diversification, fluidity of divisional boundaries?

- What are the potential opportunities and threats emerging from advances in key technologies - electronic chips, computing and telecommunications, software, biotechnology, materials and other new developments?
- What are the technological competencies and where are they located within the firm – technical fields, core enabling and emerging, central research laboratory, divisional, design and production engineering, purchasing and distribution?
- How do we identify potentially new technological competencies - corporate visions, technical judgments, product-technology matrices, incremental trial, error and learning?
- What is the function of R&D outside the HQ country - incremental adaptation of products and processes to local conditions, monitoring local scientific and technical developments, acquiring (and transferring?) local capabilities, participating in the launch of major innovations, launching own major innovations?
- How are R&D and other innovation expenditures evaluated – the role of the technical and finance functions, the use of discounted cash flow and similar methods of investment appraisal, any special procedures to evaluate the learning (option) benefits of R&D investments, the role of expert judgements, the use of *ex post* performance indicators? ?
- How are innovation strategy and corporate strategy linked – is there a formal innovation strategy, how clear and specific is it, how does it link to broader corporate strategy, is there a corporate technical officer on the main board, how does the technical function influence corporate decisions on the level and balance of R&D expenditures, R&D organization, technological and market positioning, patenting and licensing policies, is the corporate strategic style (financial control versus entrepreneurship, centralization versus decentralization), compatible with the nature of the technological opportunities open to the firm?

Has the organization established effective external linkages?

- Do we identify lead customers and fully exploit them?
- Do we use formal tools to promote communication between marketing and development functions, e.g. QFD?
- Does the organization use exploratory techniques to identify and predict future trends, e.g., brainstorming, scenario analysis and Delphi?
- Are new product launches viewed as experiments, or simply labelled ‘successes’ or ‘failures’?
- Is the development capability of lead suppliers fully exploited?
- Are criteria for external development clear?
- Are the criteria for licensing clear?
- Are our motives for collaborating made explicit, and related to subsequent outcomes?

- Is a clear distinction made between alliances for technology or market access versus acquisition of know-how?
- Are our objectives reflected in choice of partners, form of alliance and staffing?
- Are all influential parties captured by our network?
- Do our links with government provide early warning of relevant regulation and promotion and mechanisms for responding and communicating?
- Are all our financial stakeholders involved in major new programmes to promote their understanding – invisible colleges?
- Do we seek to develop and maintain networks of formal and informal knowledge?
- Do we specify and communicate your education and training needs to local and leading providers, and provide appropriate support?

Are there effective implementation mechanisms?

- Does the organization systematically search for new product opportunities? How?
- Is product innovation planning linked to the overall business strategy? How?
- Do we work with early or advanced users?
- Do we have a system for selecting (product) innovation in the face of competing alternatives? Is this a formal or informal process?
- Is there a formal procedure for reviewing progress against a series of stage 'gates'? Is this procedure used in practice or are there alternative 'short-cuts'?
- Is there sufficient flexibility in this system to cope with small 'fast track' options?
- Is there early involvement and concurrent working within the product development system?
- Do we use cross-functional teams or other arrangements for improved integration?
- Do we use different project management structures for different projects (functional, matrix, heavyweight team, etc.)?
- Do we invest in team development?
- How do we capture learning from projects and feed it into future practice?
- How far do we know about and use formal tools and techniques (e.g. QFD, computer based aids, etc.) in your product development process?

Does innovation take place within a supportive organisational context?

- Is there top management commitment to and support for innovation? How is it expressed?
- Is there a clear shared sense of strategic vision and ownership of the business plan?
- Are key individuals recognized and supported in this organization?
- Is communication effective? Does it operate vertically and horizontally and in two-way mode?

- Are there adequate rewards and recognition for innovation?
- How far is the workforce involved in innovation (continuous incremental innovation)? Are there formal mechanisms for finding and solving problems which people use? Are these linked to monitoring and measurement systems to guide improvement? How many suggestions does the organization receive as a result of this?
- Does the structure support or inhibit innovation?
- Do we have a supportive climate for new ideas – or do people have to leave in order to carry them forward?
- How far is there effective teamwork? Is there investment in team building?
- Are there formal mechanisms in place to capture and share learning? How do they operate?

SAMENVATTING

Kwalitatief toekomstonderzoek in innovatie

Patrick van der Duin (TU Delft)

1. Introductie.
In dit proefschrift onderzoeken we hoe commerciële organisaties naar de toekomst kijken en hoe ze informatie en kennis over toekomstige ontwikkelingen toepassen in hun innovatieprocessen. De onderzoeksvraag luidt derhalve: "Hoe gebruiken commerciële organisaties kwalitatieve methoden van toekomstonderzoek in hun innovatie-processen?".
Er zijn, grofweg, drie redenen waarom organisaties naar de toekomst moeten kijken:

1. *Groeiende dynamiek*: ontwikkelingen in de samenleving gaan steeds sneller en hebben de gesloten samenleving van voorheen veranderd in een chaotische en veelkleurige samenleving die veel weg heeft van een open systeem.
2. *Anticipatie als strategisch wapen*: naast innovatie en uitmuntendheid is het kunnen anticiperen een noodzakelijke vaardigheid voor bedrijven die een goede concurrentiepositie ambiëren.
3. *Het groeiende belang van de vraag*: dankzij technologische en wettelijke ontwikkelingen zijn markten opener en meer concurrerend geworden. Bovendien zijn klanten goed opgeleid en veeleisend. Een direct gevolg van dit alles is dat de mogelijkheid die organisaties hebben om hun zakelijke omgeving te beheersen of sterk te beïnvloeden sterk is afgenomen.

Toekomstonderzoek en innovatie zijn met elkaar verbonden door: 1) de ontwikkelingstijd van innovaties: tijdens de ontwikkeling van een innovatie kunnen er vele veranderingen plaatsvinden op, bijvoorbeeld, technologisch of maatschappelijk gebied, wat van invloed kan zijn op het innovatieproces, en 2) de onzekerheid van het innovatieproces: het is zeer lastig op voorhand te weten hoe een idee voor een innovatie zich in de toekomst zal ontvouwen en welke ontwikkelingen zullen plaatsvinden.

2. Toekomstonderzoek.
Het kijken naar de toekomst heeft al veel namen gehad: futurologie, technology forecasting, technology assessment, foresight en futures research. Wij gebruiken de term *futures research* vanwege de volgende redenen:

- *Veelvoudigheid*: de term *futures* verwijst naar meerdere toekomsten (in plaats van slechts één), hetgeen tegenwoordig in toekomstonderzoek een gewone of zelfs dominante benadering is.

- *Multidimensionaliteit*: de term *futures* suggereert dat mogelijke toekomsten worden bekeken vanuit een sociaal, cultureel, economisch, politiek en technologisch perspectief.
- *Onderzoek*: de term research impliceert dat we niet van tevoren een standpunt innemen met betrekking tot de vraag of het mogelijk is de toekomst te voorspellen, scheppen of verkennen, maar dat we benadrukken dat het mogelijk is de toekomst te onderzoeken en dat we kennis over de toekomst kunnen opdoen die als waardevolle input kan dienen voor de beslissingen die we vandaag met betrekking tot de toekomst nemen.

