Biotechnology: Variety or Similarity?

A research about exploration and exploitation in the Dutch and Belgian biotechnology sector

by
Tjerk Kuipers
Jorn van der Schaaf

University of Twente
October 2006

Biotechnology: Variety or Similarity?

A research about exploration and exploitation in the Dutch and Belgian biotechnology sector

by
Tjerk Kuipers 0007269
Jorn van der Schaaf 0009040

A research report submitted as partial fulfilment of the requirements for the Master's degree in Industrial Engineering and Management at the school of Business, Public Administration and Technology of the University of Twente.

Under the authority of:
The University of Twente
Enschede, the Netherlands

And

The K.U. Leuven
Leuven, Belgium

Date:
Enschede, October 2006

Supervisory Committee:
Dr. ir. P.C. de Weerd-Nederhof (OOHR, University Twente)
Dr. ir. K. Visscher (OOHR, University Twente)
Prof. B. Van Looy (K.U. Leuven)

Summary

In the emerging biotechnology sector, it is important for organizations to find a balance between exploration and exploitation in order to function efficiently today while planning and innovating effectively for tomorrow. A dynamic, complex, or in other words, an emerging environment will not facilitate this endless struggle, but rather extend its endlessness. In literature authors have elaborated on internal organization and on external networks in relation with exploration and exploitation, but research about the internal organization and on external networks related to each other and to exploration and exploitation is scarce. This study extends the literature on balancing exploration and exploitation in an emerging sector by relating the two types of activities to both a company's internal organizational configuration and a company's external network to ensure its current and future viability.

The objective of this study is therefore facilitating organizations in the Dutch and Belgian biotechnology sector in their struggle to find a balance between exploration and exploitation. This research will not provide a best practice about balancing exploration with exploitation, but will more pellucid the balancing process.

This study is part of the research project *Patterns in New Product Development: consistent NPD configurations for sustained innovation*. 'Patterns in NPD' is an emergent European research project aimed at developing knowledge in the new product development area, by describing, exploring and analyzing the organization of the innovation journey. To collect empirical data, the questionnaire developed by the patterns in NPD project is used. The sample total which represents the biotechnology sector in the Netherlands and Belgium is 17; 14 Dutch and 3 Belgian organizations. Furthermore, four case studies are performed to enlarge the insight and to come up with possible explanations for the facts found in the analyses of the data from the questionnaires. To compare the biotechnology sector with other sectors, from the 98 organizations which the database (06-06-2006) contains, 23 Dutch or Belgian non-biotechnology organizations are selected. These organizations are active in sectors as the automotive, lighting, medical supplies, machine building, transport, and electronics.

The central question in this report is: *How do organizations in the Dutch and Belgian biotechnology sector shape their internal organizational configuration and their external network to facilitate a balance between exploration and exploitation which ensures their current and future viability?* To answer this central question, four research questions are formulated, which will together answer the central question. The research questions are discussed below.

1. Which combination of exploration and exploitation in terms of the degree and type of innovation is used by organizations in the Dutch and Belgian biotechnology sector?

The biotechnology sector is very diverse, organizations working with biotechnology can be found in different industries as the pharmaceutical industry, agriculture, food, and others, each with its own market segmentation. However, they all have one thing in

common; the NPD function, and radical innovation in specific, plays an important role. Organizations in the biotechnology sector have relatively more employees working in NPD as part of the total number of employees than organizations in non-biotechnology sectors; 36 % against 17%. These NPD employees in biotechnology organizations put significant more effort in radical innovations in contrast to their colleagues in non-biotechnology sectors; the biotechnology organizations spend on average 30% on radical innovations, where non-biotechnology organizations spend 11%. In the biotechnology sector, 22% of the sales of the last three years are obtained from radical innovation, in contrast to non-biotechnology sectors where this is only 9%.

Based on the analyses described above, one can say that organizations in the biotechnology sector balance exploration and exploitation different than organizations in other, non-biotechnology sectors. Exploration plays a more important role in the biotechnology organizations to ensure their future viability, yet there are differences between the organizations within the biotechnology sector. The difference in the percentage radical innovation between the organizations can partly (49%) be explained by the perceived environmental uncertainty. The area of application, the size, age or annual sales are not of influence. A correlation is present between the percentage NPD employees and the percentage radical innovation, but the percentage NPD employees is in this report not interpreted as being a predictor for the percentage radical innovation, since the percentage radical innovation could also be a predictor for the percentage of NPD employees.

The case studies show that there are multiple explanations for the degree and type of innovation. The organizational strategy, environmental factors and the difference in perception of the managers about the environment are of influence on the degree and type of innovation. The current degree and type of innovation are mainly determined by the organizational strategy. Although the R&D managers have some influence on it, they are pushed into one direction by their environment; competitors, customers, investors and parent companies all influence the organizations. The perception of the R&D managers about these environmental factors determines mainly the future development of the NPD function. The struggle between exploration and exploitation is, according to three out of the four interviewed managers, a relevant and difficult issue.

2. How is the combination of exploration and exploitation facilitated internally by organizations in the Dutch and Belgian biotechnology sector?

In this report, the NPD strategy, the organizational form (consisting of the organizational structure and the formalization degree of the NPD process), the NPD climate, and the ambidexterity of the NPD function are analysed as being part of the internal facilitation of the combination of exploration and exploitation.

A high percentage radical innovation is positively associated with a long-term oriented NPD strategy, which means a primary focus on long-term growth and performance, creating breakthrough new products and do focus on projects with risky outcomes. The results show that most organizations in the biotechnology sector, regardless of the

percentage radical innovation, do work with a predominantly organic structure for the NPD function. Between the formalization degree and the percentage radical innovation no pattern is recognizable. The last subject is the innovative climate of the NPD function. Organizations in the biotechnology sector are working with an open and promotive climate, which means that employees have freedom to define their own work, there is time for employees to develop unplanned new ideas, there is a strong support for further development of new ideas, etc.

The results on the team structure, formalization of the NPD process, and the NPD climate showed that, although it would be interesting for organizations in the biotechnology to use a different approach for the two types of innovation (radical and incremental), organizations currently do not make use of an ambidextrous approach.

Looking at the combination of the NPD strategy, the organizational form and the NPD climate, no pattern between these elements can be distinguished. The NPD strategy is related to the percentage radical innovation, but this is not the case with the organizational form and the NPD climate. However, the case studies show that there is a relation between the percentage radical innovation and the internal facilitation on all three aspects: the NPD strategy, the organizational form and the NPD climate. Although the managers have different beliefs about how to facilitate the balance between exploration and exploitation; in all four organizations the degree and type of innovation are, according to the managers, of influence on the NPD strategy, the organizational form and the NPD climate.

3. How is the combination of exploration and exploitation facilitated through inter-organizational linkages by organizations in the Dutch and Belgian biotechnology sector?

Furthermore, this report shows that collaboration is important for organizations in the biotechnology sector. Within the Netherlands this network of organizations is larger and there are more possibilities than in Belgium, although Belgium has two relatively large promoters for collaboration; the VIB and FlandersBio. The presence of such associations in both countries confirms the importance of collaboration. In addition a co-patent analysis shows that 55% of all co-patents are filed by an organization together with a university, a knowledge institute, the government, or an individual. The other 45% is filed together with another organization, e.g. suppliers, customers, competitors. This implies that organizations in the biotechnology sector make use of heterogeneous networks with various partners. The focus of collaboration agreements is in most cases on the development of new products followed by carrying out fundamental scientific research.

Although none of the four case study organizations has been involved in collaborations which led to the filing of a co-patent with a biotechnology classification, three out of the four organizations are involved in many collaboration agreements, varying from 20 to 80 currently active collaborations. This indicates that co-patent analysis only partly shows the collaboration between organizations. However, when an organization files a co-patent, there must have been intensive collaboration; the intensity of the current

collaborations is varying. The managers of all four organizations indicate that the importance of collaboration will only increase in the future.

4. What are the effects of the combination of exploration and exploitation, and the facilitation of this combination, on the performance of the organizations in the Dutch and Belgian biotechnology sector?
The performance of the organizations in the Dutch and Belgian biotechnology sector is measured in terms of *product concept effectiveness* and *NPD process effectiveness,* which both can be further defined in terms of *operational effectiveness* and *strategic flexibility.*

Organizations in the biotechnology sector score better on *product concept effectiveness* than on *NPD process effectiveness,* due to the high percentage radical innovation and the facilitation of the NPD function, described above. The strengths of the organizations are the performances on *fit with market demands* and *fit with firm competences*, whereas the weaknesses are the performances on *speed* and *productivity.* A difference is noticed between organizations with a high percentage radical innovation and those with a low percentage radical innovation. The difference between the performance on PCE and NPD PE is smaller for organizations with a low percentage radical innovation.

Operational effectiveness refers to the effectiveness of today's work and *strategic flexibility* refers to adapt to, anticipate on, or create future NPD performance requirements. The performance measured in terms of the *strategic flexibility* of the organizations shows no relation with the percentage radical innovation; organizations with a low percentage radical innovation are as strategic flexible as organizations with a high percentage radical innovation. Are radical innovations therefore needed to ensure an organization's future viability? The case studies show that some organizations depend on a high percentage incremental innovation being sufficient for their future viability, but this depends on the manager's perception of the future. Most managers point out the importance of radical innovations for the future.

The struggle to find a balance between exploration and exploitation will remain a relevant and difficult issue. Organizations can use this report to compare the way of organizing their NPD function with other organizations in the biotechnology sector, which will facilitate their struggle to find a balance between exploration and exploitation.

Table of Contents

List of Abbreviations

AM	Agriculture, Animal, Plant and Microbiology
EPO	European Patent Office
FB	Food Biotechnology
HD	Health and Diagnostics
IPC	International Patent Classification
NPD	New Product Development
OE	Operational Effectiveness
OI	Other Industrial Applications
PCE	Product Concept Effectiveness
PE	Process Effectiveness
SF	Strategic Flexibility
SME	Small and Medium sized Enterprise
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization

Preface and Acknowledgements

At this very moment you are looking at a research report about exploration and exploitation in the Dutch and Belgian biotechnology sector. This report is submitted as partial fulfilment of the requirements for the Master's degree in Industrial Engineering and Management at the University of Twente.

At the beginning of our sixth year of Industrial Engineering and Management, we decided it was time for us to finish our study. During our study, we both became interested in new product development processes in high innovating industries and therefore we applied to participate in the *Patterns-in-NPD project,* chaired by Petra de Weerd-Nederhof, for a research about new product development in the Dutch and Belgian biotechnology sector.

We started our graduation project in February 2006, and after two months of research at the K.U.Leuven and six months at the University of Twente we finished our research by the accomplishment of this research report.

We want to take this opportunity to mention the people who made this project possible. First of all, we would like to thank our supervisors dr.ir. Petra de Weerd-Nederhof, dr.ir. Klaasjan Visscher, and prof. Bart van Looy for their assistance, contribution, comments, and patience, which guided us through our graduation project.

Secondly, we would like to thank the R&D Managers of the participating organizations in this research, who provided the data about the configuration of their NPD function. Special thanks go to the four R&D managers of the case studies for giving more in-dept information about new product development in the biotechnology sector.

Last but not least, we would like to thank our colleagues of the department *Steunpunt O&O Statistieken* at the K.U.Leuven, for our great time we had there during our two months stay.

We wish you a pleasant reading experience,

Jorn van der Schaaf
Tjerk Kuipers
Enschede, October 2006

Chapter 1: Introduction

Organizations competing in today's world of high technology are faced with the challenges of dualism, that is, functioning efficiently today while planning and innovating effectively for tomorrow.

This statement by Katz and Allen (1985), is one of the key issues of this research report. In the biotechnology sector, organizations are subject to rapid changing market conditions and disruptive technologies. This research report describes how organizations in the biotechnology sectors adapt to this fast changing environment and more specific, how organizations organize their new product development function to ensure its current and future viability.

In chapter two, the research design, more background about the tension between exploration and exploitation is provided, followed by the research objective, the research questions and the research approach.

Chapter three forms the theoretical framework for the research, this leads to ten propositions about the degree and type of innovations in the biotechnology sector, the internal and external configuration of the NPD function, and the performance of the NPD function.

In chapter four, the research methodology is described; it elaborates on the realization of the dataset, the organizations from the dataset, and the operationalization of the research questions.

Chapter five provides the sector analysis. The biotechnology sector is further introduced, compared with other sectors and analysis about the degree and type of innovation is described.

In chapter six the internal facilitation of the balance between exploration and exploitation in organizations in the biotechnology sector is analyzed through testing the propositions. The NPD strategy is described, followed by the organizational form, the NPD climate and the ambidexterity of the NPD function.

Chapter seven elaborates on the external facilitation of the balance between exploration and exploitation in organizations in the biotechnology sector by testing a proposition.

In chapter eight the performance of the organizations is described. This is done through testing propositions and analysing their strengths and weaknesses.

This report is finished with conclusions and recommendations for further research, which are described in chapter nine.

Chapter 2: Research Design

This chapter elaborates on the balancing of exploration and exploitation. Second, the research objective will be described. In the last paragraph the research outline is provided.

2.1 Balancing exploration and exploitation in a highly innovative sector

A key issue in the management science literature is how successfully firms learn when they are *exploiting* current knowledge and skills versus *exploring* new knowledge and skills [March, 1991].

What can be understood by these two terms, exploring and exploiting, playing such a big role in management science? Exploitation involves the efficient employment of current assets and capabilities, and is needed to survive in the short term (functioning efficiently today) while exploration implies a need for constant renewal of resources and competencies to survive in the long term (planning and innovating effectively for tomorrow).

In management science literature, researchers have suggested that exploration and exploitation activities are contrarily. Levinthal and March (1993) argue that nevertheless exploration and exploitation are contrarily, firms must not engage exclusively in one of the two activities. They state that:

"An organization that engages exclusively in exploration will ordinarily suffer from the fact that it never gains the return of its knowledge. An organization that engages exclusively in exploitation will ordinarily suffer from obsolescence. The basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability. Survival requires a balance."

Speaking in terms of Katz and Allen (1985), organizations competing in today's world of high technology are faced with the challenges of "dualism", that is functioning efficiently today while planning and innovating effectively for tomorrow. Thus there is a need for managers to learn how to build parallel structures and activities that would not only permit these two opposing forces to coexist, but would also balance them in some integrative meaningful way.

This balancing of exploration and exploitation can create a tension between them. On the one hand, adaptation to existing environmental demands may foster structural inertia and reduce firms' capacity to adapt to future environmental changes and new opportunities [Hannan and Freeman, 1984]. On the other hand, experimenting with new alternatives reduces the speed at which existing competencies are improved and refined [March, 1991]. D'aveni (1994) argues that no firm can build a competitive advantage

that is sustainable because today's strength becomes tomorrow's weakness so quickly. Instead of trying to create stability and equilibrium, firms must actively work to disrupt their own advantages and the advantages of competitors by creating a series of temporary advantages.

In other words, because exploration and exploitation are contrarily, though indispensable for survival, the need occurs to manage the trade-off between the two activities. Organizations aim at finding a balance between exploration and exploitation.

The managing and organizing of exploration and exploitation is always important and never easy, but is particular essential and difficult in periods of technological turmoil and disruption. An example of a sector which can be characterized as a sector of high technological turmoil and disruption is the biotechnology sector. Recent studies on the biotechnology industry seem to agree on the fact that there have been […] fundamental changes at the sector level [Nooteboom, 2006]. A quick look at the biotechnology sector confirms this statement.

Biotechnology as such is not an industry *per se* but refers more to a set of technologies that profoundly affect existing industries such as agriculture, food processing and human health [Gilsing, 2005]. Roughly, Biotechnology can be described as *"the use of living things to make products".* Hulse (2004) elaborated the definition of biotechnology:

Biotechnologies are processes that seek to preserve or transform biological materials of animal, vegetable, microbial or viral origin into products of commercial, economic, social and/or hygienic utility and value.

Both Hulse and Gilsing define biotechnology as a collective noun of different technologies or processes. Glanzel et al. (2003) divide the biotechnology into four subfields.

- Green: Agriculture, animal, plant and microbiology
- Red: Health and Diagnostics
- White: Food
- Other industrial applications

The following characteristics of the biotechnology sector support the statement that the biotechnology sector is a sector with a high amount of technology turmoil and disruption.

The biotechnology sector is a *rapid developing sector* with a high and fast growing number of patent applications (1.4 times faster than the average number of patents). This is shown in figure 2A published by the Organization for Economic Co-operation and Development [OECD, 2005]

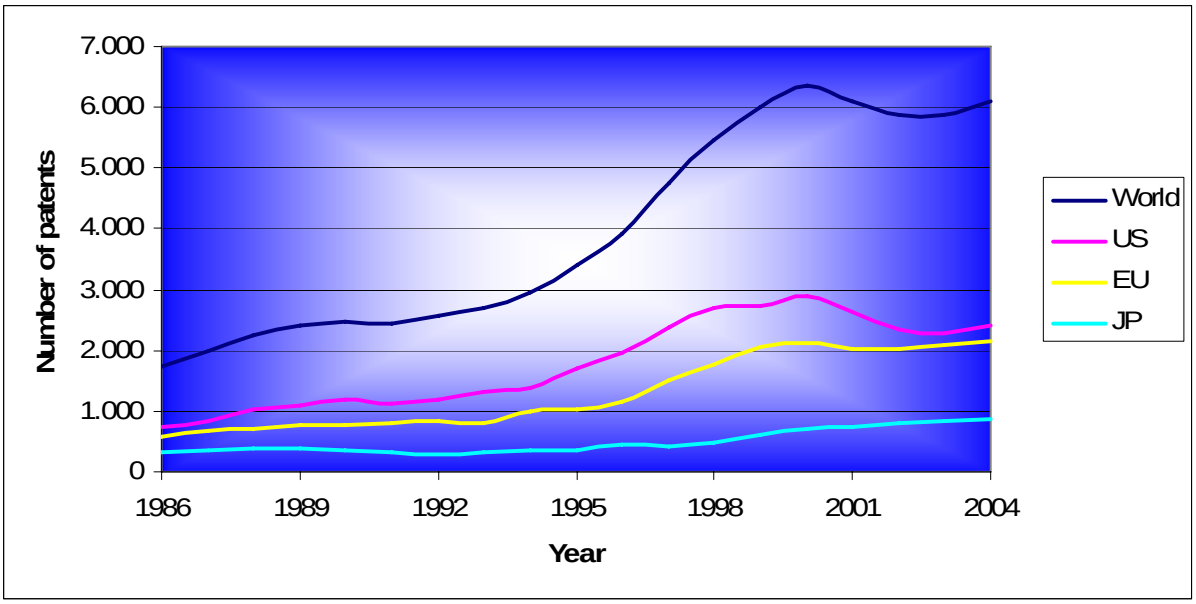


Figure 2A: total number of biotechnology patents filed at the EPO in total, source: OECD (2005)

Figure 2B shows the percentage of biotechnology patents as part of the total number of patents. This figure indicates that the number of patents in the biotechnology sector is growing relatively faster than average. The increase of biotechnology patents expressed as a percentage of the total number of patents indicates that the growing number of patents in the biotechnology sector is partly responsible for the increase in the total number of all patents.

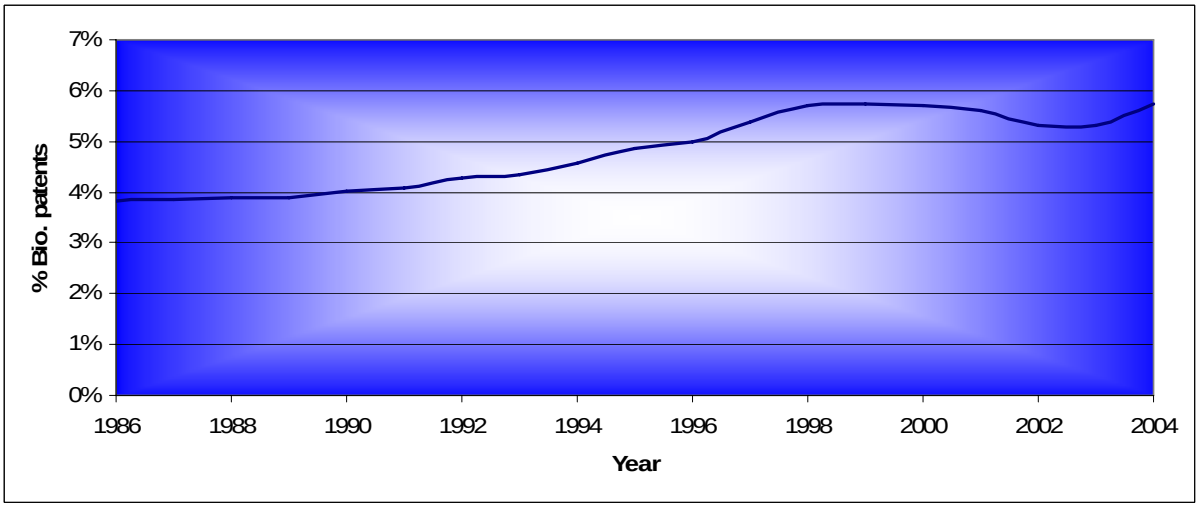


Figure 2B: Percentage Biotechnology patents as part of the total number of all patents at the EPO, source: OECD (2005)

A report made by Ernst & Young (2000) shows that the number of companies active in the biotechnology sector is growing and also the number of registered products involving biotechnology is increasing.

Reports published by the CBD, CCMO, and COGEM uncover a large-scale list of trends in the biotechnology sector in The Netherlands, for example; the growing acceptance of

genetic manipulation, more risk capital is becoming available from investors, the development of bio-fuels, etc.

In sum, the previous facts confirm the statement of the biotechnology sector being a sector with high technological turmoil and disruption. It is assumed that in this sector, where research takes an important place, balancing exploration with exploitation is one of the biggest challenges for managers. An example of failure is the story of Leadd B.V., a biotechnology organization which performed outstanding on exploration activities, but failed in their attempt to exploit their knowledge on the market, leading to the bankruptcy of the organization, despite they filed 18 patents worldwide (see Appendix A). The story of Leadd B.V. is not a unique story in the biotechnology, many small biotechnology companies have problems gaining sufficient funds to carry out their research program. Wealthy investors are afraid to invest in this high risk industry, and therefore biotechnology companies are facing problems to turn their exploration activities into exploitation activities.

Due to their financial and resource capacity, larger companies as Akzo Nobel and DSM, have more possibilities to perform on exploration and exploitation simultaneously. Still they have to deliberate constantly about the distribution of capital and (human) resources over both explorative and exploitative activities. But how exactly do organizations in the biotechnology sector balance their exploration and exploitation activities?

The balance between exploration and exploitation is facilitated both internally and externally in an organization. Internally, the resources which are available have to be distributed between exploration and exploitation. Organizations must not only focus on incremental innovation, since exploration is the search for constant renewal of resources and competencies and will lead to radical breakthroughs, therefore organizations must focus their NPD activities to both incremental and radical innovations [O'Reilly and Tushman, 2004]. Externally, the organizational networks provide input for exploration and ameliorate exploitation. This is especially interesting in the biotechnology since this sector has been identified as the industry with the highest alliance frequency among several industries characterized by high alliance activity [Hagedoorn, 1995].