De moderne geschiedenis van toekomstonderzoek kan worden samengevat als een overgang van een harde, geïsoleerde en bewuste verzameling van vaststaande activiteiten en methodes van technologievoorspellingen, naar een zachter, geïntegreerd en communicatief proces.

Er bestaan verschillende methodes om de toekomst te onderzoeken, maar wij richten ons op kwalitatieve methodes die in hun proces voornamelijk gebruik maken van kwalitatieve input (of gegevens). We kijken naar de scenariomethode, trendanalyse en roadmapping. Deze methodes worden toegepast binnen een proces dat bestaat uit stadia waarbinnen de verschillende activiteiten worden uitgevoerd. We gebruiken een lineair proces dat bestaat uit drie stadia:
1) *Pre-foresight/input*
2) *Main foresight/throughput*
3) *Post-foresight/output en actie*

We hebben voor iedere methode beschreven wat de 'good practices' zijn in ieder stadium van het proces. Zo is het bijvoorbeeld bij de scenariomethode belangrijk dat er veel verschillende mensen, zowel binnen als buiten de organisatie, worden ondervraagd. Daarnaast hebben we van de verschillende stadia voor elke methode de basiselementen beschreven. Voorbeelden van basiselementen zijn: cliënten van toekomstonderzoek, de tijdshorizon, en het beslissingstraject.

3. Innovatie en innovatieprocessen.
Innovatie is in onze definitie verbonden met de volgende zes elementen:
1. Nieuwheid: innovatie is nauw verbonden met 'iets' dat nieuw is, dat wil zeggen met processen, producten of diensten die nog niet eerder op de markt zijn gebracht.
2. Een brede visie op innovatie: innovaties van een niet-tastbare en niet-technische aard, zoals diensteninnovaties, organisatorische innovaties of nieuwe leveringsmethodes, worden ook beschouwd als innovaties.
3. Proces: innovatie is een proces waarbij een idee of uitvinden wordt gegenereerd en vervolgens getransformeerd naar een nieuw product of nieuwe dienst die met succes op de markt wordt gebracht.

4. Implementatie: innovatie is meer dan alleen maar een idee of patent, maar is ook een nieuw product of een nieuwe dienst die in de markt of samenleving wordt geïmplementeerd.
5. Onderlinge samenhang van innovaties: innovaties komen vaak niet alleen maar in groepen of clusters die zich parallel aan elkaar ontwikkelen.
6. Onzekerheid en creativiteit: onzekerheid speelt een rol, aangezien er aan het begin van en tijdens een innovatieproces een aantal factoren van invloed kunnen zijn op de ontwikkeling van een innovatie, en ook creativiteit, dat wil zeggen het kunnen denken op nieuwe en andere manieren en het ontwikkelen van een nieuwe kijk op bestaande problemen en mogelijkheden, is van cruciaal belang voor de innoverende organisatie.

Innovaties worden ontwikkeld van een idee naar een nieuw product, dienst, proces of andere vorm van innovaties (het innovatieproces). Er bestaat een onderscheid tussen innovatie op *organisatieniveau* en op *projectniveau*. Innovatieprocessen op organisatieniveau zijn algemener van aard dat op projectniveau. Innovatieprocessen op projectniveau kunnen worden gezien als één van de kernprocessen van de innovatieprocessen op organisatieniveau. Beide soorten innovatieprocessen hebben grotendeels dezelfde historische ontwikkeling doorgemaakt, waarin vier generaties te onderscheiden zijn:

1. Generatie 1950 tot 1960: technology push, technische uitvinding is gelijk aan innovatie.
2. Generatie 1960 tot 1970: market pull, incrementele innovatie.
3. Generatie 1970 tot 1980: combinatie van market pull en technology push, parallelle innovatieprocessen.
4. Generatie 1980 tot heden: het eind van het lineaire innovatieproces, innovatie in netwerken, opkomst van innovatiesystemen.

We hebben het innovatieproces in drie stadia verdeeld:

1. Input in het innovatieproces.
2. Throughput van het innovatieproces
3. Output van het innovatieproces.

Voor elk stadium hebben we innovatie-indicatoren geselecteerd. Een innovatie-indicator voor het input-stadium is bijvoorbeeld het aantal patenten, voor het throughput-stadium kan het de betrokkenheid van het topmanagement zijn, en een indicator voor het output-stadium is het aantal innovaties dat de afgelopen drie jaar daadwerkelijk op de markt gebracht is.

4. Onderzoeksstructuur.

1. *Interviews*: we hebben werknemers van alle betrokken organisaties ondervraagd. Ze zijn werkzaam op de hoofdvestiging van hun bedrijf, op new business development-afdelingen, innovatie-afdelingen of R&D laboratoria. We hebben hen voornamelijk open vragen voorgelegd om het referentiekader van de ondervraagde mensen zoveel

mogelijk in ons onderzoek mee te nemen. Alle interviews zijn volledig uitgewerkt en de belangrijkste conclusies zijn samengevat.

2. *Documentanalyse*: we hebben documenten bestudeerd om informatie te vergaren, zowel over de manieren waarop organisaties toekomstonderzoek gebruiken in innovatieprocessen, als over toekomstonderzoek en innovatieprocessen in het algemeen. De documenten kunnen worden verdeeld in interne en externe documenten. Interne documenten zijn rapporten en presentaties die binnen organisaties zijn uitgegeven. Externe documenten zijn alle documenten die over de organisatie in tijdschriften en andere externe media zijn verschenen.
3. *Participatieve observatie*: door deel te nemen aan en verslag te doen over workshops hebben we additionele informatie verzameld over het gebruik van toekomstonderzoek in innovatieprocessen.
4. *Groepsdiscussie*: de conclusies van de cases zijn voorgelegd aan en besproken met de mensen die we hebben geïnterviewd en eventueel een aantal andere personen.
5. De cases zijn onderzocht met behulp van een *case analyse raamwerk* dat bestaat uit: 1) *Analyse van toekomstonderzoek*: door te kijken naar de methodes, de basiselementen, het proces en de 'good practices' van toekomstonderzoek, en 2) *Analyse van innovatie*: door te kijken naar de innovatie-indicatoren.

5. De cases.

KPN Research is de voormalige R&D organisatie van het Nederlandse (staats)telecommunicatiebedrijf KPN, en is tegenwoordig bekend onder de naam TNO Informatie en Communicatietechnologie. Ze gebruiken de 'Innovation Chain' (IC), een methode waarin de scenario-methode wordt gebruikt om nieuwe ICT-producten en diensten te onderzoeken. KPN Research past deze methode toe op klanten van het moederbedrijf KPN. Het doel van de methode is niet het vinden van verschillende versies van bestaande producten en diensten, maar het richten op echte innovaties door het identificeren van de toekomstige communicatiebehoeften van klanten van KPN.

De IC van KPN Research is een interactieve methode die heel specifiek de toekomstige (communicatie-)behoeften van klanten van KPN als uitgangspunt neemt van het (lineaire) innovatieproces. Hoewel de methode zeer wordt gewaardeerd door een meerderheid van de klanten, de account-managers van KPN Sales en de begeleiders van de IC, zijn de resultaten soms teleurstellend omdat er vaak geen follow-up plaatsvindt. Een manier om dat probleem aan te pakken is door kritischer te kijken naar het soort klanten waarvoor de IC een geschikte oplossing biedt. In deze aanpak zouden alleen bedrijven worden geselecteerd die daadwerkelijk op zoek zijn naar nieuwe ideeën over innovatie en die in staat zijn om werknemers af te vaardigen die in een positie zijn om de benodigde beslissingen te nemen. Bovendien zou het gebruiken van specifieke trends in een bepaalde sector, naast de bredere maatschappelijke scenario's, ervoor zorgen dat de IC klanten meer aanspreekt, wat op zijn beurt de kansen zou vergroten dat de ideeën zouden leiden tot

daadwerkelijke innovaties. De IC zou ook makkelijker te promoten zijn als KPN Research zou besluiten deze methode te gebruiken bij het bepalen van de eigen innovatiestrategie. Het zou als voorbeeld kunnen worden gebruikt om potentiële klanten over de streep te trekken.

Syntens New Technology is een non-profit organisatie die is gelieerd aan het Nederlandse Ministerie van Economische Zaken en die het MKB ondersteunt op het gebied van innovatieontwikkeling. Syntens New Technology (NT), een onderdeel van Syntens, gebruikt de 'ToekomstWijzer' (TW), een methode die voornamelijk wordt toegepast voor en samen met Nederlands MKB'ers. De belangrijkste uitkomst van de TW, die is gebaseerd op een expert meeting, is een lijst van nieuwe ideeën voor innovaties. De TW wordt uitgevoerd op verschillende niveaus: zowel op nationaal en regionaal niveau als op sector- en organisatieniveau. De TW is een interactieve methode waarbij de deelnemers elkaars ideeën voortdurend beoordelen.

De TW is een methode die regelmatig wordt toegepast voor en door bedrijven uit het MKB en die een verband legt tussen toekomstige trends in verschillende sectoren en onderdelen van de samenleving, en mogelijke ideeën voor innovaties. Een belangrijke functie van de TW is ervoor zorgen dat het kijken naar de toekomst een expliciete activiteit wordt. De methode zou een zogenaamd business-environment-model, dat meer structuur geeft aan de lijst van toekomstige trends, goed kunnen gebruiken. Gelet op het feit dat veel MKB'ers het kijken naar de toekomst nog steeds verwarren met het voorspellen ervan, en op die manier het potentieel ervan niet volledig beseffen, ligt het voor de hand meer aandacht te schenken aan verschillende toekomstscenario's, in plaats van te denken in termen van toekomstige trends. Als de TW ambitieuzer zou worden en meer aandacht zou schenken aan het vervolgtraject, zou dat leiden tot concretere resultaten. Het zou dan een interessanter instrument worden voor MKB'ers, die de mogelijke voordelen beter zouden begrijpen. Als laatste willen we benadrukken dat het gevaar bestaat, net als overigens bij andere benaderingen, dat de aanpak in vaagheid verzandt. Begeleiders moeten zich realiseren dat het geven van vage omschrijvingen van toekomstige trends en het uitnodigen van deelnemers die niet echt overtuigd zijn van het nut van deze aanpak het nut en de resultaten van de TW negatief kunnen beïnvloeden.

DaimlerChrysler is een wereldwijd opererend automobielbedrijf met het hoofdkwartier in Stuttgart. De Society & Technology Research Group (STRG) maakt onderdeel uit van de Research & Technology afdeling en houdt zich bezig met het verrichten van toekomstonderzoek. Hoewel STRG verschillende methodes van toekomstonderzoek toepast, kan trendanalyse worden gezien als de kernactiviteit. STRG is een groot voorstander van een 'outside-in' benadering en ziet zichzelf als een belangrijke interface tussen DC en de buitenwereld. STRG heeft een betrekkelijk lange geschiedenis (het

onderdeel werd opgericht in 1979) en is met 40 werknemers wereldwijd één van de grootste in toekomstonderzoek gespecialiseerde organisaties.

STRG neemt toekomstonderzoek zeer serieus. De medewerkers gebruiken een uitgebreid arsenaal aan onderzoeksmethodes, zijn in staat om die methodes toe te passen, en hebben zichzelf strategisch gepositioneerd tussen DC en de buitenwereld. De maatschappelijke aspecten van het werk van STRG spelen een prominente rol, en het werken voor een multinational als DC biedt voldoende (financiële) armslag om het werk uit te voeren. Aan de andere kant maakt de omvang van het moederbedrijf het moeilijk om voldoende invloed uit te oefenen binnen DC. Bovendien ondervindt STRG de financiële gevolgen van de wereldwijde problemen in de automobielbranche, hetgeen het werk bemoeilijkt, mede gelet op het feit dat het van cruciaal belang is dat de portefeuille van onderzoeksmethoden continu wordt vernieuwd, bijvoorbeeld door meer aandacht te schenken aan methodes en instrumenten die toekomstonderzoek en innovaties integreren en combineren.

TNO Industry is een Nederlands non-profit organisatie die bedrijven adviseert op het gebied van innovatie. Een onderdeel van TNO genaamd Product Development (PD) houdt zich bezig met roadmapping. De belangrijkste klanten zijn MKB'ers en voor hen wordt roadmapping uitgevoerd in twee fases. Eerst wordt er een roadmap gemaakt voor de sector waarbinnen een bedrijf opereert. Daarna wordt de 'sector-roadmap' op het individuele bedrijf toegespitst. De sector-roadmap maakt bedrijven in de provincie Noord-Brabant bewust van het nut van innoveren en van de technologische en zakelijke mogelijkheden die er zijn. Een bedrijfs-roadmap is bedoeld als het begin van een innovatieproces.

TNO Industry past roadmapping op een uitgebreide manier toe. Dat wil zeggen dat er veel instrumenten worden gebruikt, dat goed wordt gekeken naar de stappen die nodig zijn voor het ontwerpen van een roadmap, en dat roadmapping wordt beschouwd als een dienst die aan klanten (het MKB) wordt aangeboden. Veel klanten zijn niet alleen geïnteresseerd in 'hoe' ze moeten vernieuwen, maar ook in 'wat' ze moeten vernieuwen. Dit betekent dat de toekomstonderzoekers van TNO hun inhoudelijke kennis zullen moeten uitbreiden. Dat kan door andere experts van TNO Industry en andere onderdelen van TNO uit te nodigen. Niettemin is het noodzakelijk meer inzicht te verkrijgen in hoe roadmapping daadwerkelijk wordt uitgevoerd. Dat betekent niet alleen dat het duidelijker moet zijn in hoeverre er verschillen bestaan tussen 'handboek' en 'praktijk', maar ook wat het logische verband is tussen de verschillende stappen binnen het roadmappingproces. Ten slotte is het verstandig om veel mensen te betrekken in het BBR-project, aangezien dat de steun voor deze methode zal vergroten, hoewel het ook met zich meebrengt dat het proces verschillende doelen zal moeten dienen die niet altijd met elkaar in overeenstemming zijn te brengen.