2.2 Research objective

In the former paragraph is argued how important it is for companies to succeed in their struggle to find a balance between their explorative and exploitative activities. A dynamic, complex environment, or in other words, an emerging environment will not facilitate this endless struggle, but rather extend its endlessness. In literature authors have elaborated on internal organization and on external networks in relation with exploration and exploitation, but research about the internal organization and on external networks related to each other and to exploration and exploitation is scarce. This study will extend the literature on balancing exploration and exploitation in an emerging sector by relating the two types of activities to both a company's internal organizational configuration and a company's external network.

The objective of this study is therefore facilitating companies in the biotechnology sector in their struggle to find a balance between exploration and exploitation. This study will not provide a best practice about balancing exploration and exploitation, but will more pellucid the balancing process. This study will focus on biotechnology companies in the Netherlands and Belgium.

To fulfil this objective the following question must be answered:
How do organizations in the Dutch and Belgian biotechnology sector shape their internal organizational configuration and their external network to facilitate a balance between exploration and exploitation which ensures their current and future viability?

A balance, as mentioned in this question, does not necessarily mean a fifty-fifty distribution between exploration and exploitation, but means an organization devotes its energy to both exploitation and exploration in order to function efficiently today for surviving in the short term, and planning and innovating for surviving in the long term.

It is clear that a strategy of exploitation without exploration is a route to obsolescence [March, 2003]. Therefore in a highly innovative sector it is unthinkable for organizations to start directly with the exploitation phase of a product; first the phase of exploration has to be fulfilled. The replacement of dominant technologies by new entrants, rather then incremental change by existing technology providers, has been the source of important radical innovations this century [Ashford, 2002]. Expected is therefore that in the Dutch and Belgian biotechnology sector which is, according to the various authors mentioned earlier in this chapter, highly innovative and in which many new firms accede, organizations will focus, with a relatively large extent, on radical innovation.

2.3 Outline research

From the objective and the central research question four important variables concerning the balancing of exploration and exploitation can be distinguished; an emerging environment, the internal organization, the external networks, and the viability. Tidd (2001) has visualised the relation between these elements in a model.

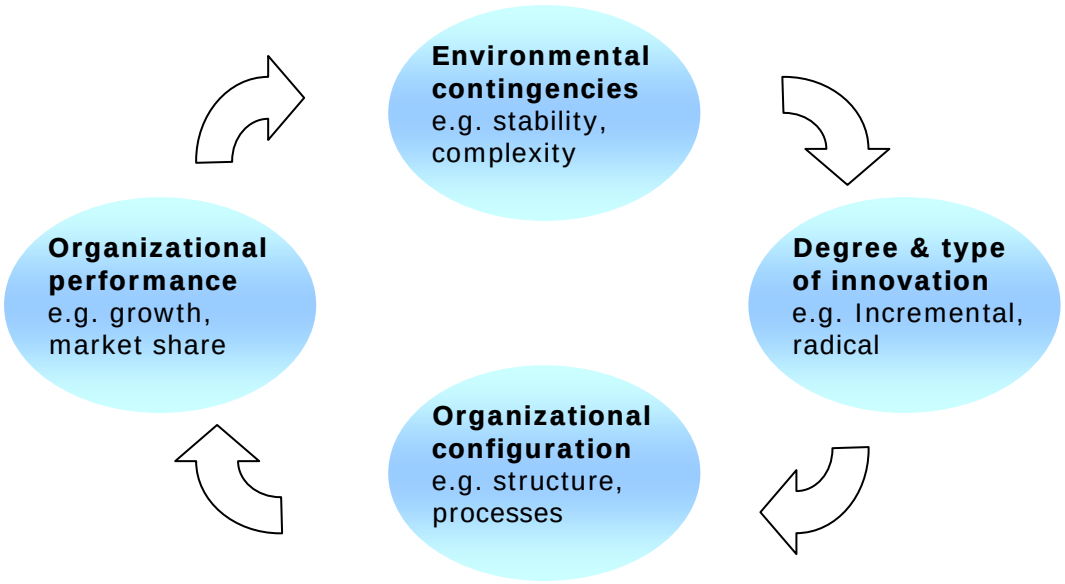


Figure2C: Environment, Innovation, Organizational configuration and Performance [Tidd, 2001]

In this report the first element in the figure reflects the biotechnology sector, which, according to Nooteboom (2006), can be characterised as being an emerging sector. According to Ernst & Young (2000) and the OECD (2005) this emerging sector is highly innovative, which is reflected in the second element of the figure. The first research question therefore is:

1. *Which combination of exploration and exploitation in terms of the degree and type of innovation is used by organizations in the Dutch and Belgian biotechnology sector?*

The degree and type of innovation will reflect whether the biotechnology sector is highly innovative or not. Besides the degree to which the biotechnology sector is innovative the answer to the question will provide information about the balance between exploration and exploitation, which is the first variable in the central research question. The third element in the figure corresponds to the facilitation of a balance between exploration and exploitation. The second and third research questions are based on this facilitation:

2. *How is the combination of exploration and exploitation facilitated internally by organizations in the Dutch and Belgian biotechnology sector?*

3. *How is the combination of exploration and exploitation facilitated through inter-organizational linkages by organizations in the Dutch and Belgian biotechnology sector?*

The second research question reflects the second variable in the central question and the third research question the third variable in the research question. The fourth, and last, element in the figure is the performance. The fourth research question is stated as follows:

4. *What are the effects of the combination of exploration and exploitation, and the facilitation of this combination, on the performance of the organizations in the Dutch and Belgian biotechnology sector?*

The answer to the fourth question will provide the performance in terms of the current and expected future viability, which reflects the fourth variable in the central question.
The four research questions together will answer, as described above, the central question provided in paragraph 2.2. The outline which will be followed in this report to answer these questions is represented in the following figure:

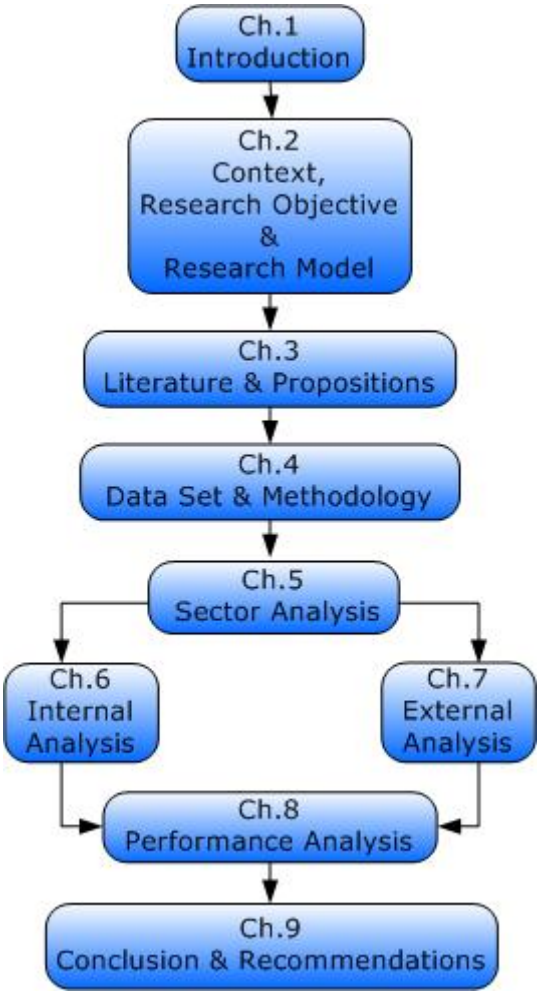


Figure 2D: Basic model of research outline

This figure represents the report outline. The relevance of each component will be explained, starting with chapter three; the literature:

Chapter 3; Literature
The third chapter will focus on literature and will be four-fold; it will provide literature on sector analysis (literature on the interaction with and influence of the environment on organizations), on internal analysis (organizational practices in relation with exploration and exploitation), on external analysis (networks in relation to exploration and exploitation), and on performance (organizational performance in relation to organizational practices). The knowledge which is relevant within the framework of this

research will be summarized. The literature study will be done to provide background and propositions based on the literature for chapters five, six, seven, and eight.

Chapter 4; Research methodology
In chapter four the data set, the data gathering process and the research methodology will be described. The data set will be created upon information from the European Patent Office database. For the data gathering the EPO database and the Patterns-in-NPD questionnaire (see Appendix B) will be used. From the EPO database data about patents of organizations and collaboration based on patents will be gathered. The patterns-in-NPD questionnaire is a standard questionnaire developed as part of the international Patterns-in-NPD project, originated at the University of Twente in The Netherlands. The questionnaire provides questions about the internal organization and the environment. The organizations which filled in the questionnaire will be introduced by a description of some general aspects. Case studies will be used to provide practical understanding and foundation for the suppositions based on the literature, the questionnaire and the patent data. Besides the dataset and data gathering, the research methodology will explain how the propositions, presented in chapter three will be tested.

Chapter 5; Sector analysis
Chapter five describes the sector analysis. This chapter will be explorative. First this chapter will describe the biotechnology sector in general. Next the proposition(s) about the NPD configuration will be tested. Last, the interviews will be described which serve as explanations and foundation of choices made by companies regarding the NPD configuration and the environment, and are a check for the proposition(s) made earlier.

Chapter 6; Internal analysis
The internal analysis will be described in chapter six. In this chapter the proposition(s) about the internal organizational configuration, which will be presented in chapter three will be tested. The results will provide information about the internal facilitation of the balance between exploration and exploitation. Next to this, the interviews will be described which will serve as explanations and foundation of choices made by organizations regarding their internal configuration and are a check for suppositions made earlier.

Chapter 7; External analysis
The external analysis will be described in chapter seven. In this chapter the proposition(s) about the networks which will be presented in chapter three will be tested. The results will provide information about the external facilitation of the balance between exploration and exploitation. Next to this, the interviews will be described which will serve as explanations and foundation of choices made by organizations regarding their network strategy and are a check for suppositions made earlier.

Chapter 8; Performance analysis
Chapter eight will elaborate on the performance of the biotechnology organizations. The last proposition(s) will be tested. The results will show on which aspects the organizations perform better or worse than other organizations. Next to this, the

interviews will be described which will serve as explanations for the results found in the analysis.

Chapter 9; Conclusion & Recommendations
In this last chapter conclusions will be drawn and recommendations will be made based on the outcomes of chapters five, six, seven, and eight.

Chapter 3: Literature

The world is always changing, some aspects faster than others. These environmental changes affect the organization again and again. They affect the degree and type of innovation, the organizational configuration and the organizational performance. This is visualized by Tidd (2001) in figure 3A.

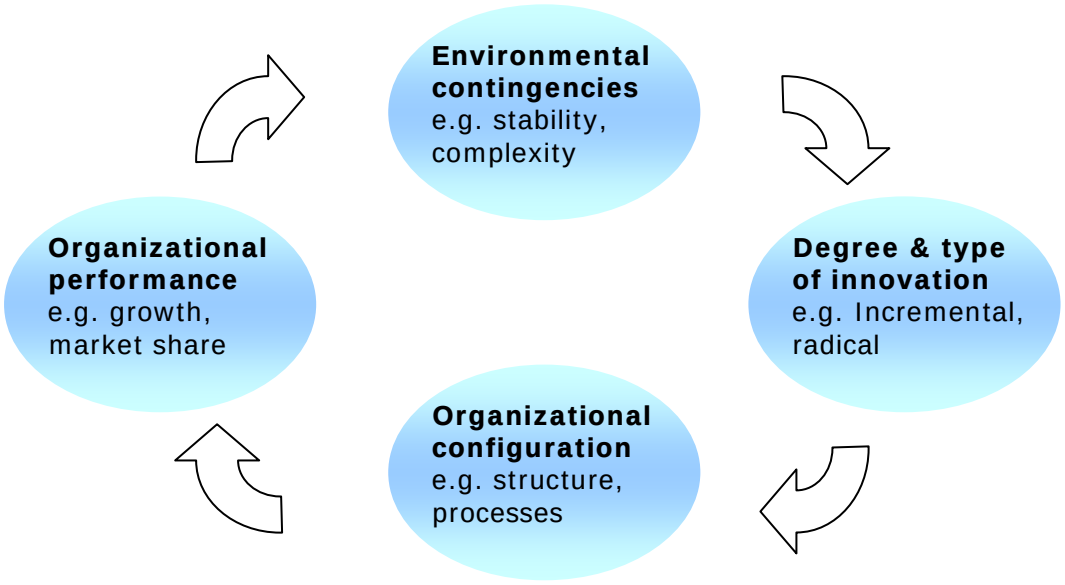


Figure 3A: Innovation, environment and performance [Tidd, 2001]

In this chapter a theoretical framework will be created about the extra-organizational context, the NPD function (which includes the type of innovation and the NPD configuration), and the business networks. All three characteristics will be related to the performance of the organization.

3.1 sector analysis theory

This paragraph will elaborate on the influence of the environment on the NPD function; why it influences the NPD function and especially how it influences the NPD function.

3.1.1 The Influence of the environment on the organization

The influence of the environment on the organization can be described along several dimensions, as summarized below [Bluedorn, 1993; Aldrich, 1979; Emery and Trist, 1965]:

- stable – unstable
- homogeneous – heterogeneous
- concentrated – dispersed
- simple – complex
- little resources available – many resources available

In terms of Daft (2001) the dimensions come down to two essential ways the environment influences the organization:

- The need for information about the environment, which is concerned with the uncertainty that environmental complexity and change create for the organization.
- The need for resources from the environment, which is concerned with scarce material and financial resources and with the need to ensure availability of resources.

This is schematised in the following figure:

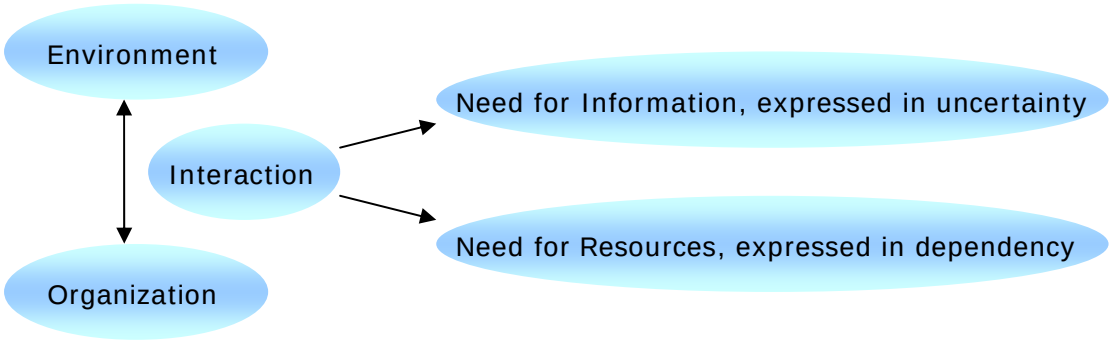


Figure 3B: Interaction between environment and organization

Organizations can respond to the environment by either adapt to the environment or try to influence the environment.

3.1.1.1 Need for Information

Organizations need information from the environmental elements so they can cater to customer demands as effective and efficient as possible. Although in a changing environment the information can be obsolete the moment it is received and therefore encompasses uncertainty. Uncertainty means that decision makers do not have sufficient information about environmental factors, and therefore face difficulty in predicting external changes. Uncertainty increases the risk of failure for organizational responses and makes it difficult to compute costs and probabilities associated with decision alternatives [Koberg and Gerardo, 1987].

The characteristics of the environmental domain that influence uncertainty are the extent to which the external domain is simple or complex and the extent to which events are stable or unstable. [Emery and Trist, 1965; Thompson, 1967; Terrebery, 1968]. Emery and Trist (1965) and Terreberry (1968) found that organizations in dynamic, turbulent environments often exceeded their capabilities for prediction and control with the result that the outcome of events became less certain. To assess the environmental uncertainty, Duncan (1972) has conceptualized the simple-complex and stable-unstable dimensions into a framework:

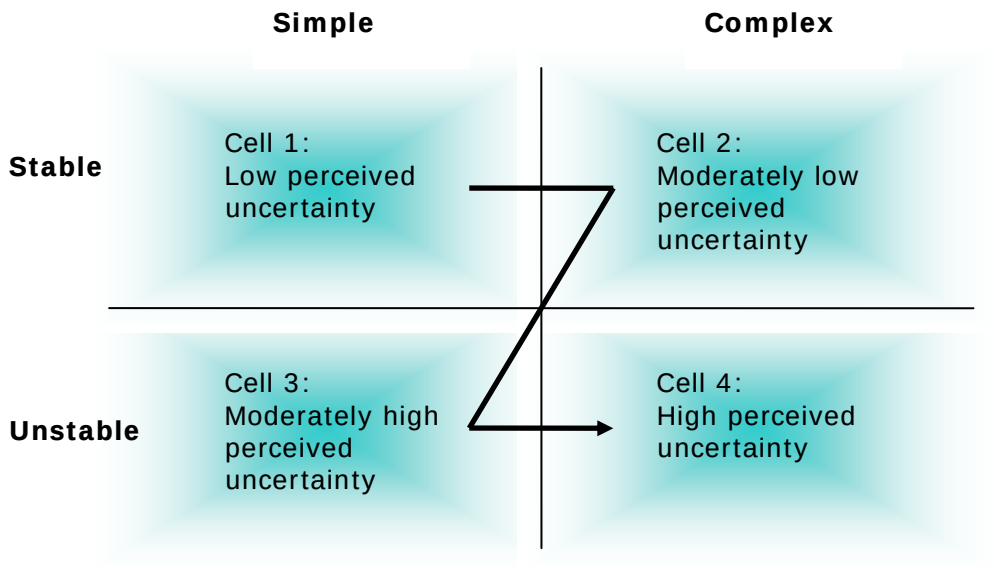


Figure 3C: Framework for assessing environmental uncertainty [Duncan, 1972]

The simple-complex dimension
The simple part of the simple-complex dimension deals with the degree to which the factors in the decision unit its environment are few in number and are similar to one another in that they are located in a few components. The complex phase indicates that the factors in the decision unit its environment are large in number.

The stable-unstable dimension
This dimension indicates the degree to which the factors of the decision unit its internal and external environment remain basically the same over time or are in a continual process of change.

Perceived uncertainty
The extent to which uncertainty is perceived differs from cell to cell, to assess the uncertainty according to Duncan (1972) the following characterisation can be used:

Stable - Unstable	Simple - Complex	Cell	Uncertainty
Stable	Simple	1	Low
Stable	Complex	2	Moderate
Unstable	Simple	3	Moderate
Unstable	Complex	4	High

Table 3.1: Uncertainty assessment table

Deduced from the former can be stated that adapting to the environment is a way of coping with the environmental uncertainty to create a fit between the internal structure and the external environment.

3.1.1.2 Need for Resources
Besides the need for information and the uncertainty this brings with it, the relation between the environment and the organization is affected by the need for material and financial resources. The environment is the source for these elements and necessary for

survival of the organization, so the organizations are dependent on the environment. Resource dependence means that organizations depend on the environment but strive to acquire control over resources to minimize their dependence [Pfeffer and Salancik, 1978; Ulrich and Barney 1984]. In response to the need for resources, organizations try to maintain a balance between linkages with other organizations and their own independence. Organizations maintain this balance through attempts to modify, manipulate, or control other organizations [Babcock, 1981]. According to Ring and Van de Ven [1994], two strategies can be used to manage the dependency:

- Establish linkages with key elements in the environment
- Shape the environmental domain

Linkages with key elements

Linkages with key elements can be established in different ways. According to Daft (2001) this can be established through:

- *Ownership* (buy a part of, or a controlling interest in, another organization), *Acquisitions* (the purchase of one organization by another), and *Mergers* (the unification of two or more organizations into a single unit)
- *Contracts* (license agreements or supplier arrangements) and *Joint ventures* (creation of a new organization that is formally independent of the parents)
- *Cooptation* (leaders from important sectors in the environment are made part of an organization), and *Interlocking directorate* (formal linkage that occurs when a member of the board of directors of one organization sits on the board of directors of another organization)
- *Executive recruitment* (transferring or exchanging executives)
- *Advertising and Public Relations*

Shape the environmental domain

For influencing or changing the domain four techniques can be used:

- Change of domain
- Political Activity and Regulation
- Trade Associations
- Illegitimate Activities

From the former can be concluded that through engaging external linkages and shaping the environment organizations can cope with the dependency originated from the interaction between the organization and its environment. Paragraph 3.3 will further elaborate on the aspect of external linkages.

3.1.2 Adapting to environmental changes

As described in paragraph 3.1.1 organizations are influenced in two ways by the environment, through the need for information and the need for resources. An organization can either adapt to the environment or try to influence the environment to fulfil these needs.

Organizational theorists emphasize that organizations must adapt to their environment if they are to remain viable [Duncan 1972]. One of the central issues in this process is

coping with uncertainty [Crozier, 1964; Thompson, 1967]. Duncan (1972), states that different organizations operate in different environments, which seems to suggest that research and development organizations tend to have more complex and dynamic environments than manufacturing organizations, which have more simple and static environments. This implies that organizations in a highly uncertain environment in proportion need more NPD-employees than organizations which operate in an environment with less uncertainty.

Hill and Jones (1998) argue that innovation in many ways is the single most important building block of competitive advantage giving a organization something unique that its competitors lack. In a competitive environment that is global, intense and dynamic the development of new commercially exploitable products is a focal point of competition [Christensen, 1997; Hamel, 2000; Hill and Jones, 1998; Johnson and Scholes, 1997; Clark and Wheelwright, 1993].

That organizations need to engage in the process of radical innovation for long-term survival is well recognised [Christensen, 1997; Hamel, 2000; Tushman & O'Reilly, 2004], and elaborately described in the previous chapter. This study states that radical innovations are radical breakthroughs where a new core process and core product is developed. Incremental innovations are next generation products, or enhancements on existing products.

Following this view, it can be stated that organizations operating in an emerging environment should focus more on (radical) innovation to ensure their survival than organizations in other environments. When organizations in an emerging environment try to create or maintain a balance between exploration and exploitation, more NPD employees will be needed to suffice in the (extra) innovation compared to organizations in other environments. Therefore the first and second propositions are stated as follows:

Proposition 1a: Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their employees to NPD than organizations in non-biotechnology sectors.

Proposition 1b: Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their NPD activities to radial innovation than organizations in non-biotechnology sectors.

3.2 Internal analysis theory

This paragraph elaborates on the internal facilitation of the balance between exploration and exploitation in the NPD function of the organization. According to the model of Tidd, on which this study is based, the NPD configuration is subject to the degree and type of innovation as described in the previous paragraph. The distinction between radical and incremental innovation (or, the percentage radical innovation) will better reflect the balance between exploration and exploitation than the percentage NPD employees. For example; a high percentage NPD employees does not necessarily mean that the organization is to a large extent explorative, whereas the possibility exists that all the

NPD employees are full time working on improving existing products. The percentage radical innovation does reflect this balance between exploration and exploitation, whereas radical innovations are positively associated with exploration and incremental innovations are positively associated with exploitation [Tushman and O'Reilly, 2004].