PinkRoccade is een Nederlands IT-bedrijf dat is gespecialiseerd in IT-diensten en IT-infrastructuurmanagement. De bedrijfsscenario's zijn het resultaat van een project genaamd

'Foresight', en zij worden vaak vertaald naar zogenaamde 'business scenario's' die binnen de verschillende gebieden waarin PinkRoccade actief is worden gebruikt. De scenario's worden gebruikt voor business development, hetgeen zich niet beperkt tot het zoeken naar (en vinden van) nieuwe zakelijke kansen en concepten, maar ook wordt gebruikt om te bepalen hoe PinkRoccade zich binnen de verschillende markten moet positioneren. Bovendien worden de bedrijfsscenario's gebruikt als input voor PinkRoccade's strategische proces.

PinkRoccade's Foresight-project heeft geresulteerd in een viertal scenario's die worden gebruikt zowel voor business development als voor strategische doeleinden, hoewel de invloed ervan op business development niet moet worden overschat. Dit heeft tot op zekere hoogte te maken met de informele benadering die het bedrijf heeft ten opzichte van het managen van innovatieprocessen, wat het moeilijk maakt de scenario's op een structurele manier te koppelen aan innovatieprocessen. Gelet op het verband tussen de scenario's en de strategie van het bedrijf, waarvan het belang door een aantal van de door ons ondervraagde mensen werd aangegeven, en gelet op de steun die het Foresight-project krijgt van het topmanagement, is dit onfortuinlijk. De invloed van Foresight op de bedrijfsontwikkeling (of innovatie) van PinkRoccade zou vele malen groter zijn als er een specifieke methode zou worden gebruikt om de scenario's te koppelen aan het innovatieproces (en omgekeerd), en als klanten van PinkRoccade daarbij betrokken zouden worden, aangezien dat de business cases relevanter zou maken.

Philips Medical Systems opereert in de markt van medische systemen en maakt onderdeel uit van het wereldwijd actieve elektronicabedrijf Philips Electronics. Cardio Vascular (CV) is een business unit van PMS die röntgensystemen en platforms ontwikkelt en verkoopt die worden gebruikt om ingrepen te minimaliseren en om hart- en vaatziekten te behandelen. CV maakt gebruik van roadmapping. Binnen de sector waarin CV opereert wordt innovatie steeds belangrijker, en CV investeert er steeds meer in. CV maakt roadmaps over verschillende onderwerpen (b.v. wetenschap, technologie, markt) die worden gecombineerd in een product-roadmap. Deze product-roadmap is de tweede fase van het productontwikkelingsproces (d.w.z. hun innovatieproces). CV richt zich steeds minder op het ontwikkelen van afzonderlijke (medische) producten en diensten, en steeds meer op (medische) systemen en platforms. Hoewel het langer duurt om deze systemen en platforms te ontwikkelen, wordt de tijdshorizon steeds korter, aangezien de nadruk steeds meer ligt op de (huidige) marktsituatie en de activiteiten van concurrenten.

Roadmapping is een belangrijk onderdeel van het innovatieproces van CV. De innovatieprocessen zijn gestructureerd en geformaliseerd en er wordt veel aandacht aan besteed. Daar staat tegenover dat roadmapping verhoudingsgewijs een veel vager proces is; de manier waarop dit proces plaatsvindt is niet goed in kaart gebracht en wordt beïnvloed door onderhandeling tussen de verschillende *stakeholders*. Het proces zou baat hebben bij een formelere aanpak (vergelijkbaar met die van het algemene innovatieproces), als we

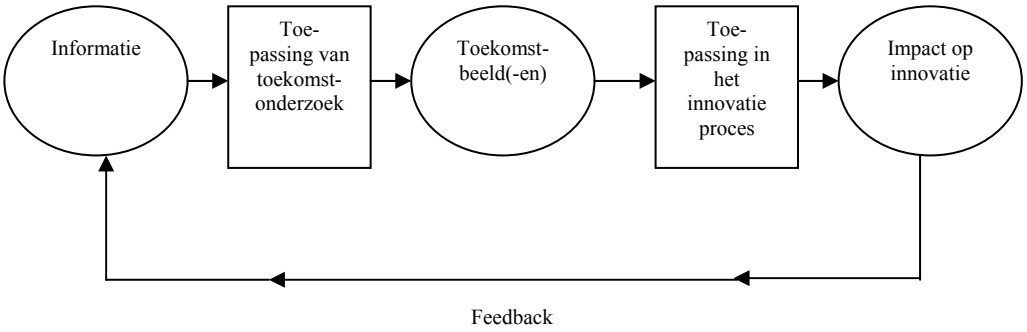
aannemen dat er voldoende inhoudelijke kennis voorhanden is, en er dus alleen verbeteringen mogelijk zijn die te maken hebben met het *proces*. Hoewel er voldoende expertise is op het gebied van *content*, zou meer expertise op het gebied van *proces* welkom zijn. Het toont overigens ook aan dat roadmapping en innovatie sterk worden beïnvloed door ontwikkelingen in de sector waarbinnen CV (en PMS) actief is, en door het klimaat binnen de organisatie. Een grotere nadruk op de snelle ontwikkeling van nieuwe medische systemen betekent dat innovatieprocessen grotendeels parallel plaatsvinden en dat er niet altijd voldoende middelen beschikbaar zijn voor de roadmaps. Roadmaps en innovatie beïnvloeden elkaar echter ook. Dat wil zeggen dat het gebruik van roadmaps er toe heeft geleid dat er een verschuiving is geweest van incrementele naar radicale innovaties. De roadmaps bieden ruimte voor radicalere benaderingen van innovatie, en geven dankzij hun 'evolutionaire' karakter de voorkeur aan radicale innovaties.

6. Conclusies.

1. *Verschillende vormen van interactie tussen toekomstonderzoek en innovatie*: de les die we uit de cases in dit proefschrift kunnen trekken is dat de link tussen toekomstonderzoek en innovatie nogal impliciet is. Hoewel de meeste organisaties zich realiseren dat toekomstonderzoek belangrijk is, vinden ze het moeilijk om de resultaten ervan in het innovatieproces te integreren. Dit betekent ook dat toekomstonderzoek niet altijd een heldere en directe invloed heeft op de innovatie. Gegeven de verschillen in de mate waarin toekomstonderzoek en innovatie gecombineerd worden, kan men niet automatisch aannemen dat een volledige integratie tussen beiden ook de beste link is. Hoewel bij Philips Medical Systems toekomstonderzoek en innovatie nauw met elkaar verbonden zijn, is deze verbintenis bij TNO Industrie aanzienlijk zwakker. Ook bij KPN Research en PinkRoccade lijken toekomstonderzoek en innovatie nauwer met elkaar verbonden dan bij TNO Industrie. Als een gevolg hiervan kan gesteld worden dat het gebruik van toekomstonderzoek in innovatieprocessen diffuus is waardoor het niet altijd eenvoudig is om de impact van toekomstonderzoek op innovatie vast te stellen.
2. *Toekomstonderzoek als bron van inspiratie*: in alle cases wordt toekomstonderzoek gebruikt in de eerste fase van het innovatieproces. Dit betekent dat het doel van toekomstonderzoek en toekomstonderzoek is om innovatoren te inspireren tot het bedenken van innovaties, hetgeen een algemeen aanvaard gebruik is van toekomstonderzoek, en niet om de 'toekomstvastheid' of 'toekomstbestendigheid' van bestaande ideeën te toetsen. Het gaat er in deze fase ook om mensen bewust te maken van de noodzaak van innovatie en om veelbelovende richtingen aan te wijzen.
3. *Toekomstonderzoek en type innovatie*: uit de cases wordt duidelijk dat de scenario-methode en roadmapping meer te maken hebben met radicale innovaties en dat trendanalyse zich vanwege zijn 'evolutionaire' karakter beter leent voor incrementele (technologische) innovaties. Bijvoorbeeld, bij Philips Medical Systems vindt een verschuiving plaats van afzonderlijke innovaties (een nieuw product of dienst) naar