The facilitation of the combination radical and incremental innovation will be described in terms of the NPD strategy, the organizational form of the NPD function, the NPD climate and the ambidexterity of the NPD function.

3.2.1 NPD Strategy

The (requested) output of the NPD function is largely determined by the NPD strategy. The NPD strategy can be defined as the set of goals, focus, and means to exploit and explore markets by developing new products [Altena, 2004]. According to Clark and Wheelwright (1993) the NPD strategy consists of the following six elements:

- Development of goals and objectives
- Technology strategy
- Product strategy
- Market strategy
- Project plan
- Project management and execution

This research will focus on the goals and objectives of the NPD strategy.

The goal and the objective of the NPD strategy lie within two extremes. The first extreme is a NPD strategy which is purely focussed on long-term growth and performance, projects with risky outcomes, and creating breakthrough new products. The opposite of such a strategy, is a NPD strategy focussed on short-term profit and performance, projects with predictable outcomes and creating incremental new products [March, 1991; March and Levinthal, 1993; Tushman and O'Reilly, 2004; Cooper et al., 2004].

Tushman and O'Reilly (2004) distinguish two profoundly different types of businesses; those focused on exploiting existing capabilities for profit and those focused on exploring new opportunities for growth. Both businesses require different strategies, structures, processes, and cultures, they state that:

"On the short term, […], most companies need to maintain a variety of innovation efforts. They must constantly pursue incremental innovations, […], that let them operate more efficiently and deliver even greater value to customers. On the long term, businesses need to come up with discontinuous innovations -radical advances- that profoundly after the basis for competition in an industry often rendering old products or ways of working obsolete".

Cooper et al. (2004), state that a long term orientation is essential for sustained success of new product development in emerging sectors. As stated in the first proposition it is expected that organizations in the biotechnology sector spend more energy in developing radical innovations than in other industries. Due to this expected high percentage radical breakthroughs in the biotechnology sector, it is expected that the NPD function of

organizations in the biotechnology sector must primary focus on long-term growth, long-term performance, and creating breakthrough new products. Therefore the proposition is formulated as follows:

Proposition 2a: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a long-term oriented NPD strategy.

3.2.2 Organizational form of the NPD function

Organizations competing in the world of high technology are faced with the challenges of dualism [Katz and Allen, 1985]. Therefore, organizations in the Dutch and Belgian biotechnology sector have to function efficiently today in order to make profit while planning and innovating effectively for tomorrow; managers must find a balance between exploration and exploitation. In order to reach this goal, organizations in emerging industries must focus their NPD activities to both incremental and radical innovations [O'Reilly and Tushman, 2004]. As stated in the previous paragraphs, the biotechnology sector can be characterized as a sector with a high percentage radical innovation if compared with other sectors. Therefore, the strategy of the NPD function has a long-term orientation, but the question remains how this high percentage of radical innovations is further facilitated in terms of organizational form, NPD climate, and the ambidexterity of the NPD function.

Organizations in the biotechnology sector can respond to their environment by the way they organize their formal structure and control imposed on employees [Daft, 2001]. Burns and Stalker (1961) identified two organizational forms: Organizations with an organic structure and organizations with a mechanistic structure. They define an organic structure as an organizational structure that is free flowing, has few rules and regulations, encourages employee teamwork, and decentralizes decision making to employees doing the job. The opposite of this is the mechanistic structure, which is defined as an organizational structure with rigidly defined tasks, many rules and regulations, little teamwork, and centralized decision making.

Burns and Stalker (1961) stated in their book *"Management of Innovation"* that in dynamic sectors, organizations with an organic structure are more effective than those with a more mechanistic structure. Organizations with a more organic structure can perform better in the development of radical innovations. It is important to notice the word *more* in *more organic,* the two organizational forms are two extremities and the organizational structure which is pure organic or mechanistic does hardly exists. Burns and Stalker state that: *"…, the two forms of system represent a polarity, not a dichotomy, intermediate stages between the extremities empirically known to us. Also the relationship of one form to the other is elastic, so that a concern oscillating between relative stability and relative change may also oscillate between the two forms."*

The main advantage of the organic structure is its flexibility to deal with changing external and technical circumstances. This is usually achieved by having jobs defined broadly and then redefined continually. Furthermore, the organic structure allows both horizontal and vertical interactions and uses communication between people on different

hierarchical levels more as consultation and deliberation rather than as vertical commands [Aiken & Hage, 1971]. Although flexibility is achieved by an organic structure in small organizations, Burns and Stalker state that it may not be adequate for larger organizations (in this report, larger NPD departments).

The NPD process, focussed on procedures, determines how activities and tasks are formalized within the organizational form. In their search for best practices, Griffin and Page (1996) developed a scale for the measurement of the NPD process based on the formal procedures. The research covers whether formal procedures are used in the new product development process. A highly formalized process means that the organization has a formally-documented process where a cross-functional team uses a staged process with overlapping, fluid stages and "fuzzy" or conditional stage decisions [Griffin, 1997]. The opposite is a non-formalized process, which means that there is no standard approach to new product development.

There are many theories about the effect of the degree of formalization on the innovation performance of an organization. Cooper (1990), states that a formal process for controlling NPD is only slowly moving into organizations, even though previous research has demonstrated that formal NPD processes improve the probability of product development process. In high technology areas, the number of organizations following no process or just an informal process is still astoundingly high [Griffin 1997]. Ettlie et al. (1984) found that a high degree of formalization has a positive influence on the innovation performance of large organizations, whereas for smaller organizations a more loose way of working can be productive for the development of new products. But a high formalized development process can work counterproductive, because of the bureaucracy of the process, which thwarts the development process turning an idea into a new developed product. According to Moenaert (1995), decentralization of planning activities in the planning stage and *some* degree of formalization both have a positive effect on the successful development of radical breakthroughs. However, Lichtenhaler et al. (2004) argue that the degree of formalization for radical innovations must be lower than for incremental innovation. Due to the high percentage radical innovation in the Dutch and Belgian biotechnology sector, the proposition about the organizational form is formulated as follows:

Proposition 2b: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a predominately organic structure and a low formalization degree.

3.2.3 NPD Climate

Several scholars examined the influence of the organizational climate on a number of organizational variables as performance, innovativeness, productivity, etc. For example, Hellriegel and Slocum Jr. (1974) found that employees working in a supportive climate, characterized by independence of thought and the ability to be productive in free, unstructured situations, perform better than employees in a less-supportive climate. This indicates that the organizational climate contributes to the performance of the

organization. Cooper et al. (2004), state that the organizational climate is one of the strongest drivers of NPD performance.

What do all these scholars mean with organizational climate? Isaksen (1999) defines the organizational climate as the recurring patterns of behaviour, attitudes and feelings that characterize life in the organization. Although the organizational climate is perceived by individuals, it exists independently of these perceptions and is considered an attribute of the organization [Ekvall, 1997]. Isaksen, Lauer, Ekvall, and Britz (2000), state that the organizational climate can be both supportive and counterproductive to the development and utilization of new products and technologies. The climate for creativity and change is a climate which promotes the generation, consideration and use of new products, services and ways of working.

An important note is the difference between organizational climate and culture. Organizational culture includes the beliefs, history and traditions [Isaksen and Lauer, 2002] and refers to the deeper and more enduring values within the organization.

Ekvall (1996) states that the measurement of climate makes a difference between innovative and stagnated organization and is based on ten dimensions, later decreased to nine by Lauer et al. (1999). The nine dimensions of organizational climate are:

- Challenge and involvement: Degree to which people are involved in daily operations, long-term goals, and visions.
- Freedom: Independence in behaviour exerted by the people in the organization.
- Trust/Openness: Emotional safety in relationships.
- Idea time: Amount of time people can use (and do use) for elaborating new ideas.
- Playfulness/Humor: Spontaneity and ease displayed within the workplace.
- Conflict: Presence of personal and emotional tensions in the organization.
- Idea support: Ways new ideas are treated.
- Debate: Occurrence of encounters and disagreements between viewpoints, ideas, and differing experiences and knowledge.
- Risk Taking: Tolerance of uncertainty and ambiguity in the workplace.

The study of Isakson and Lauer shows that innovative organizations score significant higher on eight of the nine dimensions and significant lower on conflict. This means that all the dimensions of Ekvall are positively related to innovativeness except the conflict dimension. A climate which scores high on the eight dimensions positively related to innovativeness will be defined as an open, promotive climate. The next proposition can be formulated as follows:

Proposition 2c: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a more open, promotive climate.

3.2.4 Combination of NPD strategy, organizational form, and NPD climate

As described in the previous three subparagraphs, it is expected that organizations in the Dutch and Belgian biotechnology sector are working with a specific NPD strategy,

organizational form and NPD climate. The question is, if there is a pattern recognizable between the percentage radical innovation, the NPD strategy, the organizational form and the NPD climate. For example, an organization with a predominately mechanistic structure and a high formalization degree will have a less open, promotive climate and a short-term oriented NPD strategy. The combination of the percentage radical innovation, the NPD strategy, organizational form and the NPD climate will be tested by the next proposition.

Proposition 2d: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a combination of a long-term oriented NPD strategy, a predominately organic structure, a low formalization degree and a more open, promotive climate.

3.2.5 Ambidexterity of the NPD function

Organizations in the biotechnology sector must constantly pursue incremental innovations in their existing products and operations to increase the value to customers (exploitation) and at the same time the organizations need to come up with radical innovations that profoundly alter the basis for competition in the biotechnology sector, often rendering old products or ways of working obsolete (exploration) [Tushman and O'Reilly, 2004]. The NPD function of biotechnology organizations is responsible for both types of innovation, which require both a specific approach. An organization with a separate approach for radical and incremental innovation is called an ambidextrous organization.

In their research, Tushman and O'Reilly (2004) studied the relation between the (team) structure of the breakthrough projects and the performance. They found that successful organizations tended to structure their breakthrough projects in independent units, each having its own processes, structures, and cultures, but still integrated into the existing senior management hierarchy. On the other hand incremental innovations are much more integrated with existing organizational management structures.

Clark and Wheelwright (1992) have distinguished four different types of team structures, which perform well in a specific combination of environment, size of the organization and the type of innovation. Each type has their specific dependency on the organizational departments These four types are:

1. Functional team structure
2. Lightweight team structure
3. Heavyweight team structure
4. Autonomous team structure

These four types of team structures are visualized in figure 3D and a short summary is given below:

1. Functional team structure: A team structure in which team members are not co-located. In this structure the different functions coordinate ideas through detailed specifications, and in occasional meetings issues that cut across groups are

discussed. Primary responsibility for the project passes sequentially from one function to the next. This structure is found in larger, more mature organizations

2. Lightweight team structure: In the lightweight team structure people assigned to the team remain physically in their functional areas but each functional area has a liaison person that represents the functional area in a project coordinating committee. The project manager is often a junior- or middle-level person and the resources remain under the control of their respective functional managers.
3. Heavyweight team structure: A team structure in which the project manager is a senior manager who has primary influence over the people working on the development effort and supervises their work directly. The team members are dedicated and physically co-located.
4. Autonomous team structure: A team structure, also known as a *tiger team,* which has a project leader that is given full control over the resources contributed by the different functional groups. This project leader also becomes the sole evaluator of the contribution made by individual team members. The project team is not required to follow existing organizational practices and procedures, but is allowed to create its own. The risk is however that the project team may "go away" (or get carried away) from senior management which may cause serious problems.

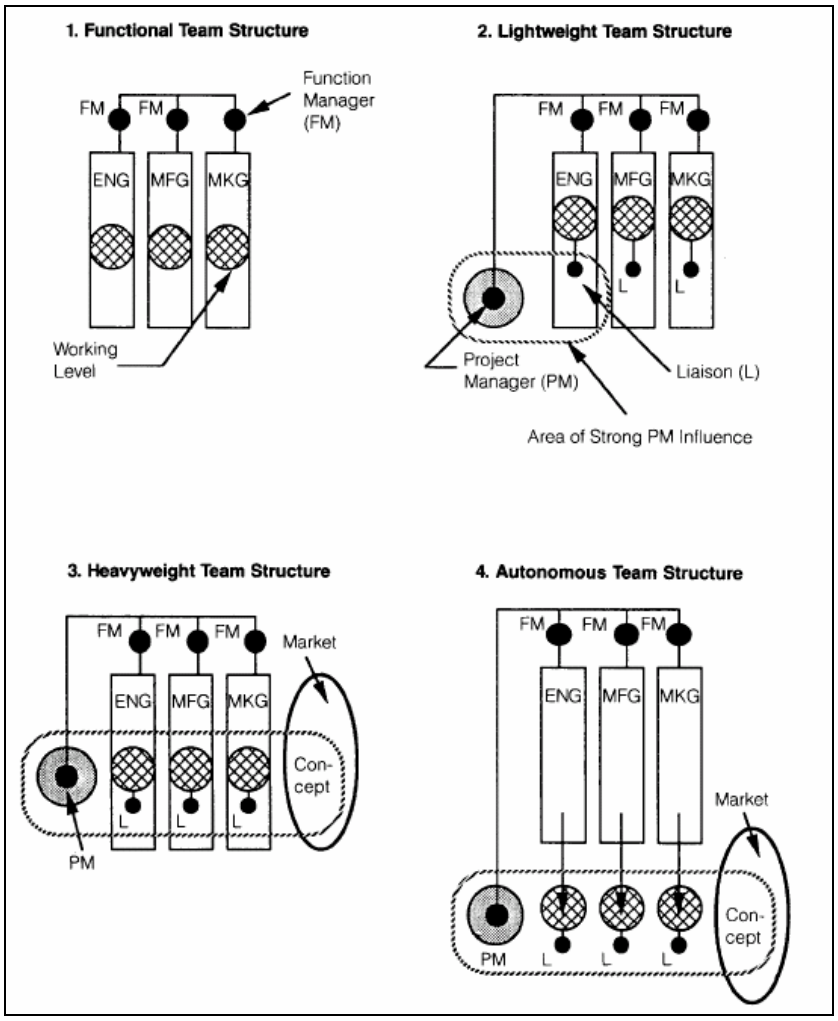


Figure 3D: Team structures according to Clarke and Wheelwright.

According to the theory of Tushman and O'Reilly it is expected that organizations in the Dutch and Belgian biotechnology sector prefer type 3 and 4 for radical innovations and prefer type 1 and 2 for incremental innovation.

As described before in subparagraph 3.2.2 there is a difference in the formalization degree between radical and incremental innovation. Lichtenhaler et al. (2004) argue that the degree of formalization for radical innovations must be lower than for incremental innovation. Duncan (1976), states that radical innovation is positively associated with high complexity, low formalization, and low centralization. Attributes of bureaucratic control have a reverse effect on radical innovation [Zaltman et al., 1973].

Freedom and responsibility can be derived from the formalization degree, but is also inherent to the NPD climate. Ekvall (1996) discriminates between incremental and radical innovation. He states that a more open, promotive climate, as described in subparagraph 3.2.3, is required for radical innovation. In order to succeed with radical breakthroughs, freedom, risk taking and debates must be dominant present in the NPD climate, than in the NPD climate of incremental innovation [Isaksen and Lauer, 2002].

The theories about team structure, formalization degree and NPD climate state that a separate approach for radical and incremental innovation contributes to higher performance, the so-called ambidextrous approach. Therefore the next proposition is formulated.

Proposition 2e: Organizations in the Dutch and Belgian biotechnology sector make use of separate approaches for radical and incremental innovations.

3.3 Network analysis theory

Faced with pressure on all fronts to do more with less, a growing number of organizations are pooling their resources together. The goal is to make better, more efficient use of shrinking resources to create high-quality, and high technological end-products. As stated before, the biotechnology industry has been identified as the industry with the highest alliance frequency among several industries characterized by high alliance activity [Hagedoorn, 1995].

Collaborative arrangements involve two or more organizations in which the partners hope to learn from each other's technologies, products, skills, and knowledge that are otherwise not available. The partners may range from suppliers and customers to competitors, unrelated organizations, or organizations in the public sector. Although such arrangements are pervasive in the day-to-day operations of a organization, in matters related to technology two special characteristics can be observed [Narayanan, 2001].

First, one of the major functions performed by collaborative arrangements is the transfer of knowledge from one organization to another, which requires that the individual organizations understand the operations of their partners much more intensely than in for example, a customer-supplier relationship. Secondly, the choice of the partners is

determined greatly by strategic reasons. Thus whereas organizations may avoid competitors in their day-to-day operations, many technology-related collaborative arrangements exists between competitors.

Narayanan (2001), states that there are three main reasons for organizations to start a collaboration agreement.

- The resources required for a particular venture are so high that no single organization can do it alone.
- The risk associated with a venture may be so high that organizations may want to incur only a portion of the total risk of the venture.
- Different organizations have different capabilities, and some ventures may require pooling the capabilities of different organizations for successful implementation.

Nooteboom (1999) gives two additions on the three main reasons. He states that organizations can speed up the innovation process. Collaboration with other organizations is inherent to collaboration with new knowledge and skills, therefore organizations become more flexible to adapt new technologies and market developments. Another reason can be to acquire a monopoly in their own niche-market by joining a collaborative agreement with the biggest competitor. Besides, Ring & Van de Ven (1994), state that organizations establish linkages with key elements in the environment as a strategy to manage the dependency of an organization.

Especially in high technological industries as biotechnology, organizations cope with technological disruption and the unstable environment by concerning new collaborations with other organizations (or institutes). Gilsing (2005) gives an explanation for the fact that networking in the biotechnology sector is one of the keys to deal with the unstable and competitive environment. He states that large (e.g. pharmaceutical) organizations made limited use of taking over a dedicated biotechnology organization to incorporate the new knowledge base because of the difficulty to identify up-front which search process in a particular technological field would be most likely to yield success, and then, which biotechnology organization would be most capable in realizing this potential. A network of various biotechnology organizations makes it possible to explore in different directions without the costs of acquisition.

Besides take-overs of large organizations, biotechnology organizations can choose to grow without the collaboration of other organizations and become a large organization themselves. The advantage is direct access to a potentially large profitable market and the avoidance of being dependent on other biotechnology organizations, generating relational risk. But there are some thresholds and disadvantages inherent to this process.

- Most biotechnology organizations have a strong mono-disciplinary orientation, whereas the development of e.g. a new drug requires a much broader, more general knowledge base, both in technical and in organizational terms [McKelvey and Orsenigo, 2001].
- Most biotechnology organizations do not have the large scale marketing and distribution advantages.

- Biotechnology organizations are in desperate need of cash. Therefore venture capitalists are more prepared to invest when there is support from a large pharmaceutical organization.
- A biotechnology organization will lose their advantage of their small size and flexibility for exploration.

Networks have emerged as the dominant organizational form opposed to alternatives such as integrated forms or stand alone forms.

Two different main types of networks can be distinguished; homogeneous and heterogeneous networks. The difference between both types of networks is the variety of the partners. In a homogenous network, the partners do focus on the same products and technologies whereas in a heterogeneous network the partners do differ from each other, e.g. they can have seller-buyer relationships or a collaboration agreement between a university and an organization.

Faems et al. (2005) state that organizations engage in a variety of interorganizational collaborative agreements -within the framework of their innovation strategy- will be more effective in terms of innovative performance. The second statement is that the more a organization engages in exploitative interorganizational collaborations, the more effective it will be in terms of improving and further developing existing technologies and their implied products whereas engaging in explorative inter-organizational collaborations will lead to a more effective way of developing new technologies and/or products. Explorative interorganizational networks are alliances focused on the 'R' in the Research and Development process and are aimed to discover something new [Koza & Lewin, 1998]. Exploitation alliances focus on the 'D' in the research and development process and are aimed at jointly developing [Koza & Lewin, 1998]. The findings of Faems et al. (2003) highlight the relevance for senior management of adopting a portfolio approach to interorganizational collaborations in order to achieve results in both terms of developing existing technologies and creating new ones. This last statement is confirmed for the biotechnology sector by Rothaermel and Deeds (2003). The fifth proposition is stated as follows:

Proposition 3: Organizations in the Dutch and Belgian biotechnology sector make use of heterogeneous collaboration agreements to balance exploration and exploitation.

3.4 Performance

After the environmental contingencies, the degree & type of innovation and the organizational configuration have been discussed, the organizational performance is the last element in the figure of Tidd (see figure 3A). To measure the performance, the conceptual framework of De Weerd-Nederhof et al. (2005) will be used. De Weerd-Nederhof et al. state that the configuration of the NPD function in terms of strategy, structure, and climate influences the primary NPD process and the performance of the NPD function.

The performance of the NPD function can be measured in both objective and subjective measures. Objective measures are often preferred for their reliability, but they are always accompanied by a time lag [De Weerd-Nederhof et al., 2005; citing Kerssens-Van Drongelen, 1999], this means that the NPD performance can only be measured afterwards. A second point is that such an NPD performance indicator does not provide any insight in the strengths and weaknesses of the NPD function, but is only an overall measurement tool. The use of subjective measurement scales allows comparisons across organizations on the basis of individual assessment [Song and Parry, 1997], despite such a performance measurement is influenced by the different type of characters of the respondents.

The performance of the biotechnology organizations can be measured in terms of *operational effectiveness* and *strategic flexibility* [De Weerd-Nederhof et al., 2005]. *operational effectiveness* refers to the effectiveness of today's work: the degree to which NPD processes contribute to realising the innovation goals set by the organization. *Strategic flexibility* refers to adapt to, anticipate or create future NPD performance requirements [De Weerd-Nederhof, 1998]. *Strategic flexibility* can be seen as a prerequisite for future *operational effectiveness*. The operationalization of both performance dimensions is based on the work of Brown and Eisenhardt (1995). Brown and Eisenhardt distinguish *product concept effectiveness* (further divided in *fit with market needs* and *fit with firm competences*) and *process performance* (further divided in *speed* and *productivity*). De Weerd-Nederhof (1998) added *process flexibility* as a third variable of *process performance*, and called the elaborated *process performance NPD process effectiveness*. Pullen (2006) visualized the performance measurement of De Weerd-Nederhof in figure 3E:

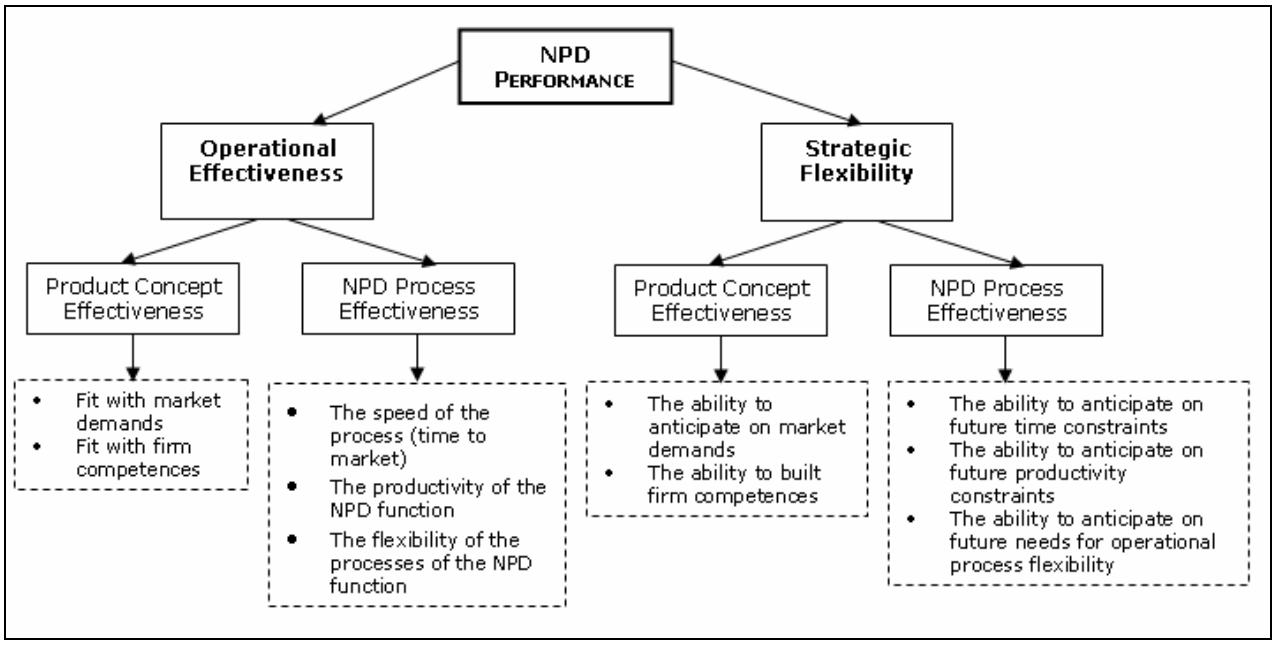


Figure 3E: NPD performance measurements

It will be interesting to compare the individual scores on the variables of product concept effectiveness (fit with market demands, fit with firm competences, and anticipating on both in the future) and NPD process effectiveness (speed, productivity, process flexibility, and anticipating on both in the future). Which variables are the strengths of an organization and which variables are the weaknesses of an organization?

The biotechnology sector is expected to be an emerging sector with a high percentage radical innovation, an organic structure, an open and promotive climate, a long term oriented NPD strategy, a separate approach for radical and incremental innovation, and heterogeneous networks. This implies that organizations primarily focus on Product Concept Effectiveness in stead of NPD process effectiveness. Therefore, it is expected that the performance on Product Concept Effectiveness is higher than on NPD Process Effectiveness. It is expected that the organizational configuration of the NPD function, which has an organic structure, a low formalization degree, an open, promotive climate, and a long-term oriented strategy, will lead to a relative low NPD Process Effectiveness. Speed, productivity, and in a lesser extent the process flexibility, as well in terms of operational effectiveness as in terms of strategic flexibility, are expected not to be the strongest elements of biotechnology organizations. The biotechnology organizations will perform best on the fit with market demands and the fit with firm competences as well in terms of Operational Effectiveness as in terms of Strategic Flexibility.

Besides the difference in performance between Product Concept Effectiveness and NPD Process Effectiveness, the combination of exploration and exploitation in the biotechnology sector and the concerned facilitation influences the current and future viability. Exploration (radical innovation) activities are related to future performance and viability [Isobe et al., 2004] and radical innovations play an important role in building competitive advantage and contribute significantly to a firm's growth and profitability [Veryzer Jr., 1998]. It is expected that a high percentage radical innovation leads to a high score on strategic flexibility, organizations in the Dutch and Belgian biotechnology sector are better able to anticipate on future developments.

Therefore the propositions about performance are formulated as follows:

Proposition 4a: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a higher performance on Product Concept Effectiveness than on NPD Process Effectiveness.

Proposition 4b: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a high Strategic Flexibility on Product Concept Effectiveness.

3.5 Propositions

The central question in this report, as stated in chapter two is formulated as follows: *How do organizations in the Dutch and Belgian biotechnology sector shape their internal*

organizational configuration and their external network to facilitate a balance between exploration and exploitation which ensures their current and future viability?

Ten propositions, which will be tested in the next chapters to answer this central question, are formulated as follows:

Proposition 1a: *Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their employees to NPD than organizations in non-biotechnology sectors.*

Proposition 1b: *Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their NPD activities to radial innovation than organizations in non-biotechnology sectors.*

Proposition 2a: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a long-term oriented NPD strategy.*

Proposition 2b: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a predominately organic structure and a low formalization degree.*

Proposition 2c: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a more open, promotive climate.*

Proposition 2d: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a combination of a long-term oriented NPD strategy, a predominately organic structure, a low formalization degree and a more open, promotive climate.*

Proposition 2e: *Organizations in the Dutch and Belgian biotechnology sector make use of separate approaches for radical and incremental innovations.*

Proposition 3: *Organizations in the Dutch and Belgian biotechnology sector make use of heterogeneous collaboration agreements to balance exploration and exploitation.*

Proposition 4a: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a higher performance on Product Concept Effectiveness than on NPD Process Effectiveness.*

Proposition 4b: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a high Strategic Flexibility on Product Concept Effectiveness.*

Propositions 1a and 1b reflect the relation between the environment and the balance between exploration and exploitation. Propositions 2a, 2b, 2c, 2d, and 2e reflect the relation between the combination of exploration and exploitation and the internal facilitation. Proposition 3 reflects the relation between the combination of exploration and exploitation and the external network. Propositions 4a and 4b reflect the relation between the combination of exploration and exploitation, the facilitation of this combination and the performance. Together these propositions will analyse all four elements of the central question; the balance between exploration and exploitation, the internal facilitation, the external facilitation and the current and future viability.

Chapter 4: The Research Methodology

In the former chapter the literature which will be used for this study is described and propositions are stated based on this literature. This chapter will provide information about the data set (paragraph 4.1) and will elaborate on the methodology (paragraph 4.2) which will be used to analyse the propositions.

4.1 The data set

This paragraph will elaborate on the research topic, the selection of the biotechnology organizations, the sample of the biotechnology organizations, the patterns in NPD database, and the general aspects of the organizations in the dataset.

4.1.1 Research Topic

This study is part of the research project *'Patterns in New Product Development: consistent NPD configurations for sustained innovation'*. "Patterns in NPD" is an emergent European research project aimed at developing knowledge in the new product development area, by describing, exploring and analyzing the organization of the innovation journey. The project is based on the assumption that an in-depth, holistic understanding of the relationships between NPD purposes and activities, organization and situational factors, and its impact on performance, will contribute to the identification of consistent configurations in NPD. The project sets out to describe a large number and variety of NPD configurations in relation to their environment and purposes (functions), and relate these to performance. To collect empirical data on the different organizational and NPD aspects the project makes use of a questionnaire. This questionnaire contains, among other things, questions about the organizational aspects, the NPD strategy, the NPD structure, the NPD climate and the NPD performance. One of the areas which has not been analyzed is the Dutch and Belgian biotechnology sector. As described in chapter two, the biotechnology sector is highly emerging, which makes this sector unique and therefore very valuable for the Patterns in NPD research project. The NPD questionnaire can be used to answer the first, second, and fourth research questions as stated in paragraph 2.3.

4.1.2 Selection biotechnology organizations

As described in the former paragraph the patterns in NPD database does not contain Dutch or Belgian biotechnology organizations. To identify which organizations are active in the biotechnology sector the European Patent Office (EPO) database is used, because this database enables the identification of biotechnology organizations based on the IPC classes from the World Intellectual Property Organization (WIPO). This selection will ensure a pre-selection of biotechnology organizations only.

The IPC classes A23C, A23J, A61K, C12Q, C12M, C12N, C12P, C12R, C12S, C07H, C07J, C07K and C07G are defined by O&O Statistieken (K.U. Leuven) as being biotechnology classes and are used to select organizations active in biotechnology. From the EPO

database 163 Dutch and 59 Belgian organizations were identified. However, the possibility exists that organizations are excluded, since the filing process of a patent application can take over 1,5 year and not every biotechnology organization has filed a patent. Therefore websites of biotechnology associations are used to extend the dataset. The Dutch Chamber of Commerce (Kamer van Koophandel) database can not be used, since none distinct group or sub-group is identified within this database as being biotechnology organizations. From websites of biotechnology associations, 15 Dutch and 8 Belgian organizations are identified. The total number of organizations identified in the Netherlands and Belgium together is 245.

4.1.3 Sample of biotechnology organizations

First, the organizations are screened on existence and, if possible, on having more than 5 NPD employees. In the Netherlands 119 organizations remained and in Belgium 46 organizations, which is a total of 165 organizations. These organizations were contacted to ask whether or not they were interested to participate in the survey. In the Netherlands 119 organizations were contacted from which 34 organizations were willing to anticipate. In Belgium 46 organizations were contacted from which 11 organizations were willing to anticipate. The R&D managers (organizations) willing to participate were sent the Patterns in NPD questionnaire (Appendix B). 19 R&D managers (organizations) responded and filled in the questionnaire, which means a response rate of 42 percent was received. Unfortunately two organizations did not have the required 5 employees working in NPD and are therefore not included in this study. The sample total which represents the biotechnology sector in the Netherlands and Belgium is 17; 14 Dutch and 3 Belgian organizations. This is 10,3 percent of the organizations which they represent.

Although the questionnaires contain empirical data about the organizations and their NPD functions, they do not explain the background of the data. Therefore, from the 17 organizations which filled in the questionnaire, 4 organizations are selected for case studies, two organizations which are quite similar and two organizations which are the complete opposite. The case studies will be done through interviewing the R&D managers to enlarge the insight and to come up with possible explanations for the facts found in the analyses.

4.1.4 Patterns in NPD database

The database used in this report (06-06-2006) contains information about 98 organizations from different European countries as: Belgium, Denmark, Spain, the Netherlands, Finland and Turkey. From this database, the Dutch and Belgian organizations which are not active in the biotechnology are selected. These organizations will be compared with the biotechnology organizations. From the 98 organizations which the database (06-06-2006) contains, 23 organizations are Dutch or Belgian non-biotechnology organizations, which all have at least five employees working in NPD. These organizations are active in sectors as: the automotive, lighting, medical supplies, machine building, transport, and electronics.

4.1.5 General aspects

As said before, 17 biotechnology organizations have filled out the questionnaire and a dataset of 23 non-biotechnology organizations will be used for comparison. In this paragraph the general aspects of these organizations are summarized to draw a picture of the dataset.

Size, age and annual sales

To get an impression of the similarities and differences of the dataset the aspects size, age and annual sales are classified.

The size is measured in the total number of employees and is derived from question 6 of the questionnaire (Appendix B). As shown in the table below, the dataset used for this report includes both small and relatively large organizations.

Size	Biotechnology		Non-biotechnology
	Specified	Total	Total
< 25	8, 11, 12, 13	4	1
25 - 100	9, 10, 15, 16	4	11
100 - 1000	1, 2, 6, 14, 17	5	10
> 1000	3, 4, 5, 7	4	1

Table 4.1: Size of the questionnaire organizations

The biotechnology organizations differ more in size than the non-biotechnology organizations, which mainly exists of medium to large sized organizations.

For the age must be taken into account, that the age of the organization will be the age as in the year 2006, for this report is written in this year. The year of establishment is derived from question 4 of the questionnaire (Appendix B). The age distribution within this report is quite equal. Nine organizations are younger than fifteen years of age and eight organizations older, from which five above fifty years of age, as shown in the table below.

Age	Biotechnology		Non-biotechnology
	Specified	Total	Total*
< 5	8, 10, 16	3	2
5 - 15	2, 9, 11, 13, 14, 15	6	4
15 - 50	1, 12	2	8
> 50	3, 4, 5, 6, 7, 17	6	7
*The ages of 2 organizations are not available			

Table 4.2: Age of the questionnaire organizations

As shown in the table, the biotechnology organizations are slightly younger than the non-biotechnology organizations.

The annual sales are measured in millions of Euros and are derived from question 6 of the questionnaire (Appendix B). As shown below; two organizations have relatively high annual sales. The annual sales of the other organizations are distributed quite equal.

Annual sales (mln euro)	Biotechnology		Non-biotechnology
	Specified	Total	Total*
< 10	8, 9, 11, 12, 13, 16	6	5
10 -100	2, 10, 15	3	10
100 - 1000	1, 3, 6, 7, 14, 17	6	7
> 1000	4, 5	2	0
*The annual sales of 1 organization is not available			

Table 4.3: Annual sales of the questionnaire organizations

Although the biotechnology organizations are larger in size and generally younger than the non-biotechnology organizations, the annual sales are generally higher.

In the table below the classifications are summarized to mutual compare the biotechnology organizations.

Class	Size	Age	Annual sales
1	< 25	< 5	< 10
2	25 - 100	5 -15	10 - 100
3	100 - 1000	15 - 50	100 - 1000
4	> 1000	> 50	> 1000

Table 4.4: Classification of Size, Age and Annual sales

In Figure 5E the three general aspects are visualized in a single graph according to the classification used above.

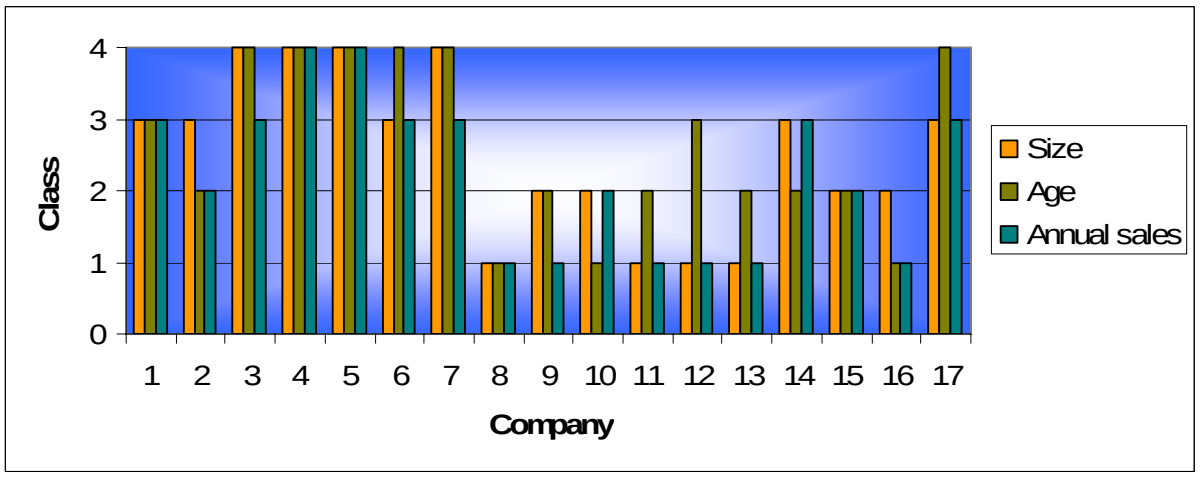
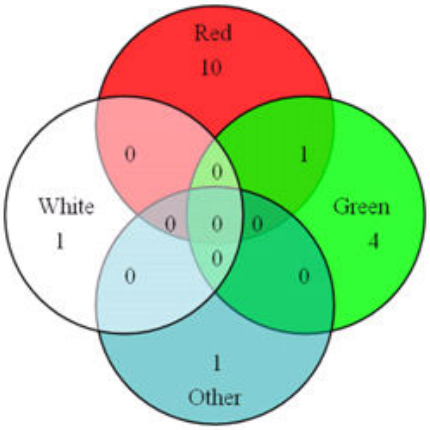


Figure 4A: Size, Age and Annual sales

The figure above shows that for the biotechnology organizations in this dataset size, age and annual sales are quite equally distributed. Larger companies are older and have a higher amount of annual sales. Only organization 12 has stayed relatively small compared to its age. These general aspects show that the dataset used in this report for the biotechnology sector is dispersed, it contains both large as small, and old as young organizations.

Areas of application

The areas of application in which these 17 biotechnology organizations participate are allocated as visualized in the picture below.



Area	Organization
Red	1, 2, 4, 5, 8, 10, 11, 12, 13, 14, 16
Green	2, 3, 7, 15, 17
White	6
Other	9

Figure 4B: Allocation of questionnaire organizations

As shown, most organizations (62%) are active in the *health and diagnostics* area of the biotechnology. In the a*gricultural* area five organizations (26%) are active. Only twelve percent of the organizations are active in the *food* and *others.*

4.2 Research Methodology

In chapter two the model of Tidd (2001) is described, which is the basis used throughout this report. In chapter three, ten propositions were stated based on literature. These propositions are visualized in figure 4C to show the relation with the model. The rest of this chapter will elaborate on the methodologies which will be used to analyse these propositions.

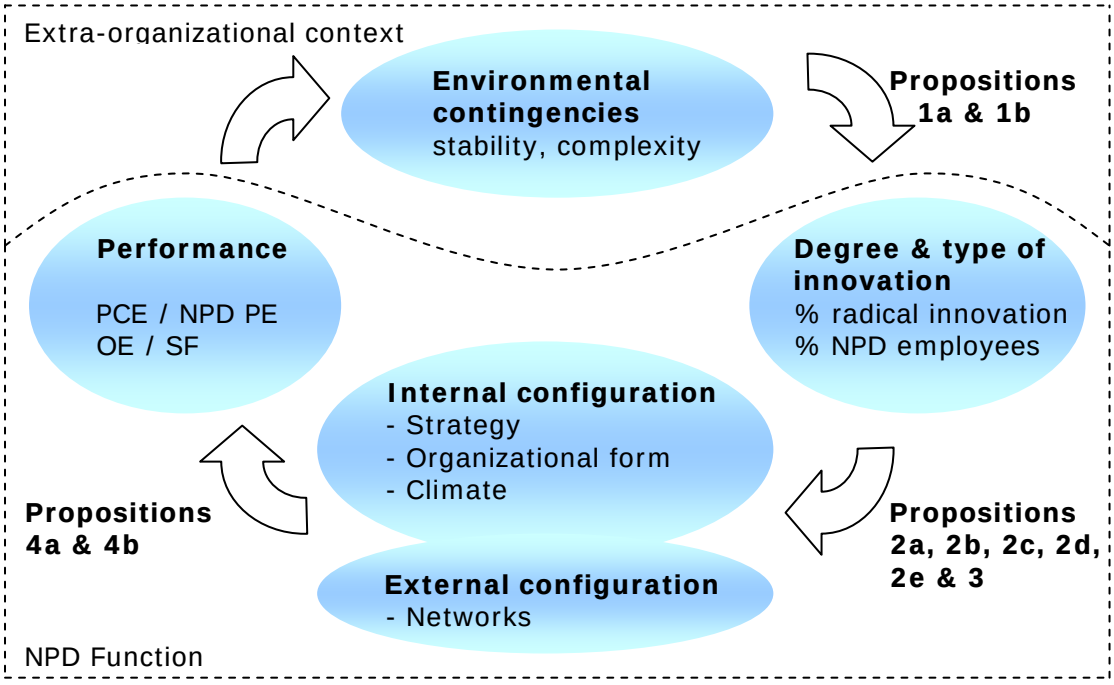


Figure 4C: Model of propositions

4.2.1 Sector analysis methodology

The first and second proposition stated in chapter three will be analysed in chapter five. In the next paragraph, the methods, which will be used, are described.

4.2.1.1 Method for proposition 1a

The first proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their employees to NPD than organizations in non-biotechnology sectors.* To analyse this proposition, the percentage NPD employees must be known.

The percentage of employees working in NPD can be derived by dividing the number of employees working in NPD by the total number of employees. The total number of employees is derived from question 6, see appendix B. The number of employees working in NPD is derived from question 19, see appendix B. The percentage NPD employees can be calculated with the following formula:

$$\text{Percentage NPD employees} = \frac{\text{Number of employees working in NPD}}{\text{Total number of employees}} \cdot 100\%$$

The proposition will be tested using an independent sample T-test, with a 95% confidence interval, in which the organizations in the biotechnology are compared with the non-biotechnology organizations from the Patterns in NPD database. The test will be one tailed since the expectation is that in the biotechnology sector the percentage NPD employees is higher than in the non-biotechnology sectors.

4.2.1.2 Method for proposition 1b

The second proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their NPD activities to radial innovation than organizations in non-biotechnology sectors.* To analyse this proposition the percentage radical innovation must be known.

The percentage radical innovation as part of the total innovative activity can be derived from question 16 in the questionnaire, see appendix B. The proposition will be tested using an independent sample T-test, with a 95% confidence interval, in which the organizations in the biotechnology are compared with the non-biotechnology organizations from the Patterns in NPD database. The test will be one tailed since the expectation is that in the biotechnology sector the percentage radical innovation is higher than in the non-biotechnology sectors.

4.2.2 Internal organization analysis methodology

The third until the seventh proposition stated in chapter three will be analysed in chapter six. In this paragraph the methods, which will be used, are described.

4.2.2.1 Method for proposition 2a

This paragraph will describe the method which will be used to analyse the proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a long-term oriented NPD strategy.*

The goal of the NPD strategy is operationalized in four statements which are derived from question 31 of the questionnaire. The first question focuses on long-term growth versus short term profit. The second question focuses on risky outcomes versus predictable outcomes, the third on creating breakthrough new products versus incremental new products and the last question focuses on long-term versus short-term performance of the NPD function. From these four questions the average is calculated by using the following formula: $\bar{x} = n^{-1}\sum_{i=1}^{n} x_i$. A final ranking of 1 indicates a pure long term orientation and a final ranking of 7 indicates a pure short term orientation. To check whether or not there is a relation between the percentage radical innovation and the orientation of the NPD strategy a bivarate analysis will be performed. The analysis will be one-tailed since the expectations are that a high percentage radical innovation is associated with a long-term oriented NPD strategy.

4.2.2.2 Method for proposition 2b

This paragraph will describe the method which will be used to analyse the proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a predominately organic structure and a low formalization degree.*

Organizational structures can hardly be defined as pure organic or pure mechanistic. As described in the definition of both types, the organizational structure can be divided in some different elements as rules and regulations, teamwork, span of control, etc. The organizational structure can contain both organic and mechanistic elements; therefore the structure will be ranked on a scale from 1 to 7 (where 1 means a pure mechanistic structure while 7 means a pure organic structure). The ranking is derived from question 35a. The final score will be derived from the score on nine different characteristics of the organizational structure by using this formula: $\bar{x} = n^{-1}\sum_{i=1}^{n} x_i$. The degree of formalization of the NPD process is determined by questions 25 and 26 which both discriminate 6 development processes, question 25 for incremental innovations and question 26 for radical innovation. A ranking of 1 means that no standard approach is applicable and a ranking of 6 means a formally documented approach is used. To check whether or not there is a relation between the percentage radical innovation and the structure or the formalization degree two bivarate analyses will be performed. The analyses will be one-tailed since the expectations are that a high percentage radical innovation is associated with an predominately organic structure or a low formalization degree.