geïntegreerde innovaties (een nieuw medisch systeem). Deze verschuiving heeft het bedrijf doen besluiten om roadmapping te gebruiken omdat het hen in staat stelt om verschillende aspecten in het innovatieproces in te brengen. Als een gevolg hiervan is Philips Medical Systems zich ook meer gaan richten op radicale innovaties. Dit komt overeen met Pearson's onzekerheidsraamwerk (Trott, 1998) waar een grotere onzekerheid over de uitkomst van het innovatieproces en de over de vorm van het innovatieproces betekent dat de innovatie radicaal is. Deze onzekerheid wordt dus groter als er meerdere aspecten meegenomen moeten worden in het innovatieproces hetgeen ook betekent dat toekomstonderzoek deze aspecten moet adresseren. De cases laten zien dat roadmapping en de scenario-methode dit beter kunnen dan trend-analyse.

4. *Toekomstonderzoek, innovatie en het economische klimaat*: veel organisaties vinden het lastig om aan toekomstonderzoek en innovatie te doen als de zaken goed gaan en ze hard moeten werken om klanten tevreden te houden. Aan de andere kant, als de zaken slecht gaan, ontstaat er de acute zorg om het hoofd boven water te houden waardoor er niet veel resources overblijven om aan toekomstonderzoek en innovatie te spenderen.
5. *Toekomstonderzoek en innovatie zijn menselijke activiteiten*: de rol van de toekomstonderzoeker en de innovator zijn van groot belang. Ondanks de grote beschikbaarheid aan methoden voor toekomstonderzoek en voor innovatieprocessen, zijn de toekomstonderzoeker en de innovator cruciaal in het toepassen daarvan. De cases tonen aan dat, in het algemeen, de toekomstonderzoeker de proces- vaardigheden bezit en de innovator beschikt over de inhoudelijke kennis van een bepaald onderwerp. Meestal is de toekomstonderzoeker de future *process* expert en de innovator de future *content* expert. De cases laten zien dat er of een gebrek aan proces-vaardigheden met voldoende inhoudelijke kennis is, of dat er voldoende proces-vaardigheden zijn maar dat de inhoudelijke kennis de wensen nalaat. De ideale toekomstonderzoeker zou beide kwaliteiten moeten beschikken maar dat komt niet veel voor. De KPN Research-case laat zien een situatie waarin future process en content experts elkaar niet zien staan niet bevorderlijk is voor het integreren van toekomstonderzoek met innovatie. De PinkRoccade-case laat zien dat aandacht moet worden geschonken aan het verzamelen van alle benodigde informatie (proces en content) op een centrale plek in de organisatie om te voorkomen dat men te veel moet bouwen op slechts één individu.
6. *Een raamwerk voor het iteratieve gebruik van toekomstonderzoek in innovatie*: uitgaande van bovenstaande conclusies stellen wij het volgende (theoretische) framework voor zoals beschreven in Figuur Samenvatting 1. De blokken zijn de processen (toepassingen) en de bollen zijn de resultaten van de processen.



Figuur Samenvatting 1 Raamwerk voor het iteratieve gebruik van toekomstonderzoek in innovatie.

Bovenstaand figuur moet als volgt worden geïnterpreteerd. Om te beginnen wordt informatie verzameld over toekomstige ontwikkelingen door, bijvoorbeeld, (expert) interviews, desk research, brainstorming-workshops, en informatie van (internationale) websites. Daarna wordt deze informatie gestructureerd en geanalyseerd met gebruik van de meest geschikte methode, hetgeen een of meerdere toekomstbeelden oplevert. Het resultaat wordt vervolgens gebruikt in innovatieprojecten. Deze toepassing moet een belangrijke invloed hebben op het genereren en selecteren van ideeën en het te volgen traject. Omdat oude innovaties vaak leiden tot nieuwe innovaties, is er in de figuur een feedback loop aangebracht. De cases die we in dit proefschrift hebben bekeken maken duidelijk dat er een zwak verband bestaat tussen de linkerkant en rechterkant van Figuur Samenvatting 1.

Dit figuur is samengesteld uit de bovenstaande conclusies. De elementen of de bouwstenen van dit framework (de blokken en de bollen) kunnen worden beschouwd als de *units of analysis* van dit onderzoek: *Informatie* dient als input voor het toekomstonderzoeksproces; de *Toepassing van toekomstonderzoek* is de throughput fase van het toekomstonderzoeksproces; de *Toekomstbeelden* vormen de output van het toekomstonderzoeksproces; de *Toepassing in het innovatieproces* is het gebruik van toekomstonderzoek in innovatie; en de *Impact op innovatie* is de innovatie zelf en de output van een innovatieproces.

Figuur Samenvatting 1 kan gedeeltelijk gezien worden als een combinatie van Tabel 3.2 (uit Hoofdstuk 3, paragraaf 3.2) en Figuur 3.1 (uit Hoofdstuk 3, paragraaf 3.3). Het nieuwe

in dit figuur is de toevoeging van *Toepassing in het innovatieproces*. Deze toevoeging kan gezien worden als de link tussen toekomstonderzoek en innovatie. Daarnaast zijn er twee feedback loops toegevoegd waarmee dit framework een iteratief karakter krijgt.

De conclusies spelen een belangrijke rol in het combineren van de *units of analysis*. Conclusie 1 (*Verschillende vormen van interactie tussen toekomstonderzoek en innovatie*) is de link tussen *toekomstbeeld(en)* en *toepassing in het innovatieproces*. Conclusie 2 (*Toekomstonderzoek als bron van inspiratie*) en conclusie 3 (*Toekomstonderzoek en type innovatie*) verbinden de *toepassing in het innovatieproces* met *impact op innovatie*. De *feedback loop* is gerelateerd aan conclusie 4 (*Toekomstonderzoek, innovatie en het economische klimaat*) omdat dat van invloed is op de snelheid waarmee nieuwe toekomststudies worden opgezet. Tenslotte, conclusie 5 (*Toekomstonderzoek en innovatie zijn menselijke activiteiten*) linkt *Informatie* met *Toepassing van toekomstonderzoek* en *Toepassing van toekomstonderzoek* met *Toekomstbeeld(en)*.