4.2.2.3 Method for proposition 2c

This paragraph will describe the method which will be used to analyse the proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a more open, promotive climate.*

The ranking on climate is derived from questions 37 and 38. Both questions consist of 9 statements which represent the dimensions of Ekvall (1997). An open, promotive climate is an organizational climate which scores high on the nine dimensions of Ekvall, except for dimension 6 (conflict), see paragraph 3.2.3. Question 37 represents the overall climate and question 38 represents the radical climate. For radical innovations, when compared with incremental innovations, risk taking, freedom and debates are more dominant present in the organizational climate. The dimensions of the organizational climate are measured by nine statements. The respondent has to indicate the level of agreement for each statement regarding to the overall innovative climate and –if radical innovation is separated from incremental innovation- the radical NPD climate. The ranking on climate will be calculated by using the formula: $\overline{x} = n^{-1}\sum_{i=1}^{n} x_i$, the scores on questions 37f and 38f will not be part of the analysis, because this variable is not positively associated with a higher innovation performance. To check whether or not there is a relation between the percentage radical innovation and the orientation of the NPD strategy a bivarate analysis will be performed. The analysis will be one-tailed since the expectations are that a high percentage radical innovation is associated with a more open and promotive climate.

4.2.2.4 Method for proposition 2d

This paragraph will describe the method which will be used to analyse the proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a combination of a long-term oriented NPD strategy, a predominately organic structure, a low formalization degree and a more open, promotive climate.*

In the former three propositions the NPD strategy, the organizational form and the NPD climate are separately associated with the percentage radical innovation. This proposition will test whether there is a combination of these three aspects present within the Dutch and Belgian biotechnology organizations. Therefore the data of propositions 2a, 2b, and 2c, about the percentage radical innovation, the NPD strategy, the structure, the NPD climate and the formalization degree will be presented in one figure. This will be performed for the facilitation of both radical and incremental innovation. The visualization of these five elements in one figure will show whether there is a pattern recognizable or not.

4.2.2.5 Method for proposition 2e

This paragraph will describe the method which will be used to analyse the proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector make use of separate approaches for radical and incremental innovations.*

Within the questionnaire ambidexterity is expressed in three aspects; the formalization of the NPD process, the NPD team structure and the NPD climate. The formalization of the NPD process is expressed in question 25, where a distinction is made between a business unit's incremental development processes and its radical development processes. The NPD team structure is expressed in question 36, where a distinction is made between a structure for incremental innovation and for radical innovation. The NPD climate is expressed in question 37 where a distinction is made between the overall innovative climate and the radical innovation climate.

4.2.3 Network analysis methodology

In this paragraph the method will be described to analyse the proposition stated in chapter three. The proposition will be analysed in chapter seven.

4.2.3.1 Method for proposition 3

The proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector make use of heterogeneous collaboration agreements to balance exploration and exploitation.*

The collaboration agreements will be measured by the number of co-patents filed at the EPO. Therefore the patent database of the K.U. Leuven will be used. Only co-patents with a biotechnology classification as described in paragraph 4.1 will be used in the analysis. This will give a first impression of the extent collaboration. Websites will be used for additional analysis of collaboration, since not all collaboration agreements will end up in a co-patent. The heterogeneity of the collaboration will be determined by the type of partner. This can be a university, institute, organization, government or individuals. When organizations collaborate with different partners as mentioned above, their network will be defined as being heterogeneous.

4.2.4 Performance analysis methodology

In this paragraph the methods will be described to analyse the last propositions stated in chapter three. The propositions will be analysed in chapter eight.

4.2.4.1 Method for proposition 4a

The proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a higher performance on Product Concept Effectiveness than on NPD Process Effectiveness.*

The performance is measured by two variables as mentioned in chapter three. The first variable is the product concept effectiveness. This variable is further divided in four indicators, which can be found in table 4.5. The operationalization is based on theories of scholars named in table 4.5.

Product Concept Effectiveness	*Fit with market demands*	Customer satisfaction, Timeliness, Product price, Quality [Chiesa *et al.*, 1996] Sales and profit impact [Brentani; de and Kleinschmidt, 2004]
	Anticipating market demands	Product-market options [Johnson *et al.*, 2003] Windows of opportunity [Brentani; de and Kleinschmidt, 2004] Proactive market orientation [Narver *et al.*, 2004]
	Fit with firm competencies	R&D/Manufacturing Integration [Swink, 1999; Yam *et al.*, 2004] R&D/Marketing Integration [Leenders and Wierenga, 2002]
	Building competencies	Acquisition of resources [Kessler *et al.*, 2000] Deployment of resources (integrate, apply knowledge) [Yam *et al.*, 2004]

Table 4.5: Operationalization of the Product Concept Effectiveness

The performance of the first indicator will be derived from question 20a – 20f, the second indicator from question 20g – 20l, the third indicator from question 21a – 21f, and the fourth from 21g – 21l. The average score on each indicator will be calculated using the following formula: $\bar{x} = n^{-1}\sum_{i=1}^{n} x_i$. The score on PCE is equal to the average of the scores of all four indicators. The second variable is the NPD process effectiveness. This variable is further divided as shown in table 4.6. The operationalization is based on theories of scholars named in table 4.6.

Development Process Effectiveness	*Speed*	Speed relative to schedule [Kessler and Bierly, 2002] Development Time (DT), Concept to Customer Time (CTC), Total Time (TT) [Griffin, 1997] The speed and commitment of the NPD decision-making process [Griffin and Page, 1993]
	Anticipating time constraints	Anticipating Total Time (TT) [Griffin, 1997] Anticipating the speed and commitment of the NPD decision-making process [Griffin and Page, 1993]
	Productivity/ cost	Possibility for lower development budget [Iansiti, 1993] Cost relative to budget, competitors [Kessler and Bierly, 2002] Engineering hours, cost of materials, cost of tooling [Clark and Wheelwright, 1993]
	Anticipating productivity constraints	Anticipating cost relative to budget, competitors [Kessler and Bierly, 2002] Anticipating engineering hours, cost of materials, cost of tooling [Clark and Wheelwright, 1993]
	NPD Process Flexibility	Average time and cost of redesign, enhancement [Chiesa *et al.*, 1996; Thomke, 1997] The ability to change specs late [Thomke, 1997]
	Anticipating on the need for NPD process flexibility	Anticipating average time and cost of redesign [Thomke, 1997] Anticipating on changes in specs [Thomke, 1997]

Table 4.6: Operationalization of the NPD process Effectiveness

The performance of the first indicator will be derived from question 22a – 22f, the second indicator from question 22g – 22l, the third indicator from question 23a – 23e, the fourth

indicator from 23f – 23j, the fifth indicator from question 24a – 24f, and the sixth indicator from question 24g – 24l. The average score on each indicator will be calculated using the following formula: $\bar{x} = n^{-1}\sum_{i=1}^{n} x_i$. The score on the NPD PE is equal to the average of the scores of all six indicators. The proposition will be tested using an independent sample T-test, with a 95% confidence interval, in which the scores on PCE are compared with the scores on NPD PE. The test will be one tailed since the expectation is that in the score on PCE is higher than the score on NPD PE. Besides the sample T-test, the strengths and weaknesses of the organizations in the Dutch and Belgian biotechnology sector will be visualized. The method for the strength and weakness analysis is described in Appendix E6.

4.2.4.2 Method for proposition 4b

The proposition as stated in chapter three: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a high strategic flexibility on product concept effectiveness.*

To determine the strategic flexibility on PCE, the data gathered for proposition 4a is used. The average scores on 20g – 20l and 21g – 21l together will form determine the strategic flexibility score. The score on strategic flexibility will be related to the percentage radical innovation by using a correlation analysis.

4.2.5 Method for case studies

The case studies will be done to enlarge the insight and come up with possible explanations for the results of the analyses which will be performed in chapters 5, 6, 7, and 8. For the case studies the R&D managers from the organizations 7, 10, 13, and 17 are interviewed and their questionnaires are analysed. Two similar organizations (7 and 17) are compared, to analyse if these organizations, which are in exact the same market segment and which have the same product range, make use of the same or a different approach of new product development. Furthermore, two extreme different organizations (10 and 13) are compared to analyse which motives or factors are of influence on their new product development function.

Chapter 5: Sector Analysis

This study describes exploration and exploitation in the biotechnology sector. From reports and articles the impression is received that the biotechnology sector is subject to a high degree of change. Recent studies on the biotechnology industry seem to agree on the fact that there have been, […], fundamental changes at the sector level [Nooteboom, 2005]. The sector is characterized by a high and growing number of patent applications [OECD report, 2005], a growing number of companies being active [Ernst & Young, 2005], and a growing number of registered new products [Health Science, 2003; Ernst & Young, 2005]. This chapter describes the biotechnology sector and the influence of the biotechnology sector on the organizations within this sector. The first paragraph will elaborate on the context in terms of the history, definition, areas of application, trends, the future, and biotechnology in the Netherlands and Belgium in specific. The analysis of the first proposition is described in paragraph 5.2, the second proposition in paragraph 5.3. In paragraph 5.4, biotechnology organizations will be compared with non-biotechnology organizations in terms of radical innovations as part of the sales. In paragraph 5.5 the dataset is grouped according to the percentage radical innovation. In the next paragraph, 5.6, possible explanations for differences between the organizations in the biotechnology sector and organizations in non-biotechnology sectors in terms of the percentage radical innovation will be analysed. In paragraph 5.7, four case studies will be described; two similar organizations and two extreme different organizations. In the last paragraph, 5.8, the conclusions of this chapter will be provided based on the analyses done in this chapter.

5.1 Context

First the history will be described, followed by the definition of biotechnology and the areas of application. Next the trends and the future will be defined. Last the biotechnology in the Netherlands and Belgium will be described.

5.1.1 History

Biotechnology is as old as mankind, but despite the long history, the term biotechnology first appeared in Yorkshire early in the 20th century. The *Bureau of Biotechnology* began as a consultant laboratory providing advisory services in chemistry and microbiology to fermentation industries in the north of England. In 1923, Dr. Thomas Kennedy Walker welcomed the first students into his Department of Fermentation Industries, possibly the first of its kind, in what is now the University of Manchester Institute of Science and Technology. Later the departmental name was changed to Industrial Biochemistry, which is about the same as *biotechnology*. The graduated students of Professor Walker advanced to senior positions in food, pharmaceutical and related bio-industries in countries all over the world. Through the years biotechnology has transformed from empiricism (study through observation) into science. In the beginning of the early 1970's biotechnology took a great flight forward with the first gene being cloned. In 1976, a group of scientists formed Genentech, the first specialised bioscience organization to

exploit rDNA research. From 1981 the number of specialists in biosciences companies all over the world grew explosively.

5.1.2 Definition

In this report the definition of Joseph H. Hulse (2003), as mentioned in paragraph 2.1, will be used: *Biotechnologies are processes that seek to preserve or transform biological materials of animal, vegetable, microbial or viral origin into products of commercial, economic, social and/or hygienic utility and value.*

5.1.3 Areas of application

The domain study of biotechnology based on publications and patents carried out by Steunpunt O&O Statistieken of the K.U. Leuven provides insight in the biotechnology research area. As mentioned in paragraph 2.1 the biotechnology can be divided into the following four fields:

- Food biotechnology (FB), referred to as *white* biotechnology
- Health and Diagnostics (HD), referred to as *red* biotechnology
- Agriculture, Animal, Plant and Microbiology (AM), referred to as *green* biotechnology
- Other industrial applications (OI)

The Next two figures show the division of patents filed within the field of biotechnology at the European Patent Office (EPO) and the United States Patent and Trademark Office (USPTO).

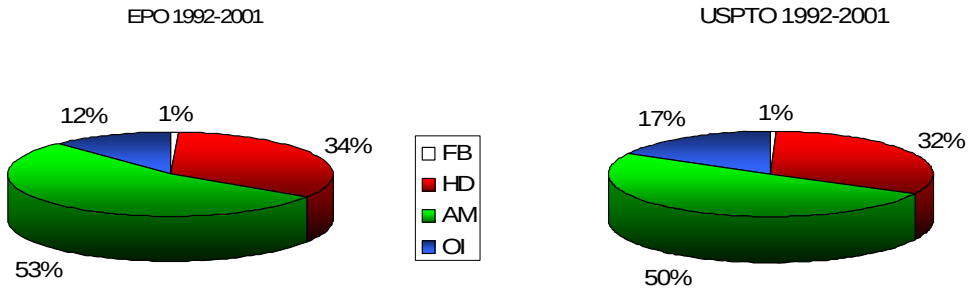


Figure 5A: Distribution of biotechnology patent applications filed at the EPO and USPTO

These figures show the difference between the four areas of applications. Most patents (50-53%) are filed in the field of Agriculture, Animal, Plant and Microbiology followed by the area of Health and Diagnostics (32-34%). Other industrial applications are a relative small area (12-17%) and Food biotechnology is the smallest area with only 1% of all biotechnology patents filed. Belgian patents filed at the EPO correspond with the global trend.

5.1.4 Trends & Future

Biotechnology is a comprehensive term; hundreds of trends can be described here. Each area of application has its own trends and innovations, which are rapidly changing; when this report is being published the trend(s) might be past already. Important innovation activities nowadays are gene therapy, pharmacogenetics, genetic modified food,

nanotechnology, stem cell research, the development of new applications in bio-fuels, bio-plastics and bio-plants, etc. Food and drug industries constantly expand and diversify their product portfolio to satisfy demands of the expanding population.

Biotechnology in the future is promising; within the next years biotechnology will lead to many new and useful applications of products such as medicines against diseases which are currently incurable, food which prevents diseases, and crops being able to grow in unfavourable circumstances (Niaba; Dutch Biotech Industry Association, 2005). The most promising field is genomics, but also a lot is being expected from the integration of biosciences with developments in three other technology areas: informatics, nano-technology and material science. The rapid succession of radical breakthroughs in the pharmaceutical industry, in which the share of biotechnology related products is high, will continue.

5.1.5 Biotechnology in the Netherlands and Belgium

The biotechnology sector in the Netherlands and Belgium is influenced by many actors. The most important types of actors are: Organizations, Institutes, Universities, Sector Associations (Brancheverenigingen), Consultants, Governmental departments (Ministeries), Councils (Raden), and Labour Unions (Vakverenigingen).

The areas of application, described in paragraph 5.1.3, in which the biotechnology patents are filed, are shown in the next figures.

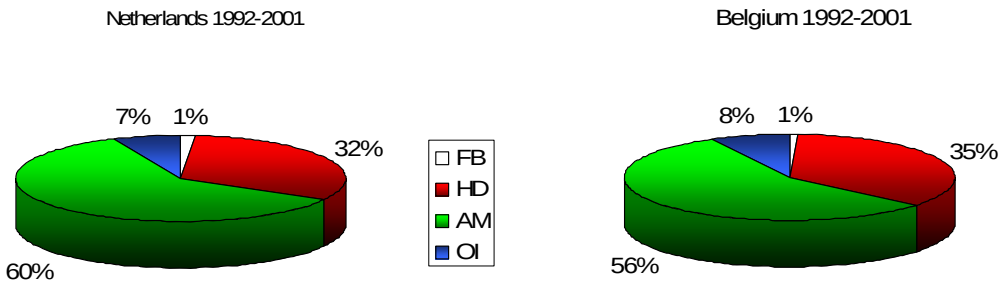


Figure 5B: Distribution of biotechnology patent applications filed by Dutch and Belgian organizations.

Comparing these figures with the figures in paragraph 5.1.3, shows that the Agriculture, Animal, Plant and Microbiology area (AM) is larger and the Other industrial applications area (OI) is smaller.

Besides the areas of application, the filed patents can be categorized by ownership. A distinction is made in patents owned by companies, university hospital, public institutes, non-university hospitals and a rest group (e.g. persons, unknown holders, etc). The categorization of patents is shown in figure 5C below.

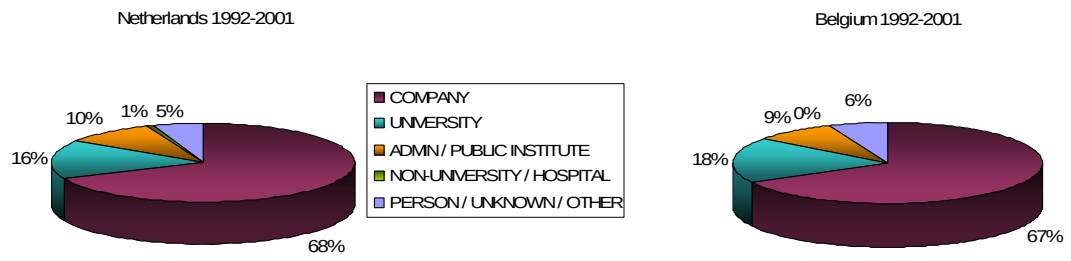


Figure 5C: Dutch and Belgium patents categorized by ownership

The figures show that most patents (67-68%) are owned by a organization, followed by a relative small number of patents filed by universities (16-18%), public institutes (9-10%), unknown holders (5-6%) and only a few patents (0-1%) are filed by non-university hospitals.

Both the figures of the application areas and the figures of ownership show no striking differences between the Netherlands and Belgium.

5.2 Analysis of the degree of innovation

This paragraph is devoted to the first proposition (1a) proposed in chapter three: *Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their employees to NPD than organizations in non-biotechnology sectors.*

As described in chapters two and three, the biotechnology sector can be characterised as a emerging sector which is unstable and dynamic, and therefore differs from other sectors. In this analysis, organizations in the biotechnology sector will be compared with other organizations from the Patterns in NPD database as described in paragraph 4.1.4 and 4.2.1.1.

The percentage NPD employees is obtained by dividing the number of NPD employees by the total number of employees, as described in chapter four. The results are shown in the table below.

Company Number	% NPD
1	24%
2	15%
3	4%
4	25%
5	18%
6	1%
7	29%
8	71%
9	33%

Company Number	% NPD
10	12%
11	42%
12	22%
13	83%
14	100%
15	20%
16	48%
17	6%
Average	36%

Table 5.1: The percentage NPD employees

From the table can be deduced that the average percentage of NPD employees of the biotechnology organizations is high. To check whether this percentage is significantly higher than in non-biotechnology sectors an independent sample T-test is carried out. The biotechnology organizations (17) are compared with the dataset of non-biotechnology organizations (23) from the Patterns in NPD database. The results are shown below.

Independent Samples Test

	Group	N	Mean	SD
Percentage NPD	Biotechnology	17	35,71	28,12
	Non-Biotechnology	23	16,83	18,92

	Mean difference	Sig.
Percentage NPD	18,88	0,012

Table 5.2: Independent Sample T-Test Percentage NPD Employees

The results of the independent sample T-test shown above clearly indicate the difference between the biotechnology sector and the non-biotechnology sectors. The non-biotechnology organizations have a mean of 17% NPD employees, where the biotechnology organizations have 36%, which is a difference of 19%. As shown the significance level in this test is high (0,012). Analysing the data more specifically shows that the peaks in the non-biotechnology dataset are lower; 71, 63, 38, 34, and 28 percent against 100, 83, 60, 48, and 42 percent in the biotechnology dataset. This shows that the non-biotechnology data set contains only three organizations which have a percentage of NPD employees which is higher than the average of the biotechnology data set. The lowest percentages for the non biotechnology data set are: 2, 2, 2, 3, and 5 percent against 1, 4, 12, 15, and 18 percent for the biotechnology organizations. This shows that only four biotechnology organizations have a percentage of NPD employees which is lower than the average of the non-biotechnology organizations. Analysis of the peaks of both groups strengthens the result of the analysis; there is a significant difference between the biotechnology organizations and the non-biotechnology organizations.

Based on the results of the analyses the conclusion can be drawn that the proposition is valid; organizations in the biotechnology sector devote a larger part of their employees to NPD. This signifies that biotechnology organizations have relatively large NPD functions.

5.3 Analysis of the type of innovation

This paragraph is devoted to proposition 1b, proposed in chapter three: *Organizations in the Dutch and Belgian biotechnology sector devote a larger part of their NPD activities to radial innovation than organizations in non-biotechnology sectors.*

As described in chapters two and three, the biotechnology sector can be characterised as an emerging sector which is unstable and dynamic, and therefore differs from other sectors. In the former paragraph is proved that the percentage of NPD employees in the

biotechnology sector is significantly higher than in non-biotechnology sectors. This paragraph elaborates on the allocation of NPD activities within the NPD function. Stated is in the proposition that biotechnology organizations devote a larger part of their NPD activities to radical innovation. Therefore, in this analysis, organizations in the biotechnology sector will be compared with other organizations from the Patterns in NPD database as described in paragraph 4.1.4 and 4.2.1.2 to check whether or not the percentage radical innovation in biotechnology organizations is significantly higher.

The percentage radical innovation, can be obtained directly from the NPD-questionnaire, and represents the part of the innovation activities focussed on radical, breakthrough, new products. In the table below the percentage radical innovation for each organizations is shown.

Company Number	%RAD
1	20%
2	40%
3	5%
4	60%
5	50%
6	20%
7	33%
8	20%
9	5%

Company Number	%RAD
10	5%
11	40%
12	3%
13	90%
14	80%
15	10%
16	20%
17	5%
Average	30%

Table 5.3: The percentage radical innovation

From the table can be deduced that the average percentage of radical innovation is high. To check whether this percentage is significantly higher than in non-biotechnology sectors an independent sample T-test is carried out. The mean of the biotechnology sector is compared with the data set of non-biotechnology organizations from the Patterns in NPD database (23 organizations). The results are shown below.

Independent Samples Test

	Group	N	Mean	SD
Percentage RAD	Biotechnology	17	29,76	26,97
	Non-Biotechnology	23	10,70	10,04

	Mean difference	Sig.
Percentage RAD	19,06	0,002

Table 5.4: Independent Sample T-Test Percentage Radical Innovation

Again, the results of the independent sample T-test shown above clearly indicate the difference between the biotechnology sector and the non-biotechnology sectors. The non-biotechnology organizations have a mean of 11% NPD employees, where the biotechnology organizations have 30%, and again, with a high significance level (0,002).

Analysing the data more specific shows that the peaks in the non-biotechnology data set are lower; 40, 30, 20, 20, and 15 percent against 90, 80, 60, 50 and 40 percent in the

biotechnology data set. This shows that the non-biotechnology data set contains only 2 organizations which have a percentage of radical innovation which is equal to or higher than the average of the biotechnology data set. The lowest percentages for the non biotechnology data set are: 0, 0, 0, 0, and 3 percent against 3, 5, 5, 5, and 5 percent for the biotechnology organizations. This shows that both datasets contain organizations which a low percentage radical innovation. However, the sixth and seventh lowest organizations in the biotechnology data set have respectively 10 and 20 percent radical innovation, which implies that 6 organizations of the biotechnology data set have a percentage radical innovation which is equal to or lower than the average of the non-biotechnology data set. Analysis of the peaks of both groups strengthens the result of the analysis; there is a significant difference between the biotechnology organizations and the non-biotechnology organizations.

Based on the results of these analyses, the conclusion can be drawn that the second proposition is valid; organizations in the biotechnology sector devote a larger part of their NPD activities to radical innovation. This indicates that radical innovations play a more important role in the biotechnology sector than in other (non-biotechnology) sectors.

5.4 Contribution of the NPD function to annual sales

In the former paragraph is concluded that the biotechnology organizations in the dataset have a significant higher percentage NPD employees and focus for a relatively larger extent on radical innovation than organizations which are not active in the biotechnology sector. One way to express the performance of the NPD function is by measuring the percentage sales from products introduced in the last 3-5 years [Chiesa et al., 1996; Tidd, 2001]. As described in chapter four the performance in terms of the contribution of the NPD function to the sales of the last three years, can directly be obtained from question 17 of the questionnaire. Comparing the performance of the organizations within the dataset with organizations in non-biotechnology sectors, will provide a sufficient view whether or not the contribution of the NPD function to the sales is higher, and whether the radical innovations as part of the NPD function is accountable for a higher part of the sales compared to organizations in other sectors. Table 5.9 shows the results of an independent sample T-test, with a 95% confidence interval (one tailed), between organizations in the biotechnology and organizations in non-biotechnology sectors.

Independent Samples Test

	Group	N	Mean	SD
Total NPD	Biotechnology	17	63,24	32,14
	Non-Biotechnology	23	60,17	30,01
Radical innovation	Biotechnology	17	22,12	26,87
	Non-Biotechnology	23	9,44	11,54

	Mean difference	Sig.
Total NPD	3,07	0,380
Radical innovation	12,68	0,025

Table 5.5: SPSS results for independent sample T-test of performance of NPD function

Although there is a significant difference between biotechnology organizations and non-biotechnology organizations in percentage employees working in NPD, as concluded in paragraph 5.4, the contribution of the NPD function to the sales is quite the same. Only a small difference is noticeable; 63% for biotechnology organizations against 60% for non-biotechnology organizations. However, the significance is 0,380, which implies that statistically there is no difference in the contribution of the NPD function to the sales between biotechnology organizations and non-biotechnology organizations.

When dividing the NPD activities into radical and incremental innovations, differences are noticeable. The table above shows that in the biotechnology organizations radical innovation is accountable for 22% of the sales in the past three years, compared to 9% for non-biotechnology organizations. The significance level of 0,025 confirms that the difference between the biotechnology organizations and the non-biotechnology organizations is significant.

From the former the conclusion can be drawn that the outcome of the NPD function in biotechnology organizations and in non-biotechnology organizations are of equal importance, both contributing for around 60% to the sales. However, there is a difference between the types of innovation; for the biotechnology organizations radical innovations are more important because they account for a significant larger part of the annual sales in the past three years compared to the non-biotechnology organizations.

5.5 Grouping of questionnaire organizations

In paragraphs 5.2 and 5.3 is described that there is a significant difference between the biotechnology sector and non-biotechnology sectors in terms of the percentage NPD employees and the percentage radical innovation. Paragraph 5.4 showed that in biotechnology organizations radical innovations account for a significant larger part of the annual sales compared to the non-biotechnology organizations, which indicates that radical innovations are (very) important in the biotechnology sector.

According to the model of Tidd, on which this study is based, the NPD configuration is subject to the degree and type of innovation. As described in paragraph 3.2, the distinction between radical and incremental innovation (or, the percentage radical innovation) will better reflect the balance between exploration and exploitation than the percentage NPD employees. Therefore, to compare the organizations throughout the rest of this report, the organizations are classified according to the percentage radical innovation. The figure below shows a clear distinction between the organizations.

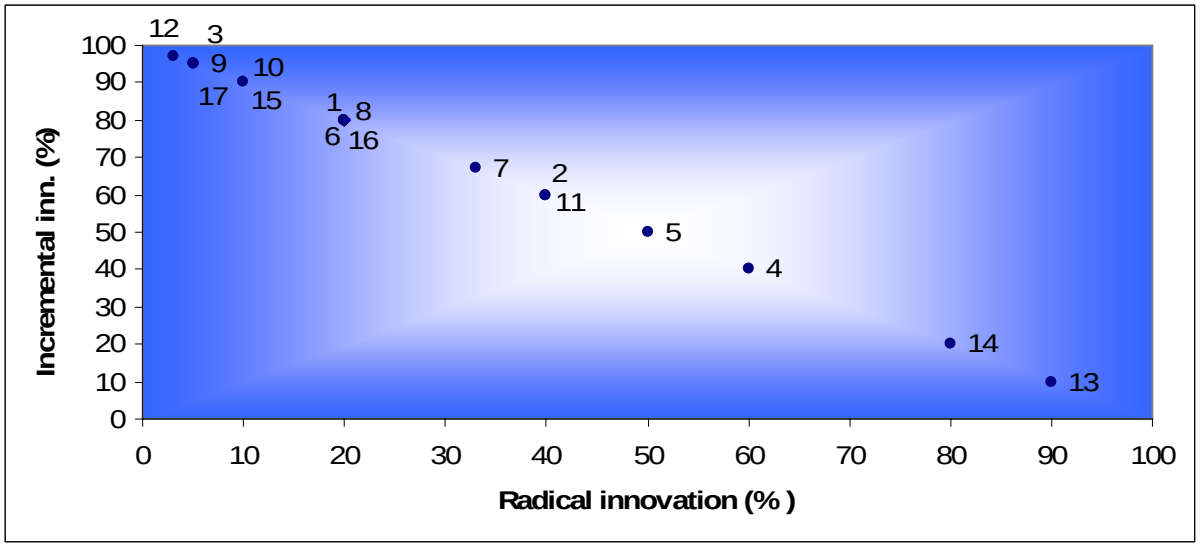


Figure 5D: Radical and Incremental innovation

In the Patterns in NPD questionnaire the activities of the NPD function are divided into three different types of innovation:

- Radical breakthroughs in core products and processes
- Next generation of core product and / or process
- Enhancements, hybrids, and derivatives of core product and or process

In the figure above a distinction between radical and incremental innovation is made, where radical innovation equals *radical breakthroughs in core products and processes* and incremental innovation equals the sum of *next generation of core product and/or process* and *enhancements, hybrids, and derivatives of core product and or process*. In the figure below *radical breakthroughs in core products and processes* are related to *next generation of core products and/or process* to provide a better understanding of the diversity of the organizations within the dataset.

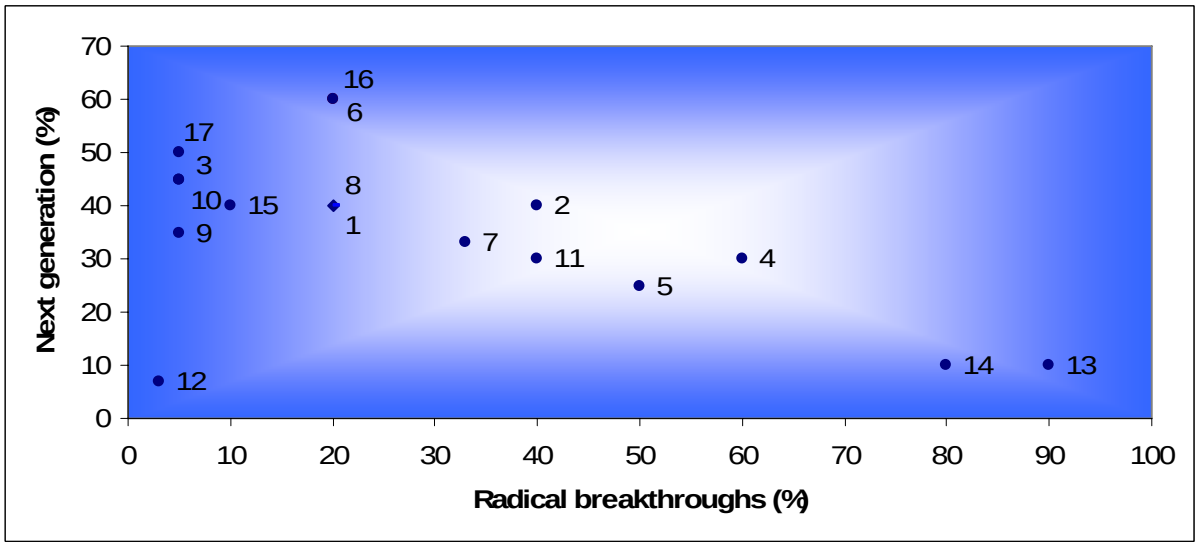


Figure 5E: Radical breakthroughs & Next generation

Based on this figure the organizations are classified into three groups; less than twenty-five percent radical innovation (group A), between twenty-five and seventy-five percent (group B), and higher than seventy-five percent (group C). In the table below the groups are shown based on the percentage radical innovation.

Classification	Company	Radical
> 75% Group A	13	90%
	14	80%
25% - 75% Group B	4	60%
	5	50%
	2	40%
	11	40%
	7	33%
< 25% Group C	1	20%
	6	20%
	8	20%
	16	20%
	15	10%
	3	5%
	9	5%
	10	5%
	17	5%
	12	3%

Table 5.6: Grouping based on radical innovation.

5.6 Explanations for the percentage radical innovation

In paragraphs 5.2 and 5.3 is proved that there is a significant difference between the biotechnology and non-biotechnology sectors in terms of the percentage NPD employees and the percentage radical innovation. In the former paragraph the biotechnology organizations are grouped based on the percentage radical innovation. Although the average percentage of radical innovation is high, there are differences within the sector, as visualized in figures 5D and 5E. This paragraph will elaborate whether the percentage NPD employees, the perceived environmental uncertainty or one of the general aspects (size, age, or annual sales) can be accounted for this difference within the biotechnology sector.

The percentage NPD employees

In paragraph 5.2 is shown that biotechnology organizations have a higher percentage NPD employees than other (non-)biotechnology organizations. To check whether or not there is a correlation within the biotechnology sector between the variables *percentage NPD employees* and *percentage radical innovation* a bivarate analysis is done. The results are shown below.

Bivarate Analysis

Variable	N	Correlation	sig.
Percentage NPD	17	0,555	0,021
Percentage RAD			

Table 5.7: Correlation between percentage NPD and percentage RAD

As shown in the table, the bivarate analysis indicates that there is a correlation (0,555) between the percentage NPD employees and the percentage radical innovation with a significance level of 0,021. This analysis indicates that here is a relation between the two variables, but does not prove whether a higher percentage NPD employees leads to a higher percentage radical innovation or a higher percentage radical innovations leads to a higher percentage NPD employees. For example: When an organization has relatively many NPD employees, the choice for putting more effort in radical innovation seems logical, but on the other hand; when an organization chooses to put relatively much effort in radical innovation, it seems logical that they devote more employees on NPD. In this report both variables are interpreted as being dependent of each other and therefore influence each other.

The perceived environmental uncertainty

As said before, the biotechnology sector is an emerging sector with periods of technological disruption; this causes uncertainty for organizations within the sector (chapter 3). To analyse this, the actual perceived uncertainty measured in the questionnaire is used; questions 13d, e, f, g, and h are used to derive a score on the stable-unstable dimension and questions 23i, j, and k are used for the simple-complex dimension. The results are shown in the figure below.

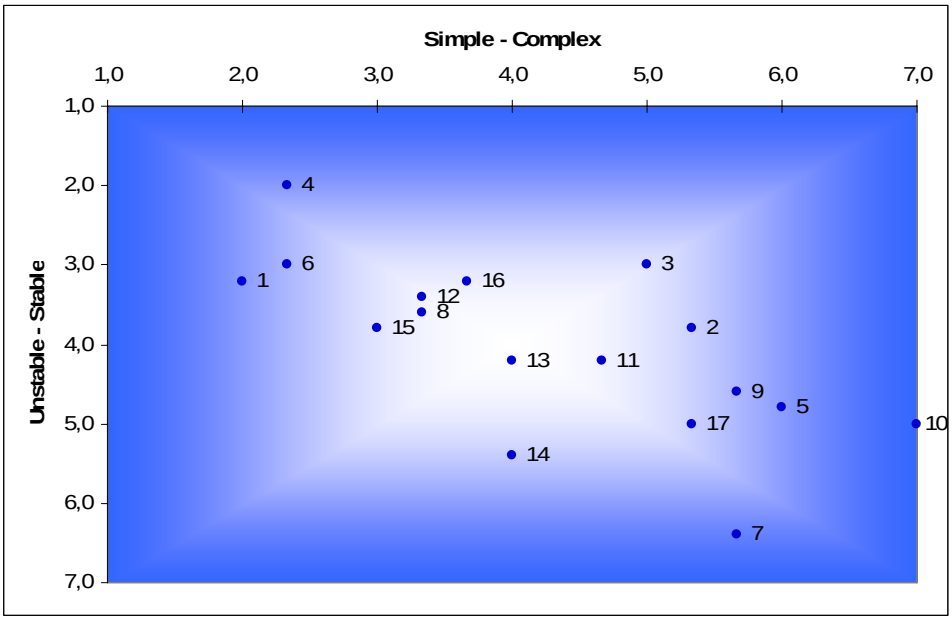


Figure 5F: environmental uncertainty in the biotechnology

To assess the uncertainty, the rankings on the stable-unstable and on the simple-complex dimension are combined (see figure 3E, and table 3.1, chapter 3). From figure 5J can be deducted that only four organizations (4, 9, 10, and 17) of the dataset are not in line with these expectations. The other companies are all in line with the expectations. A linear regression analysis confirms the relation between the two variables. The results are shown below.

Regression Analysis

Variable		N	Beta	sig.
Independent	Environmental uncertainty	17	0,493	0,044
Dependent	Percentage radical innovation			

Table 5.8: Regression environmental uncertainty and percentage radical innovation

The analysis provides a regression beta 0,493 (significance level is 0,044) which entails that the perceived environmental uncertainty is statistically accountable for 49% of the percentage radical innovation.

The General aspects

Next, the general aspects; area of application, size, age and annual sales of the organizations are analysed. The tables must be read as stem and leaf tables.

Classification	Area of application			
	Red	Green	White	Other
> 75% Group A	2	-	-	-
25% - 75% Group B	4	1	-	-
< 25% Group C	5*	4*	1	1

* One organization is involved in both Red and Green Biotechnology

Table 5.9: Grouping and Area of application

Classification	Size			
	< 25	25 - 100	100 - 1000	> 1000
> 75% Group A	1	-	1	-
25% - 75% Group B	1	-	1	3
< 25% Group C	2	4	3	1

Table 5.10: Grouping and Size

Classification	Age			
	< 5	5 -15	15 - 50	> 50
> 75% Group A	-	2	-	-
25% - 75% Group B	-	2	-	3
< 25% Group C	3	2	2	3

Table 5.11: Grouping and Age

Classification	Annual sales			
	< 10	10 - 100	100 - 1000	> 1000
> 75% Group A	1	-	1	-
25% - 75% Group B	1	1	1	2
< 25% Group C	4	2	4	-

Table 5.12: Grouping and annual sales

The first table shows that organizations active in the Red biotechnology are present in every group. The Green biotechnology organizations on the other hand are only active present in group B and C, from which 1 in B and 4 in C. From the other three tables can be noticed that no striking relation is visually present between the percentage radical innovation and one of the general aspects. Linear regression analyses confirm this. The significance levels for the general aspects are 0,085 (area of application), 0,715 (size), 0,960 (age), and 0,931 (annual sales). Since all the significance levels of the general aspects exceed the threshold value of 0,050, which ensures 95% reliability, they are not to be considered of influence on the percentage of radical innovation.

Conclusion

The analyses indicate that the perceived environmental uncertainty is a predictor for the percentage radical innovation. The area of application, the size, age or annual sales are not of influence. A correlation is present between the percentage of NPD employees and the percentage radical innovation, but the percentage of NPD employees is in this report not interpreted as being a predictor for the percentage radical innovation, since the percentage radical innovation could also be a predictor for the percentage of NPD employees.

The perceived environmental uncertainty is accountable for 49% of the percentage radical innovation. Other explanations, as implicated in chapter three, could be the limitation of dependency or restrictions from a parent company, or partners, etc. The case studies in the next paragraph will elaborate on these other possible explanations.

5.7 Case studies

For the case studies the R&D managers from the organizations 7, 10, 13, and 17 are interviewed and their questionnaires are analysed to enlarge the insight and come up with possible explanations for the results of the analyses performed earlier in this chapter.

In the former paragraphs is shown that the biotechnology is different from other (non-biotechnology) sectors in terms of the percentage NPD employees and the percentage radical innovation. Based on these analyses can be concluded that the NPD function and radical innovation in specific play an important role in the biotechnology sector. However, as shown in paragraph 5.5, among the organizations in the biotechnology there are large differences. The case studies are done to enlarge the insight and come up with possible explanations for the degree and type of innovation of the biotechnology organizations.

Two similar organizations (7 and 17) are compared, to analyse why the organizations, which are in exact the same market segment and which have the same product range, choose for a different degree and type of innovation. Furthermore, two extreme different organizations (10 and 13) are compared to analyse which motives or factors are of influence on their degree and type innovation.

5.7.1 Similar cases

An in-depth analysis of the questionnaires of both organizations and interviews with the R&D managers resulted in the cross table below in which an overview is provided of the two organizations.

		Organization	
		7	**17**
General Aspects	**Size (employees)**	> 1000	100 - 1000
	Age (years)	> 50	> 50
	Annual sales (mln Euros)	100 - 1000	100 - 1000
	Area of Application	Green	Green
	Operating countries	40 all over the world	15 all over the world
	Headquarter	Netherlands	Netherlands
NPD Function	**% NPD**	29%	60%
	% Radical innovation	33%	5%
Perceived Environmental Uncertainty	**Simple - Complex**	5,7 (high)	5,3 (high)
	Stable - Unstable	6,4 (high)	5,0 (high)
Explanation Current Situation of the relation between Radical Innovation and the Environment	**Main similarity**	High varying customer demand	
	Main differences	Limited competition	Many competitors
		Prospector	Analyser
View on Future	**Innovation**	Radical innovation most important	Incremental innovation most important
	Restrictions / Problems	General accaptance is low Government restrictions Patents limit innovation	

Table 5.13: Crosstable CH5: Similar Cases

The cross table shows that the organizations make use of a different degree and type of innovation. The main reason for both organizations to spend this amount of effort on the NPD function is to retain (and increase) their market position. According to the managers several factors are of influence on the degree and type of innovation, which are:

- The organizational strategy
- High varying customer demand
- The level of competition
- Society does not widely support the radical innovations (genetic manipulation)
- Restrictions of the government
- Patents are 'hot', everybody files patent applications, which restricts radical innovations.

The first factor, the NPD strategy, is an internal factor, which is mainly derived from, or influenced by, the organizations as a whole. All other factors are environmental factors, which are to a large extent similar for both organizations. The level of competition is

different; according to the manager of organization 7, only the larger organizations are their direct competitors, which make their organization one of the leading firms in the business. Although the limited number of competitors, they are operating in a market which is rapid changing and in which customer demand varies widely. The manager of organization 17 identifies smaller organizations, active in their environment, as their direct competitors.

Although the strategy and the environmental factors are of influence on the degree and type of innovation, the difference in perception of the manager on these aspects is probably of equal or more importance, since it is the manager who makes the decisions. This difference in perception expresses itself in the current situation but also in the views on the future; the manager of organization 17 believes that the future customer demand can be fulfilled with enhancements in the current product portfolio, or in other words; incremental innovation, whereas the manager of organization 7 believes that radical innovation is the key to future success.

The former indicates that not only the environmental factors are of influence on the NPD function, because for both organizations these environmental factors are to a large extent similar, but also the perception of the R&D manager about these environmental factors and the organizational strategy are important. Supplementary information about the analysis of the two organizations is provided in appendix C.

5.7.2 Extreme different cases

An in-depth analysis of the questionnaires of both organizations and interviews with the R&D managers resulted in the cross table below in which an overview is provided of the two organizations.

		Organization	
		10	**13**
General Aspects	**Size (employees)**	25 - 100	< 25
	Age (years)	< 5	5 - 15
	Annual sales (mln Euros)	10 - 100	< 10
	Area of Application	Red	Red
	Orientation	International	International
	Headquarter	USA	Netherlands
NPD Function	**% NPD**	12%	83%
	% Radical innovation	5%	90%
Perceived Environmental Uncertainty	**Simple - Complex**	7,0 (high)	4,0 (Moderate)
	Stable - Unstable	5,0 (high)	4,2 (high)
Explanation Current Situation of the relation between Radical Innovation and the Environment	**Main differences**	Limited competition	No competition
		Analyser strategy	Prospector strategy
		Focus on exploitation	Focus on exploration
		Strategy and type of innovation defined by parent company	Exploitation to please investors
View on Future	**Innovation**	Radical innovation very important	Radical innovation most important
	Restrictions / Problems	Rules defined by the parent company	Wants and demands of investors
			Financial certainty

Table 5.14: Crosstable CH5: Extreme Cases

The cross table shows that the organizations make use of an extreme different degree and type of innovation; organization 10 is currently exploiting its current products as much as possible, where organization 13 only focuses on the initial phase of the development of radical new products and leaves the rest of the development process to other (larger) organizations. Despite this distinction, the organizations are quite similar on other aspects; both are active in the 'red' biotechnology, relatively young, and small in size. The R&D managers mention several factors being of influence on the configuration of the NPD function:

- The organizational strategy
- Investors
- Personnel
- Science level
- Restrictions by the parent company

According to the managers the organizational strategy determines the basic degree and type of innovations, which is further fine tuned by other factors as investors, personnel and science level. Organization 10 is part of a larger company which determines, based on their organizational strategy, the degree and type of innovation of organization 10. Or in other words: Indirect the organizational strategy of the parent company is determinative for the degree and type of innovation of organization 10's NPD function. Managers of both organizations 10 and 13 want to spend more effort on radical innovation, and see this as important aspects for the future. However, organization 10 is restricted by the parent company and organization 13 by its investors, who want short term revenues, which are created with incremental innovations.

The former indicates that the perception of the R&D managers about the environment is of importance for future development of the NPD function; however the current configuration is mainly determined by the organizational strategy. Supplementary information about the analysis of the two organizations is provided in appendix C.

5.8 Conclusion

This chapter elaborates on specific aspects of the biotechnology sector. In the first part the biotechnology sector is described; the biotechnology is emerging, the sector is relatively new and four areas can be distinguished; food, health and diagnostics, agriculture and others. According to the European Patent Office database, agriculture is the largest area (50-53%) and health and diagnostics (32-35%) the second largest. The future seems promising since many ideas and products are still in an early stage of development, indicated by the amount of patent applications which are filed the last years.

The analysis of the first proposition clearly indicated a significant difference between the biotechnology sector and the non-biotechnology sectors. Organizations in the biotechnology have a higher percentage of NPD employees, 36% against 17%, which indicates that their NPD functions are relatively larger. The analysis of the second

proposition indicates a significant difference between the percentage radical innovation of biotechnology and non-biotechnology organizations; 30% against 11%, which means that organizations in the biotechnology sector devote a larger part of their NPD activities to radical innovation. This indicates that radical innovations play a more important role in the biotechnology sector than in other (non-biotechnology) sectors.