SUMMARY

Qualitative futures research for innovation

Patrick van der Duin (Delft University of Technology)

1. Introduction.
In this thesis we investigate how commercial organisations look to the future and how they use information and knowledge about future developments in their innovation processes. Our research question is: "How do commercial organisations use qualitative futures research methods in innovation processes?".
Basically, there are three reasons why organisations need to look to the future:

1. *Increasing dynamics*: Societal developments accelerate and have turned the closed society from before into a chaotic, multi-coloured society that very much resembles an open system.
2. *Anticipation as a strategic weapon*: In addition to innovation and excellence, anticipation has become a necessary capacity for an organisation to obtain a competitive edge.
3. *Towards a demand-driven business*: Due to technological and legal developments, markets have become more open and contestable. In addition, customers are well-educated and selective. A direct consequence of all this is that the power of organisations to control or strongly influence their business environment has weakened significantly.

Futures research and innovation are linked by: 1) the lead time of the innovation process: during the development time, many changes in, for instance, technology or business can take place, which influences the innovation process, and 2) the uncertainty of the innovation process: it is very difficult to know in advance how an idea for an innovation will evolve in the future and which developments it will encounter.

2. Futures research.
Looking to the future has been given many different names: futurology, conjecture, technology forecasting, technology assessment, foresight, and futures research. We use the term *futures research* because of the following reasons:

- *Multiplicity*: the term *futures* refers to thinking in multiple futures (instead of just one), which nowadays is very common or even dominant in studies of the future.
- *Multidimensionality*: the term *futures* also suggests that possible futures are considered from a social, cultural, economic, political, and technological point of view.

- *Investigation*: the term *research* implies that we do not adopt an *a priori* standpoint with regard to the question whether or not it is possible to predict, create or explore the future, emphasizing instead that the future can be investigated and knowledge about the future can be gained which can serve as a valuable input to today's decisions about the future.

The modern history of futures research can be summarized as a transition of a hard, isolated, and conscious set of distinct activities and methods of technology forecasting, towards a softer, integrated, and communicating process.

There are many different methods of futures research, but we focus on qualitative methods of futures research that primarily use qualitative input (or data) in their process. We look at the scenario-method, trend-analysis, and roadmapping. These methods of futures research are applied within a process that consists of stages within which different activities are carried out. We use a linear process consisting of three stages:

1) *Pre-foresight/input.*
2) *Main foresight/throughput.*
3) *Post-foresight/outputs and action.*

For every method we have described what the good practices are in each stage of the process. For example, for the scenario-method it is important that many different people, both inside and outside the organisation, are interviewed. Furthermore, we have described the basic elements of each study of the future in each stage of the process. Examples of basic elements are: clients of futures research, time horizon, and decision-making.

3. Innovation and innovation processes.

Our definition of innovation links it to the following six elements:

1. Newness: Innovation is strongly related to 'something' that is new, i.e., a process, a product, or a service that has not been introduced to a market earlier.
2. A broad view on innovation: Innovations of a more intangible and non-technical nature, such as service innovations, organisational innovations, or new supply methods are also considered innovations.
3. Process: Innovation is also a process by which an idea or invention is generated and subsequently transformed into a new product or a new service which is successfully introduced to the market.
4. Implementation: Innovation is more than just an idea or patent, but a new product or service that is implemented in the market or society.
5. Interconnectedness of innovations: Innovations often do not come alone but in groups or clusters that develop in a parallel way.
6. Uncertainty and creativity: Uncertainty plays a role, since at the start and during an innovation process there are many factors that may influence the development of an innovation, and being creative, that is to say, being able to think in new and different

ways and to develop a new view on existing problems and opportunities, is an essential asset for the innovating organisation.

Innovations are developed from an idea into a new product, service, process or any other type of innovation (i.e., the innovation process). There is a distinction between innovation at the *organisational* level and at the *project* level. Innovation processes at the organisational level have a more general nature than those at a project level. Innovation processes at the project level can be regarded as one of the core processes of the innovation processes at the organisational level. Both types of innovation processes follow the same historical development consisting of four generations:

1. Generation 1950 to 1960: technology push, technical invention equals innovation.
2. Generation 1960 to 1970: market pull, incremental innovation.
3. Generation 1970 tot 1980: combining market pull and technology push, parallel innovation processes.
4. Generation 1980 tot present: end of linear innovation processes, innovation in networks, rise of innovation systems.

We have divided the innovation process into three stages:

1. Input to the innovation process.
2. Throughput of the innovation process (i.e., the innovation process itself).
3. Output of the innovation process.

For each stage we have selected innovation indicators. For example, an innovation indicator in the input stage is the number of patents, an innovation indicator in the throughput stage is top management commitment to and support for innovation, and an innovation indicator in the output stage is the number of innovations introduced over the past three years.

4. Research structure.

Our research consists of five elements:

1. *Interviewing*: We carried out interviews with employees of all the organisations involved. They work in their companies' head office, new business development departments, innovation offices or R&D laboratories. We asked predominantly *open* questions to take into account the frame of reference of the interviewees as much as possible. Each interview has been transcribed in full and its main conclusions summarized.
2. *Document analysis*: Documents are studied to obtain information about ways companies use futures research in innovation processes, as well as about futures research and innovation processes in general. These documents can be divided into internal and external literature. Internal literature refers to reports and presentations published within organisations, and external documents to all publications about the organisation in journals and other external media.

3. *Participant observation*: By attending and reporting about workshops additional data is collected about the use of futures research in innovation processes.
4. *Group discussion*: The conclusions of the case studies will be presented to and discussed with the interviewees and a number of other persons.
5. The cases have been researched with the support of a *case-analysis framework* consisting of: 1) *Analysis of futures research*: by looking at the methods, the basic elements, the process, and the 'good practices' of futures research, and 2) *Analysis of innovation*: by looking at the innovation indicators.

5. The cases.

KPN Research: the former R&D organisation of the Dutch (incumbent) telecom-operator, nowadays known as TNO Information and Communication Technology. They use the 'Innovation Chain' (IC), a method that uses the scenario-method to explore new ICT-products and services. KPN Research applies this method for customers of its mother-company KPN. The aim is not to find different versions of existing ICT products and services, but to focus on genuine innovations by identifying the future communication needs of KPN customers.

The IC of KPN Research is an interactive method that specifically takes the future (communication) needs of customers of KPN as the starting point of a (linear) innovation process. Although the method is greatly appreciated by a majority of IC customers, the account managers of KPN Sales, and the facilitators of the IC, the results are sometimes disappointing because there is often no follow-up. One approach to solving that may be to be more critical as to what customers are to be considered suitable candidates for an IC. This approach would involve selecting only those companies that are genuinely looking for new ideas on innovation and that are able to send employees who are in a position to make the decisions that need to be made. In addition, using more specific industry trends in addition to the broader societal scenarios would ensure that the IC appealed to its customers, which in turn would increase the chance of a follow-up in which ideas could be worked out into actual innovations. It would also make it much easier to promote the IC if KPN Research were to decide to use it to formulate its own innovation strategy. It could serve as a showcase that could convince potential customers of the IC. After all, why not practice what you preach?

Syntens New Technology: a non-profit organisation linked to the Dutch Ministry of Economic Affairs and involved in supporting SMEs in developing innovations. Syntens New Technology (NT), a department of Syntens, uses the 'ToekomstWijzer' (TW), a method that is mainly used for and together with Dutch SMEs. The main output of the TW, which is based on an expert-meeting, is a list of new ideas for innovation. The TW is carried out at various levels: at national and regional as well as at industry and company

level. The TW is an interactive method and participants are constantly reviewing each other's ideas.

The TW is a frequently used method for and by SMEs that connects future trends in various industries and parts of society to possible ideas for innovation. It has an important function in making looking to the future a more explicit activity. It would benefit from a so-called business environment model that would give the list of future trends more structure. Given that many SMEs still confuse looking to the future with predicting the future and therefore fail to see the full potential, it may make sense to focus more on various future scenarios rather than on future trends. The TW should become more ambitious and pay more attention to what happens next if it is to lead to more tangible results. This may make it a more valuable tool for SMEs, since they would have a clearer idea as to what the benefits may be for them. Last but not least, as with any method, the phrase 'garbage in, garbage out' also applies. The facilitators of the TW should be aware that providing vague formulations of future trends and inviting participants that are not really convinced of the value of these types of meetings can damage the usefulness of the outcome of the TW.

DaimlerChrysler: a globally operating car company with its head office in Stuttgart, Germany. The Society & Technology Research Group (STRG) is part of its research department Research & Technology and carries out futures research. Although STRG uses many different methods of futures research, trend-analysis can be considered the core of its work. It very much advocates an 'outside-in'-approach in its work and sees itself as an important interface between DC and the outside world. STRG has quite a long history (it was established in 1979) and, with 40 employees worldwide, is one of the largest organisations specializing in futures research.

Futures research at STRG is carried out very seriously. Its futures researchers use a broad portfolio of futures research methods, they posses the skills to apply those methods, and they have positioned themselves very strategically as the DC's interface with its societal and business environment. The societal aspects of its work are very prominent and working for a multinational such as DC offers enough (financial) space to carry out the work. However, the enormous size of the 'mother company' also makes it difficult to have a sufficiently big impact on innovation at DC. In addition, STRG has felt the effects of the global problems facing the automotive industry in its budget. This makes its work more difficult, since satisfying its clients also means renewing its futures research method portfolio, for instance by paying more attention to methods and tools that integrate or combine futures research and innovation.

TNO Industry: a Dutch non-profit research organisation that advices companies on how to innovate. A sub-department Product Development (PD) of TNO Industry carries out roadmapping. Its main clients are SMEs and for them roadmapping is carried out in two

phases. First, a roadmap is made for the sector in which an SME operates. Second, the 'sector roadmap' is tailored to specific SMEs. The sector roadmap makes SMEs in the Dutch province of North-Brabant aware of the need to innovate and of the technological and market opportunities that exist. A company roadmap is meant to be used as the start of an innovation process.

Roadmapping by TNO Industry is conducted in a quite extensive way. That is to say, many tools are used, much attention is devoted to defining which steps need to be taken to build a roadmap, and roadmapping is considered a service that is offered to clients (i.e., SMEs). The shift in demand from clients from 'how to innovate' towards 'what to innovate' not only is a reason to apply roadmapping, but also means that futures researchers at TNO Industry need to increase their knowledge with respect to the content (of the roadmap). This can be done by involving other experts from TNO Industry and other parts of TNO. Nevertheless, more insight also needs to be provided into how roadmapping is actually carried out. This not only means that it needs to be clear to what extent there are differences between 'the handbook' and 'the practice' of roadmapping, but also how the various steps of the roadmapping method are logically connected. Finally, with regard to the BBR-project ('Branche agenda for Business Roadmapping') it is good to involve many actors, since that will increase support for roadmapping, but it also means that roadmapping-projects need to serve many different goals that cannot always be aligned with each other.

PinkRoccade: a Dutch IT-company that specializes in IT services and IT infrastructure management. They use corporate scenarios for business development at the Dutch IT-company PinkRoccade. The corporate scenarios are the output of a project called 'Foresight' and they are often specified in so-called 'business scenarios' that are used within the various business areas of PinkRoccade. The scenarios are used for business development, which not only includes searching (and finding) new business opportunities and concepts, but also for deciding how PinkRoccade should position itself within the different markets it serves. In addition, the corporate scenarios are used as input to the strategy process of PinkRoccade.

PinkRoccade's Foresight project has resulted in a set of scenarios that are used not only for business development but also as input to corporate strategy. However, its impact on business development should not be exaggerated. To some extent this has to do with the company's informal approach to managing innovation processes which makes it difficult to link the scenarios to innovation processes in a structural way. In light of the link between the scenarios and the company's corporate strategy, the need for which was brought up by several of the people we interviewed, and the support from the top of PinkRoccade to the Foresight-project, this is unfortunate. The impact of Foresight on business development (or innovation) at PinkRoccade would be much greater if there was a specific method to link

the scenarios with the innovation process (and vice versa) and if clients of PinkRoccade were to be involved, because that would make the business cases much more important.

Philips Medical Systems (PMS): operates in the medical systems industry and is part of globally operating electronic company Royal Philips Electronics. Cardio Vascular (CV) is a business unit of PMS that develops and sells X-ray systems and platforms that are used to minimize invasive diagnostics and treatment of vascular and cardiac diseases. CV applies roadmapping. Within their business, innovation is becoming more important and they put more resources into it. CV makes roadmaps on different topics (e.g., science, technology, market) that are combined into a product-roadmap. This product-roadmap is the second phase of the product creation process (i.e., their innovation process). CV is making a shift from developing separate (medical) products and services towards (medical) systems and platforms. Although these systems and platforms need more innovation time, the time horizon of innovation is becoming shorter because more focus is put on the (current) market situation and the actions of competitors.

Roadmapping is an important element of the innovation process at CV. Its innovation processes are structured and formal and much effort is put into them. Roadmapping at CV, by contrast, is a much more fuzzy process; the process of building the roadmaps is not clearly documented and it is influenced by negotiations between different stakeholders. Roadmapping at CV would benefit from a more formal approach (as is done with regard to innovation) because, given that there is sufficient expertise about the future, the only room left for improving is in the *process* of building roadmaps. CV has enough future *content* experts, so one or more future *process* experts would be welcome. It also shows that both roadmapping and innovation are heavily influenced by developments in the industry of CV (and PMS) and by the organisational climate. Greater emphasis on a faster development of new medical systems means that innovation processes are to a larger extent carried out in parallel, and that sufficient resources are not always put into the roadmaps. However, roadmaps and innovation are also influencing each other. That is to say, using roadmaps has led to a change in the types of innovation: from incremental to radical innovation. The roadmaps leave ample room for more radical approaches to innovation, and by their 'evolutionary' nature favour radical innovations.