The large amount of effort which biotechnology organizations put in radical innovation expresses itself in the sales of the last three years. Although biotechnology organizations have significantly larger NPD units compared to non-biotechnology organizations, the total contribution of the NPD function to the sales is equal for biotechnology organizations and non-biotechnology organizations. However, the distribution of the contribution of the NPD function to the sales is significantly different; 22 percent of the sales of biotechnology organizations are generated by radical innovations against 9 percent in non-biotechnology organizations.

Grouping of the organization in the dataset based on the percentage radical innovation and subsequently analysing the possible explanations for these differences showed that the difference in percentage radical innovation between biotechnology organizations can partly (49%) be explained by the perceived environmental uncertainty. The area of application, the size, age or annual sales are not of influence. A correlation is present between the percentage NPD employees and the percentage radical innovation, but the percentage NPD employees is in this report not interpreted as being a predictor for the percentage radical innovation, since the percentage radical innovation could also be a predictor for the percentage of NPD employees.

The case studies show that there are multiple explanations for the degree and type of innovation and the percentage radical innovation in specific. The organizational strategy, environmental factors and the difference in perception of the managers about the environment are of influence on the degree and type of innovation. The current degree and type of innovation are mainly determined by the organizational strategy. Although the R&D managers have some influence on it, they are pushed into one direction by their environment; competitors, customers, investors and parent companies all influence the organizations. The perception of the R&D managers about these environmental factors mainly determines the future development of the NPD configuration. The struggle between exploration and exploitation is, according to three out of the four interviewed managers, a relevant and difficult issue.

Chapter 6: Internal analysis

This chapter will focus on the relation between the percentage radical innovation and the internal NPD organization in terms of strategy, organizational form (organizational type, structure and degree of formalization), climate and ambidexterity. In the first paragraph the percentage radical innovation will be related to the NPD-strategy, in the second paragraph the organizational form will be discussed, followed by a description of the NPD climate in the third paragraph. In the fourth paragraph is searched for a pattern between radical innovation and a combination of strategy, organizational form and climate. The fifth paragraph elaborates on whether or not the organizations use a different approach for radical innovations compared to incremental innovations. In the sixth paragraph the analysis will be elaborated by two case-studies. This chapter will finish with a conclusion on the results found in the first six paragraphs.

6.1 NPD Strategy

In this paragraph proposition 2a about the NPD strategy will be tested. This proposition is stated as follows: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a long-term oriented NPD strategy.*

The answers on the four statements, as mentioned in paragraph 4.2.2.1, are given in the table D1.1 of Appendix D1. Table D1.2 gives the descriptive statistics of the data, the Cronbach Alpha is 0,777. The scores on the NPD-strategy questions must be related to the percentage radical innovation. This is shown in table 6.1.

Classification	Company	Strategy	Radical
> 75% Group A	13	1,25	90%
	14	1,75	80%
25% - 75% Group B	4	2,25	60%
	5	2,50	50%
	2	4,00	40%
	11	2,75	40%
	7	2,75	33%
< 25% Group C	1	3,50	20%
	6	4,25	20%
	8	5,00	20%
	16	4,00	20%
	15	4,50	10%
	3	6,00	5%
	9	4,00	5%
	10	6,25	5%
	17	2,50	5%
	12	5,00	3%

Table 6.1: NPD-strategy vs. Percentage radical innovation

A first look at the results shows that there is indeed a relation between the percentage radical innovation and the NPD strategy. This is visualized within the next figure.

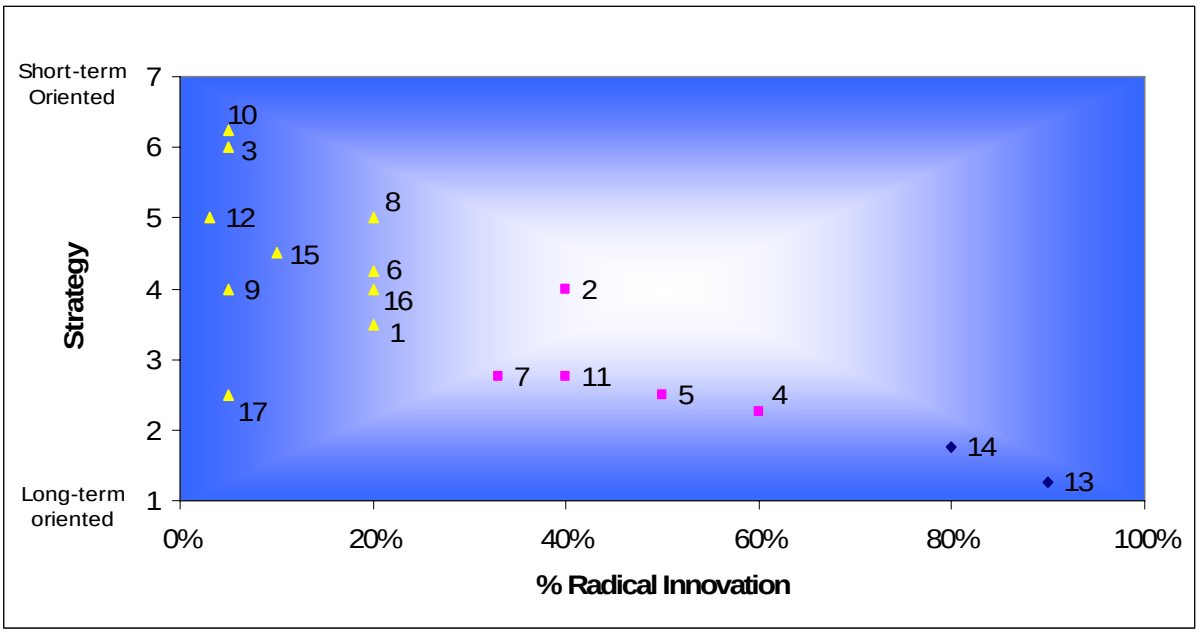


Figure 6A: NPD-strategy vs. Percentage radical innovation

Figure 6A provides a view of the current situation. A score of 1 stands for a long term oriented NPD strategy and a score of 7 stands for a short term oriented NPD strategy. The figure shows a clear difference between the three groups of organizations. The NPD-strategies of the organizations in Group A have a more long term orientation than those in Group B. The NPD-strategies of organizations in Group C have a more short term orientation compared to those of Group B. The table below shows the results of a bivarate analysis between the NPD strategy and the percentage radical innovation.

Bivarate Analysis

Variable	N	Correlation	sig.
NPD Strategy	17	0,792	0,000
Percentage RAD			

Table 6.2: Correlation between the NPD Strategy and percentage RAD

Although the dataset consists of only seventeen organizations, there is a significant correlation of 0,792 between the NPD-strategy and the percentage radical innovation. There is no correlation found with neither age nor size (both provided in chapter four) of the NPD function, see tables D4.1 and D4.2 of appendix D4. This means that, irrespective the age of the organization and the size of the NPD function (number of employees working in NPD), organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a long-term oriented NPD strategy and a high percentage incremental innovation with a short-term oriented NPD strategy.

6.2 Organizational Form

In this paragraph proposition 2b about the organizational form will be tested, this proposition is stated as follows: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a predominately organic structure and a low formalization degree.*

6.2.1 Organic vs. Mechanistic

The results on the questions about the NPD structure are given in table D2.1 of Appendix D2. The Cronbach Alpha of the questions is 0,871. Unfortunately, three respondents did not fill in the questions about the organizational form. These scores on the NPD-structure are related with the percentage radical innovation, which is presented in the table below.

Classification	Company	Radical	Structure	Size NPD
> 75% Group A	13	90%	6,89	10 - 20
	14	80%	5,11	> 200
25% - 75% Group B	4	60%	N.A.	> 200
	5	50%	N.A.	> 200
	2	40%	2,44	10 - 20
	11	40%	4,56	< 10
	7	33%	5,33	> 200
< 25% Group C	1	20%	4,11	50 - 200
	6	20%	5,56	< 10
	8	20%	5,56	< 10
	16	20%	5,89	10 - 20
	15	10%	5,11	< 10
	3	5%	N.A.	50 - 200
	9	5%	4,11	10 - 20
	10	5%	4,89	< 10
	17	5%	4,00	> 200
	12	3%	5,56	< 10

Table 6.3: NPD Structure related with the percentage radical innovation

The average of the scores is 4,94 with a standard deviation of 1,06. This means that organizations in the biotechnology sector work with a more organic structure, which seems to be in line with the theory that organizations in an emerging sector as the biotechnology sector need a predominantly organic structure to facilitate radical innovations. The table below shows the results of a bivarate analysis between the NPD structure and the percentage radical innovation.

Bivarate Analysis

Variable	N	Correlation	sig.
Structure	14	0,291	0,314
Percentage RAD			

Table 6.4: Correlation between the Structure and percentage RAD

The bivarate analysis shows that there is no significant correlation between the NPD structure and the percentage radical innovation. Furthermore, the relation is visualized in figure 6B. The organizations in biotechnology sector are all working with a predominately organic structure. The two organizations with the highest percentage radical innovation use very organic structures. Organic structures seem to be a condition for biotechnology organizations in order to stay competitive. Organization 2 is the only exception to this; their organizational structure has a predominantly mechanistic form and this is not due to the size of the NPD function. Between 10 and 20 employees are working within the NPD function. Furthermore there are three organizations in the biotechnology sector which have a score around 4,00, which means that their NPD structures have both organic and mechanistic characteristics.

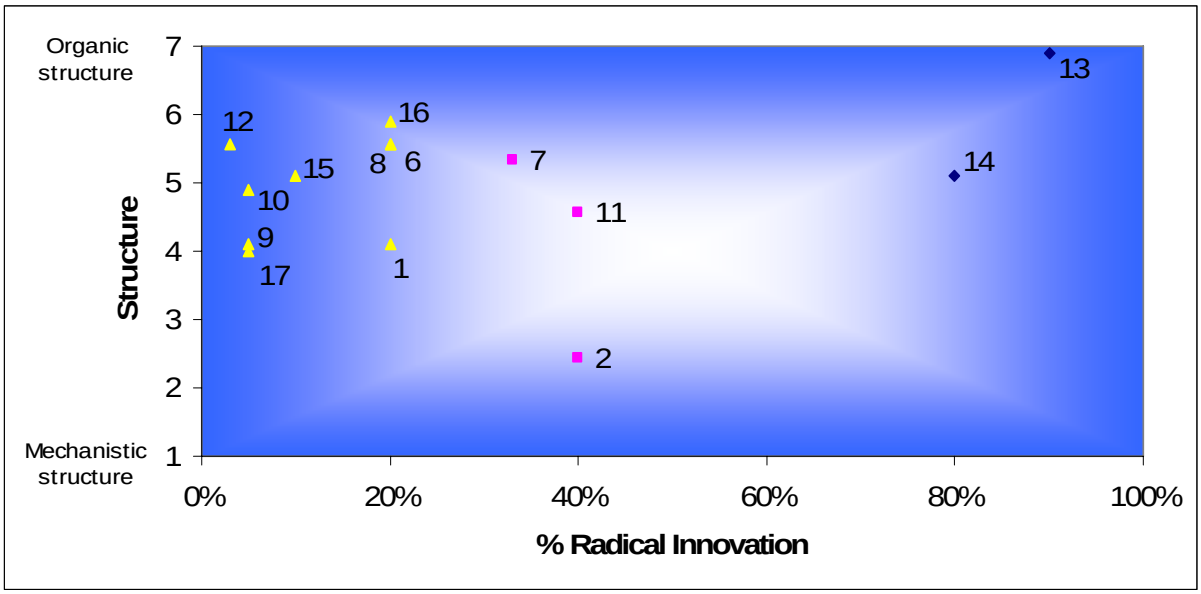


Figure 6B: Type of structure versus Radical Breakthroughs as percentage of all innovations

Burns and Stalker (1961), state that an organic structure may not be adequate for larger organizations. No correlation has been found in this data set between the size nor the age of the NPD function and the structure of the NPD function, see tables D4.3 and D4.4 of appendix D4. The four organizations with a less predominately organic structure have both large and small NPD functions. There is also no correlation between age of the organization and the structure of the NPD function.

6.2.2 Formalization Degree

The results on the degree of formalization of the NPD process are presented in table 6.5. A score of one means that there is no standard approach used for new product

development, a score of six stands for a high formalization degree; there is a formally-documented process.

Classification	Company	% Radical	Radical	Incremental	Size NPD
> 75% Group A	13	90%	2	2	10 - 20
	14	80%	4	4	> 200
25% - 75% Group B	4	60%	N.A.	1	> 200
	5	50%	N.A.	N.A.	> 200
	2	40%	1	1	10 - 20
	11	40%	1	2	< 10
	7	33%	1	6	> 200
< 25% Group C	1	20%	4	4	50 - 200
	6	20%	2	3	< 10
	8	20%	5	4	< 10
	16	20%	2	2	10 - 20
	15	10%	1	1	< 10
	3	5%	1	3	50 - 200
	9	5%	5	5	10 - 20
	10	5%	6	6	< 10
	17	5%	1	1	> 200
	12	3%	5	5	< 10

Table 6.5: The formalization degree in the biotechnology sector

Two bivarate analyses are performed to check whether or not there is a correlation between the percentage radical innovation and the formalization degree for radical/incremental innovation. The results are shown below.

Bivarate Analysis

Variable	N	Correlation	sig.
Formalization degree RAD	15	0,169	0,546
Percentage RAD			

Table 6.6: Correlation between the Formalization degree RAD and the percentage RAD

Bivarate Analysis

Variable	N	Correlation	sig.
Formalization degree INC	16	0,256	0,339
Percentage RAD			

Table 6.7: Correlation between the Formalization degree INC and the percentage RAD

Both tables show a high significance which indicates that statistically there is no correlation present. The formalization degree is widely dispersed which is visualized in figure 6C. According to Ettlie et al. (1984) a high formalization degree has a positive influence on the innovation performance of large organizations. However there is no pattern recognizable between the formalization degree and the number of employees working at the NPD department nor the age of the NPD department, see tables D4.5,

D4.6, D4.7 and D4.8 of appendix D4. The statement that a higher number of employees is positively associated with a higher formalization degree of the NPD process is not valid for this dataset of biotechnology organizations.

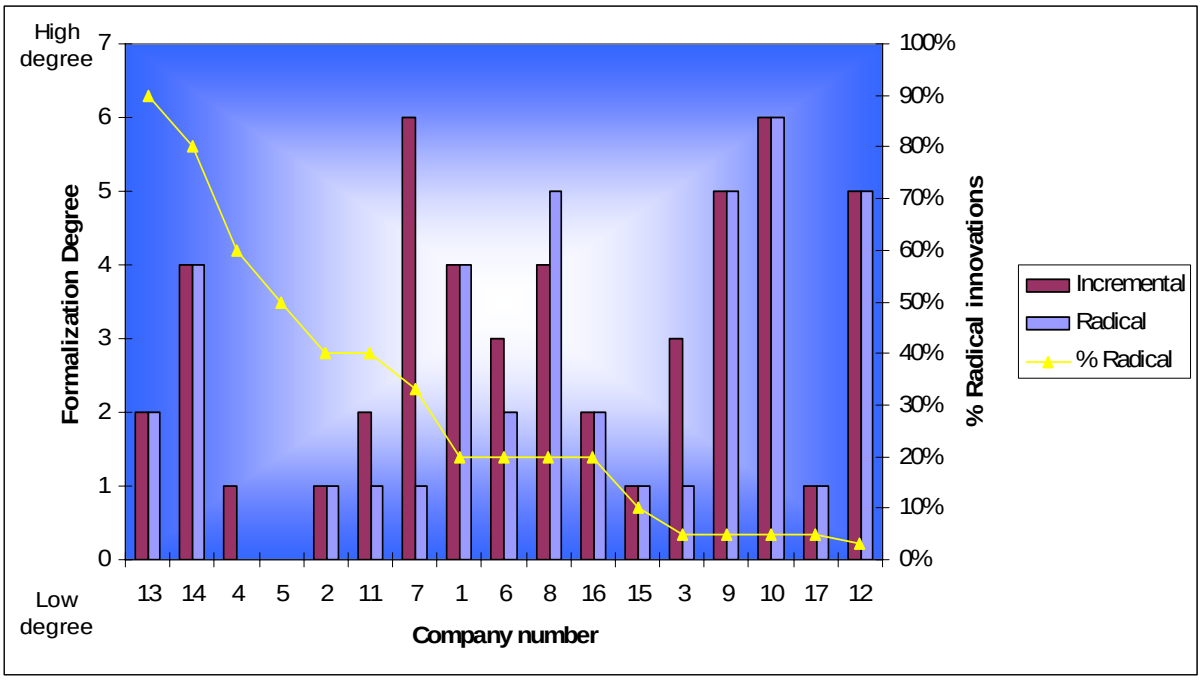


Figure 6C: Degree of formalization at the biotechnology organizations

Organizations in the Dutch and Belgian biotechnology sector are working with a predominately organic structure irrespective of the percentage radical innovation, size of the NPD function and age. The formalization degree is widely dispersed in the Dutch and Belgian biotechnology sector. No pattern can be recognized between formalization degree and the percentage radical innovation, size of the NPD function and age.

6.3 NPD Climate

In this paragraph the proposition about the NPD climate will be tested. The proposition is stated as follows: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a more open, promotive climate.*

The nine aspects of the climate are operationalized in nine questions, as described in the methodology, chapter four. The answers on the nine questions are given in table D3.1 in Appendix D3. These results represent the overall innovative NPD climate. Only those eight dimensions which have a positive relation with the innovativeness of the organization are represented here; the level of conflict (dimension F) has been left out of this table, because this dimension has a negative influence on the innovation performance (see the theory in chapter three). A score of 7 stands for a fully open, promotive climate, an outstanding foundation for being highly innovative. The mean averages and the standard deviations of the eight items of the overall innovative climate are shown in table D3.2 in Appendix D3, the Cronbach Alpha is 0,901. The average

scores are shown in table 6.8. Only four organizations have a score of four or lower on the overall NPD climate, these organizations are highlighted.

Classification	Company	Radical	Climate
> 75% Group A	13	90%	6,57
	14	80%	5,43
25% - 75% Group B	4	60%	4,71
	5	50%	5,43
	2	40%	3,86
	11	40%	5,71
	7	33%	6,14
< 25% Group C	1	20%	6,29
	6	20%	5,43
	8	20%	6,86
	16	20%	5,86
	15	10%	4,86
	3	5%	2,86
	9	5%	4,00
	10	5%	3,71
	17	5%	5,43
	12	3%	5,00

Table 6.8: Organizational climate vs. % Radical innovation

The scores on the dimensions of the NPD overall innovation climate must be related to the percentage radical innovation. The results of a bivarate analysis are shown in the table below.

Bivarate Analysis

Variable	N	Correlation	sig.
NPD Climate	17	0,370	0,143
Percentage RAD			

Table 6.9: Correlation between the NPD Climate and percentage RAD

As shown in the table, the significance level is too high to statistically prove a correlation between the NPD climate and the percentage radical innovation. Furthermore, the scores are visualized in figure 6D. According to the theory described in chapter three, it is expected that a higher percentage radical innovation must be facilitated with a more open, promotive organizational climate. The figure does not show a linear pattern between the overall innovative climate and the percentage radical innovation, but only four out of the seventeen companies score a four or lower on organizational climate. Three of these companies belong to group C and spend only five percent of their NPD activities on radical innovations. The only 'outsider' is organization 2, which spends 40 percent of their NPD activities on radical innovation, but their organizational climate is not very open and promotive, they score a 3,86 on organizational climate. The cause of this can be found in the fact that during the measurement, the organization was involved

in an important change. The organization was transforming from a service provider into a production company.

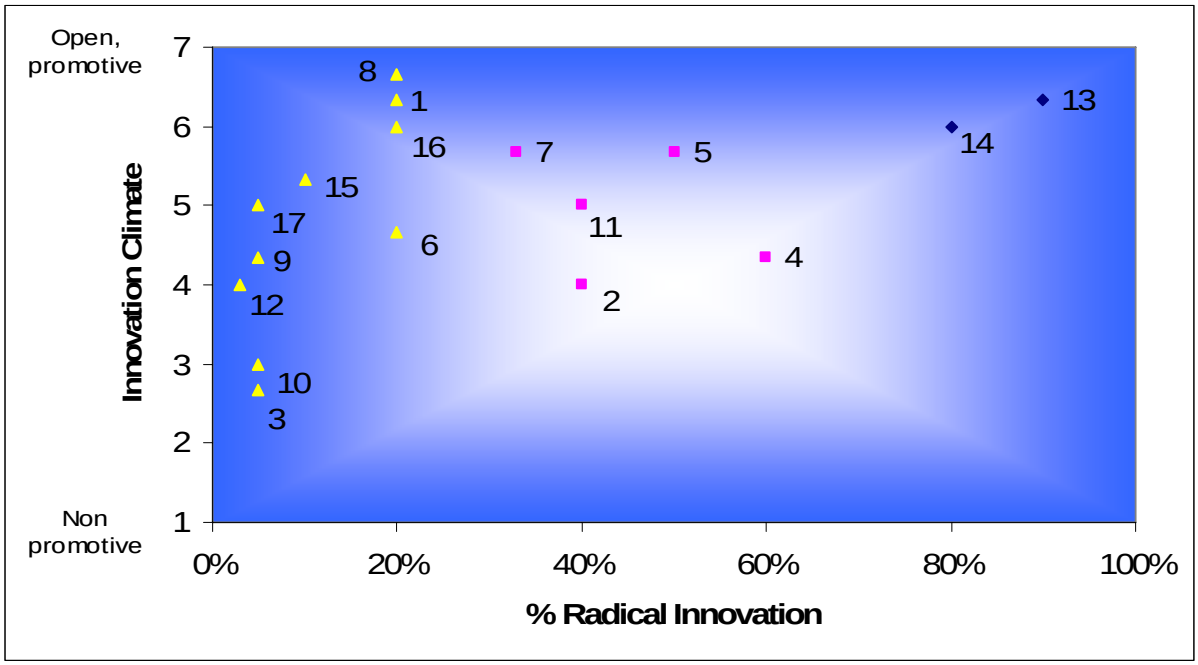


Figure 6D: the overall organizational climate vs. the percentage radical innovation

Again no correlation found between the NPD climate and the size of the NPD function and age of the organization, see tables D4.9 and D4.10 in appendix D4. Irrespective of NPD size, age and the percentage radical innovation, organizations in the Dutch and Belgian biotechnology sector are working with an open, promotive climate.