6. Conclusions.

1. Different interactions between futures research and innovation.

The lesson from the cases in this thesis is that the connection between futures research and innovation is rather implicit. Although most organisations realize that futures research is important, they find it difficult to integrate its results into the innovation process. This also means that in most organisations futures research does not always have a clear and direct influence on the development of innovations. Of course, all this depends on how futures research and innovation are integrated. Given the differences in the extent to which futures

research and innovation can be integrated, one should not automatically assume that integration provides the best connection between futures research and innovation. Although at Philips Medical Systems futures research and innovation are closely linked, this link is much weaker at TNO Industry. Also, futures research and innovation seem to be connected much more closely at KPN Research and PinkRoccade than at TNO Industry. As a consequence, the use of futures research in innovation processes is rather diffuse which does not always make it easy to determine its impact on innovation.

2. Futures research as a source of inspiration.
In all the cases described in this thesis, futures research is used in the early phase of the innovation process. This means that the purpose of futures research is to inspire innovators to generate new ideas for innovation, which is a common function of futures research, and not to test the 'future-proofness' of existing ideas. Also, in this early phase futures research is intended to create awareness with regard to the need for innovation and to show promising directions.

3. Futures research and type of innovation.
The scenario-method and roadmapping are linked to more radical innovations, and trend-analysis, because of its evolutionary nature, is more suitable for incremental (technological) innovations. For instance, at Philips Medical Systems a shift was made from developing singular innovations (a new product or a new service) towards more integrated innovations (a new system). This shift made the company decide to use roadmapping, because it enables the incorporation of various challenging aspects in the innovation process. As a result, Philips Medical Systems witnessed an internal shift towards developing more radical innovations. This is in line with Pearson's uncertainty map (Trott, 1998), where the fact that there is a higher level of uncertainty concerning the outcome of the innovation process and the innovation process itself means that an innovation is (more) radical. This uncertainty is higher when more new aspects are taken into account in developing the innovation, which also means that futures research should address this multitude of aspects. The cases show that roadmapping and the scenario-method are better able to take these aspects into account than trend-analysis.

4. Futures research, innovation, and the economic climate.
Many organisations find it hard to carry out futures research and innovation when business is going well and they are working hard to satisfy short-term customer demand. On the other hand, when business slows down, there is the immediate concern of trying to keep afloat, which more often than not leaves few financial resources to spend on futures research and innovation.

5. Futures research and innovating are human activities.
The role of the futures researcher and the innovator are vital. Despite the wide range of methods of futures research and different innovation processes, the futures research and the innovator are of vital importance in applying these methods. The cases show that, in general, the futures researcher brings in the process skills and the innovator brings in information and knowledge about the issue involved. Usually, the futures researcher is a future *process* expert and the innovator a future *content* expert. The cases make it clear that at present there is either a lack of process skills with sufficient content knowledge, or there are sufficient process skills but a lack of content knowledge. The ideal futures researcher possesses both sets of skills, but this is a very rarely the case. The KPN Research-case shows, for instance, that a situation in which process and content experts ignore each other is not helpful to integrating futures research and innovation. The PinkRoccade-case shows that attention should be paid to collecting all relevant knowledge of futures research (process and content) within an organisation at a central place to avoid having to rely too heavily on one individual.

6. Towards a theoretical framework for the iterative use of futures research in innovation.
Based on the above-mentioned overall conclusions, we suggest the (basic) theoretical framework described in Figure Summary 1. The boxes are processes (applications) and the balls are the results of these processes.

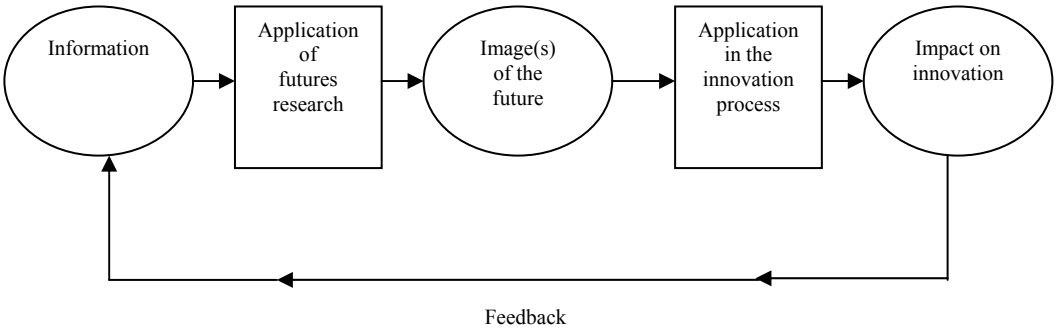


Figure Summary 1 Framework for the iterative use of futures research in innovation.

Figure 10.1 should be read as follows. First, information is gathered about future developments through (expert) interviews, desk research, brainstorming workshops, and information from (international) websites. Next, this information is structured and analyzed by using a suitable method of futures research, which results in one or more images of the future. The result is used in innovation projects. This application should have an important

impact on idea generation and idea selection with regard to innovation. Because old innovations propel new innovations, there is a feedback loop between the two. The cases in this thesis show that there is a weak connection between the left hand part and the right hand part of this framework.

As said, this framework is based on the overall conclusions outlined above. The elements or building blocks of this framework (the boxes and balls) can be considered the units of analysis of this research: *information* serves as input to the process of futures research; the *application* of futures research is the throughput of the process of futures research; the *image(s)* of the future, which can be considered the output of the process of futures research, the a*pplication* in the innovation process, which is the use of futures research in innovation processes; and, the *impact* on innovation, which is the innovation and the result of an innovation process.

Figure Summary 1 can be partly seen as a combination of Table 3.2 (from Chapter 3, section 3.2) and Figure 3.1 (from Chapter 3, section 3.3). What is new in this figure is that the *Application in the innovation process* has been added. This addition can be seen as the link between futures research and innovation. Also, two feedback loops have been added that make this framework an iterative one.

The overall conclusions play a role in the connection between the units of analysis. Overall conclusion 1 (*different interaction*) is the link between *image(s) of the future* and *application in the innovation process*. Overall conclusions 2 (*futures research as a source of inspiration*) and 3 (*futures research and type of innovation*) link *application in the innovation process* with *impact on innovation*. The *feedback loop* is related to overall conclusion 4 (*futures research, innovation, and the economic climate*) since that influences the speed with which new studies of the future are set up again. Finally, overall conclusion 5 (*futures research and innovating are a people's job*) is linking *information* with *the application of futures research* and *the application of futures research* with *image(s) of the future*.

CURRICULUM VITAE PATRICK VAN DER DUIN

Patrick van der Duin was born on July 29th 1970 in Amsterdam, the Netherlands. He studied (macro-) economics at the University of Amsterdam and graduated in 1995. Hereafter he worked for six years at KPN Research as an applied scientist, where he conducted numerous projects involving the future of telecommunication. In 2001 he started to work for Delft University of Technology, Faculty of Technology, Policy & Management on a parttime basis as a research fellow. Currently he works there as a assistant professor and recently has finished his PhD. His topics of interest are futures research and innovation management, and the way they can be integrated.