6.4 Combination of NPD strategy, organizational form and NPD climate

In this paragraph the next proposition will be tested: *Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a combination of a long-term oriented NPD strategy, a predominately organic structure, a low formalization degree and a more open, promotive climate.*

The proposition about the combination of elements assumes a pattern in the facilitation of the NPD function. Therefore the results of the first three paragraphs are visualized in table 6.5. The table represents the scores on strategy, structure (mechanistic vs organic), formalization degree (radical and incremental), and climate of the seventeen Dutch and Belgian biotechnology organizations. Divergent values are highlighted. There is a clear relation between the NPD strategy and the percentage radical innovation, a high percentage radical innovation means a long-term oriented NPD strategy. But there is hardly a correlation between the percentage radical innovation, the organizational form and the NPD climate. As stated before, irrespective of the percentage radical innovation, the size of the NPD function and the age of the organization, almost all organizations work with a predominately organic structure and an open, promotive climate. The degree

of formalization is widely dispersed and there is no relation found with size, age, percentage radical innovation, strategy, structure and climate.

Classification	Company	Radical	Strategy	mechanistic - organic	formalization degree (Rad-Inc)	overall NPD climate
> 75% Group A	13	90%	1,25	6,89	2 - 2	6,57
	14	80%	1,75	5,11	4 - 4	5,43
25% - 75% Group B	4	60%	2,25	N.A.	NA - 1	4,71
	5	50%	2,50	N.A.	NA	5,43
	2	40%	4,00	2,44	1 - 1	3,86
	11	40%	2,75	4,56	1 - 2	5,71
	7	33%	2,75	5,33	1 - 6	6,14
< 25% Group C	1	20%	3,50	4,11	4 - 4	6,29
	6	20%	4,25	5,56	2 - 3	5,43
	8	20%	5,00	5,56	5 - 4	6,86
	16	20%	4,00	5,89	2 - 2	5,86
	15	10%	4,50	5,11	1 - 1	4,86
	3	5%	6,00	N.A.	1 - 3	2,86
	9	5%	4,00	4,11	5 - 5	4,00
	10	5%	6,25	4,89	6 - 6	3,71
	17	5%	2,50	4,00	1 - 1	5,43
	12	3%	5,00	5,56	5 - 5	5,00

Table 6.10: Scores on strategy, organizational form and climate

The question arises if there is a pattern recognizable between strategy, organizational form and climate. This is hardly the case within the biotechnology sector: The NPD strategy is related to the percentage radical innovation, the formalization degree is widely dispersed, and almost all organizations work with a predominately organic structure and an open, promotive climate. The following two figures reflect this conclusion. In figure 6E the combination of the percentage radical innovation, the NPD strategy, the structure, the NPD climate and the formalization degree for incremental innovations are visualized.

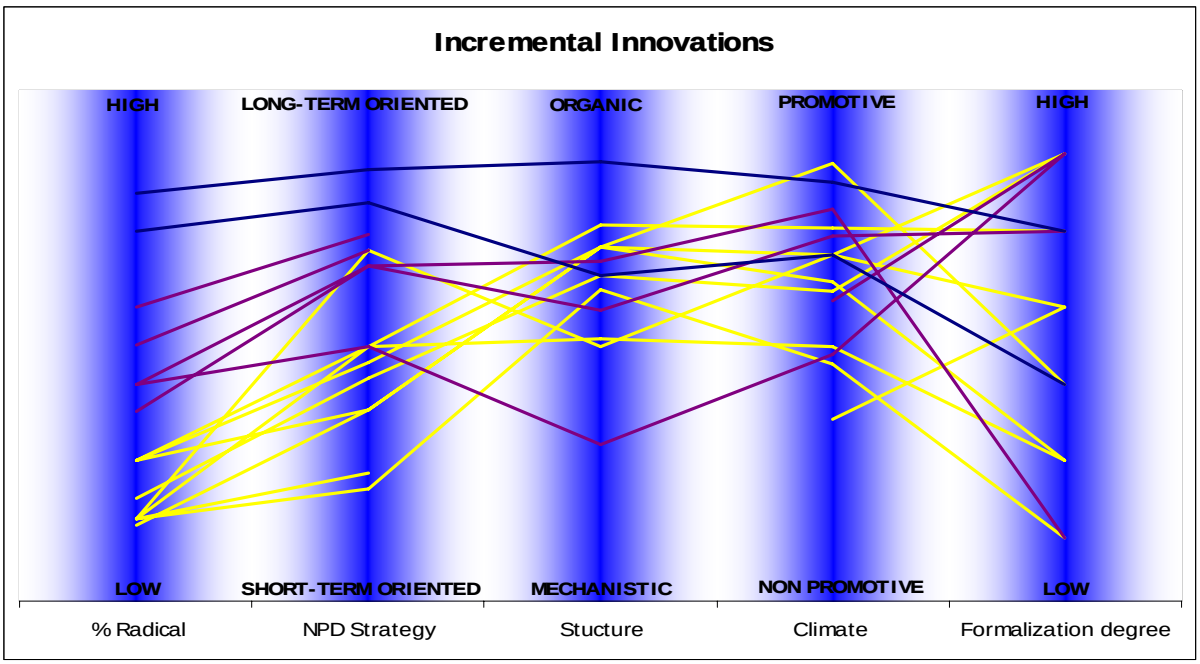


Figure 6E: The combination for Incremental Innovations

The figure above shows the obvious relation between the percentage radical innovation and the NPD strategy. Furthermore, the figure shows that almost all organizations make use of a predominantly organic structure. As shown the NPD climate is within most organizations open and promotive. The formalization degree however is widely dispersed.

In figure 6F the combination of the percentage radical innovation, the NPD strategy, the structure, the NPD climate and the formalization degree for radical innovations are visualized.

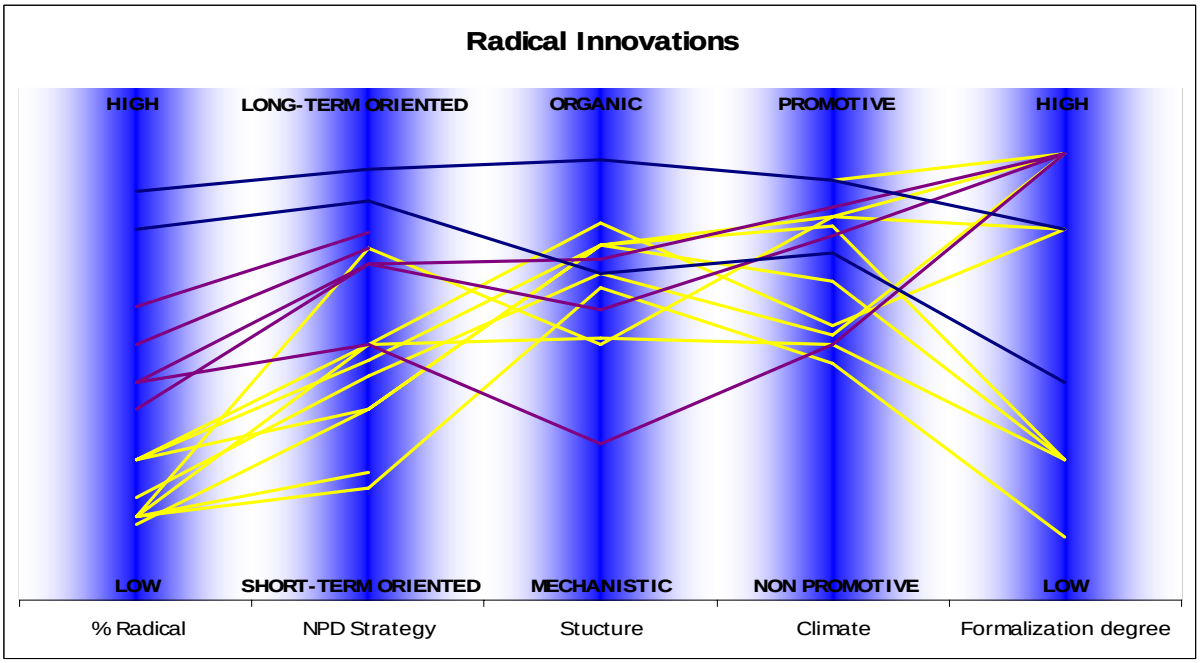


Figure 6F: The combination for Radical Innovations

The percentage radical innovation, the NPD strategy and the structure are equal to figure 6E because these are the same for the whole NPD function. However the NPD climate and the formalization degree for radical innovation differ. Compared to the former figure the NPD climates of the organizations are less dispersed, but a difference with the former figure is not noticeable. The formalization degree is dispersed differently compared to the first figure, but not less dispersed.

Based on the two figures above the conclusion which can be drawn is that within biotechnology organizations a strong correlation between the percentage radical innovation and the NPD strategy is present, the organizations make use of a predominantly organic structure and a more open and promotive NPD climate regardless of the percentage radical innovation, and the formalization degree is widely dispersed for incremental innovations as well as radical innovations.

6.5 Ambidexterity

In the former four paragraphs the internal facilitation of the combination between radical and incremental innovation is described. Interesting is that some organizations make use of a different approach for radical innovation compared to incremental innovation, so called ambidexterity. Tushman and O'Reilly (2004) argue that when it comes to launching breakthrough products, ambidextrous organizations are significantly more successful than other structures. In this paragraph the next proposition will be tested: *Organizations in the Dutch and Belgian biotechnology sector make use of separate approaches for radical and incremental innovations.*

Within the questionnaire ambidexterity is expressed in three aspects; the formalization of the NPD process, the NPD team structure and the NPD climate. This paragraph elaborates on whether or not the organizations make a distinction between radial innovation and incremental innovation in terms of these three aspects.

6.5.1 Formalization degree

The next table gives the formalization degree for both radical and incremental innovations. Four of the seventeen companies (highlighted in orange) have a lower formalization degree for radical innovation than for incremental innovation, which is in line with the theory in chapter three. Remarkable is the fact that organization 8 works with a more formalized procedure for radical innovation than for incremental innovation.

Classification	Company	Radical	Incremental
> 75% Group A	13	2	2
	14	4	4
25% - 75% Group B	4	N.A.	1
	5	N.A.	N.A.
	2	1	1
	11	1	2
	7	1	6
< 25% Group C	1	4	4
	6	2	3
	8	5	4
	16	2	2
	15	1	1
	3	1	3
	9	5	5
	10	6	6
	17	1	1
	12	5	5

Table 6.11: Formalization degree for radical and incremental innovations

6.5.2 Team structure

The second step is to determine which type of team-structure the biotechnology organizations are working with. The results are presented in the next table. Blue is the team structure used for radical innovation, yellow for incremental innovation, and green is a same team structure for both radical and incremental innovation. The four different team structures are functional, lightweight, heavyweight and autonomous team structures. Table 6.12 shows that two organizations work with a different team structure for radical innovation than for incremental innovation. The type of team structure is widely dispersed; there is no preference for one type of team structure.

Classification	Company	Fun	Light	Heavy	Auto
> 75% Group A	13	both			
	14			both	
25% - 75% Group B	4		both		
	5			both	
	2	both			
	11	both			
	7				both
< 25% Group C	1			inc	rad
	6	both			
	8				both
	16	inc	rad		
	15			both	
	3				both
	9		both		
	10		both		
	17	both			
	12		both		

Table 6.12: Type of team structures in the biotechnology sector.

6.5.3 Innovation Climate

As described in chapter three, radical innovations require a more open, promotive climate than incremental innovation. Nine out of the seventeen Dutch and Belgian biotechnology organizations distinguish their radical innovation climate from the overall innovation climate. This is presented in the next table:

Classification	Company	Radical	Climate	Rad.Clim.
> 75% Group A	13	90%	6,57	
	14	80%	5,43	
25% - 75% Group B	4	60%	4,71	4,86
	5	50%	5,43	
	2	40%	3,86	4,00
	11	40%	5,71	
	7	33%	6,14	
< 25% Group C	1	20%	6,29	6,29
	6	20%	5,43	6,00
	8	20%	6,86	5,86
	16	20%	5,86	4,29
	15	10%	4,86	4,14
	3	5%	2,86	6,57
	9	5%	4,00	
	10	5%	3,71	
	17	5%	5,43	6,00
	12	3%	5,00	

Table 6.13: Scores on radical and overall innovation climate

Five out of the nine companies have a more open and promotive climate for their radical innovations. Most interesting is the fact that three companies judge their radical innovation climate as being less open and promotive than the overall climate. This is contradictory to the theory of Ekvall. The results are shown in table 6.14.

Company	Climate	Rad. Climate	% Radical
1	6,29	6,29	20
2	3,86	4,00	40
3	2,86	6,57	5
4	4,71	4,86	60
6	5,43	6,00	20
8	6,86	5,86	20
15	4,86	4,14	10
16	5,86	4,29	20
17	5,43	6,00	5

Table 6.14: Overall Climate Vs. Radical Climate

Furthermore, Ekvall (1997) states that in order to succeed with radical breakthroughs, freedom, risk taking and debates must be dominant present in the organizational climate. The scores on freedom, risk taking and debates are given in table 6.15.

Company	Climate	Radical	% Radical
1	6,33	6,33	20
2	4,00	4,00	40
3	2,67	7,00	5
4	4,33	5,00	60
6	4,67	6,33	20
8	6,67	5,67	20
15	5,33	4,00	10
16	6,00	5,33	20
17	5,00	6,00	5

Table 6.15: Scores on freedom, risk taking and debates.

6.5.4 Ambidexterity in the Biotechnology sector

The results of the previous three subparagraphs are visualized in table 6.16. A cross mark is placed if organizations use a separate approach for radical and incremental innovation.

Classification	Company	Radical	Process	Team structure	Climate
> 75% Group A	13	90%			
	14	80%			
25% - 75% Group B	4	60%			X
	5	50%			
	2	40%			X
	11	40%	X		
	7	33%	X		
< 25% Group C	1	20%		X	X
	6	20%	X		X
	8	20%	X		X
	16	20%		X	X
	15	10%			X
	3	5%	X		X
	9	5%			
	10	5%			
	17	5%			X
	12	3%			

Table 6.16: Ambidexterity within the dataset

The table shows that none of the organizations uses a different approach on all three aspects. This is remarkable since one would expect that especially in the biotechnology sector where the percentage radical innovation is significantly high many organizations would use a different approach for radical innovations compared to incremental innovations.

As described before, organization 8 makes use of a more formally documented NPD process for radical innovation compared to incremental innovation, which is not in line with the expectations based on the theory about ambidexterity. Organizations 8, 15, and 16 all three make use of a more open, promotive climate for incremental innovation compared to radical innovation. Again, this is not in line with the expectations based on the theory about ambidexterity.

Although, it would be interesting for organizations in the biotechnology to use a different approach for the two types of innovation and a high percentage radical innovation within many of the biotechnology organizations could be a stimulation for this, the analysis showed that the organizations currently do not work with an ambidextrous approach.

6.6 Case studies

At the end of chapter 5 organizations 7, 10, 13, and 17 were described based on the data of the NPD questionnaires and interviews with the R&D managers. In that description the focus was on the degree and type of innovation, or in other words 'the balance between exploration and exploitation'. In this chapter is elaborated on how organizations in the biotechnology sector internally facilitate this balance between exploration and exploitation, which is expressed in the percentage radical innovation. Only the NPD strategy appeared to be positively associated with the percentage radical innovation. Although no relation could be proved between the percentage radical innovation and the organizational form, in general, it can be said that biotechnology organizations make use of a predominately organic structure. The NPD climate is dispersed; no relation with the percentage radical innovation could be made nor was a pattern recognized. Since it looks like no association, except for the strategy, is present, the R&D managers are asked to elaborate on this aspect and to argue whether or not the internal configuration in terms of strategy, organizational form and climate is associated to the balance between exploration and exploitation.

Two similar organizations (7 and 17) are compared, to analyse why the organizations, which operate in exact the same market segment and which have the same product range, choose for a different internal configuration of the NPD function in terms of the NPD strategy, the organizational form and the NPD climate. Furthermore, two extreme different organizations (10 and 13) are compared to analyse which motives or factors are of influence on the internal configuration of their NPD function.

6.6.1 Similar cases

An in-depth analysis of the questionnaires of both organizations and interviews with the R&D managers resulted in the cross table below, in which an overview is provided of the two organizations.

		Organization	
		7	**17**
NPD Function	**% Radical innovation**	33%	5%
	% NPD	29%	60%
NPD Strategy	**Focus**	Long-term Growth & Long-term Performance	
	Reason / Explanation	Products must almost be ready for selling when marketing asks for them; NPD activities therefore comprehend expected future demands	
Organizational form	**Setting**	Predominantly organic	Between organic and mechanistic
	Differences in setting	Tasks are broken down into subunits	Tasks are broken down into specialized units
		Tasks are continously adjusted	Tasks are rigidly defined
		Broad definition of responsibility	Specific definition of responsibility attached to the individual
		Little hierarchy of control & authority	Strict hierarchy of control & authority
	Team Structure	Autonomous	Functional
	Reason / Explanation	Result of the level of radical (or incremental) innovation	
	Formalization Degree (RAD)	No standard approach	No standard approach
	Formalization Degree (INC)	Formally documented	No standard approach
	Reason / Explanation	Degree of formalization must be balanced out through the NPD process, further in the process; more formalization	Formalization is positively associated with the extent of NPD
Climate	**Radical**	Highly promotive	Highly promotive
	Incremental		Promotive
	Reason / Explanation	High degree of radical innovation 'asks' for a highly promotive climate	A highly promotive climate for radical innovations stimulates and motivates the employees

Table 6.17: Crosstable chapter six - Similar Cases

Strategy

The manager of organization 7 points out that it is for the organization as a whole important that variations of the products (incremental innovations) are already developed, or at least that most of the development has already been done, before the marketing department asks for them. In their business this is crucial for the organization to retain its market share for that particular product. When the development is started after marketing asks for a product a high possibility exists that they are too late, because of the duration of the development process. Besides the incremental innovations, radical innovations are extremely important on the longer term for organization 7; the organization sees radical breakthrough and highly innovative products as the way to success and to distinguish the organization from their competitors. The manager of organization 17 also shares the statement that incremental innovations -variations on the existing products- are very important in their business; market shares can drop from

over 90 percent too zero percent within a snap, and vice versa, however radical breakthroughs do not play such an important role within the NPD function if compared to organization 7. These argumentations reflect the relation between the balance of exploration and exploitation (or the percentage radical innovation) and the NPD strategy; both organizations focus on long term growth and performance (as shown in the cross table), but the R&D managers simply have a different opinion or view on how to achieve this in terms of radical of incremental innovations.

Organizational form
As shown in the cross table organization 7 its structure is predominantly organic, where organization 17 its structure contains organic and mechanistic elements. Relating the organizational form to the percentage radical innovation leads to a confirmation of the theory that a higher percentage of radical innovation is positively associated with a predominately organic structure. The answers given in the NPD questionnaire indicate that the difference between the organizations is attributable to four (of the nine) aspects; organization 17 its (1) tasks are more broken down into specialized units, (2) tasks are more rigidly defined, (3) a more specific definition of responsibility that is attached to the individual his function role is used, and (4) a strict hierarchy of control and authority is used, according to the R&D manager this is inherent to the size of the NPD function and the high percentage radical breakthroughs.

The degree of formalization in both organizations considering radical innovation is equal; no standard approach is used, as shown in the cross table. Within organization 7 there is a clear distinction made between the incremental and the radical innovation process, where for the incremental innovation process formally documented processes are used, for radical innovations no standard approach is available. There is more freedom for employees working on radical innovation, because this contributes to the innovativeness. In organization 17 no distinction is made between the two types of innovation; for both types no standard approach is used.

Climate
In organization 7 no distinction is made between the incremental and the radical innovation climate. Organization 7 has a more open, promotive climate than organization 17, in which the climate for incremental innovation is to a lesser extent promotive than for radical innovation. According to the manager of organization 7 the high degree of radical innovation ‘asks’ for an open climate, employees must have freedom and must be able to define their own work. For organization 17, the manager explains that 80 percent of their research related activities are assignments, in which it is important to have a promotive climate, and 20 percent is free (*spielerei*); this 20 percent stimulates the NPD employees and the reason of the employees being very motivated. Supplementary information about the analysis of the two organizations is provided in appendix C.

6.6.2 Extreme different cases
In the former chapter is described that organizations 10 and 13 are two totally different organizations concerning exploration and exploitation; organization 10 is highly exploitative and organizations 13 highly explorative. An in-depth analysis of the

questionnaires of both organizations and interviews with the R&D managers resulted in the cross table below in which an overview is provided of the two organizations.

		Organization	
		10	**13**
NPD Function	**% Radical innovation**	5%	90%
	% NPD	12%	83%
NPD Strategy	**Focus**	Short-term Growth & Performance	Long-term Growth & Performance
		projects with predictable outcomes	projects with risky outcomes
	Reason / Explanation	Mainly focussed on exploitation and therefore the short-term focus	Organization is explorative and therefore focussed on long-term growth and performance
Organizational form	**Setting**	Predominantly organic	Highly organic
	Differences in setting	Specific definition of responsibility attached to the individual	Broad definition of responsibility
		Strict hierarchy of control & authority	Little hierarchy of control & authority
		Formal leader is assumed to be omniscient in knowledge concerning all matters	Formal leader is assumed NOT to be omniscient in knowledge concerning all matters
	Team Structure	Lightweight	Functional
	Reason / Explanation	Result of the level of radical (or incremental) innovation	This is the best setting/structure for the organization
	Formalization Degree (RAD)	Formally documented	Not formally documented although the path of the tasks to be completed is clearly understood
	Formalization Degree (INC)		
	Reason / Explanation	Special pace process is used, obliged by the parent company	A low degree of formalization is used to keep the organization flexible
Climate	**Radical**	More regulated	Highly promotive
	Incremental		
	Reason / Explanation	Through the high level of incremental innovation and the rules/demands of the parent company the climate is not promotive	A higly promotive climate is inherent to a high level of radical innovation

Table 6.18: Crosstable chapter six - Extreme Cases

Strategy

The score on strategy of the organizations (10 and 13) is the complete opposite as shown in the cross table. Both managers confirm this. The manager of organization 10 points out that their organization is currently focussed at exploitation of the current products and therefore short-term oriented. The manager of organization 13 points out that their organization is explorative; mainly performing radical innovation activities which are focussed on the long term. Organization 10 is hardly able to transform the short-term oriented strategy in a more long-term oriented strategy, which is necessary to survive in the future according to the R&D manager, because of the lack of manpower at R&D and due to restrictions by their parent company.

Organizational form

Organization 10 its structure is predominantly organic, where organization 13 its structure is highly organic. The answers given in the NPD questionnaire indicate that the difference between the organization is attributable to three (of the nine) aspects; organization 10 (1) uses a more specific definition of responsibility that is attached to the individual his function role, (2) a strict hierarchy of control and authority is used, and (3) the formal leader is more assumed to be omniscient in knowledge concerning all matters. The R&D manager of organization 13 states that a highly organic structure is the best structure for an organization with many high educated employees (researchers). Freedom in work and a broad job definition contributes to the motivation of the employees.

In organization 10 a formally documented process is used for both the incremental and the radical innovation process, in organization 13 no formally documented process is followed although the path of the tasks to be completed is clearly understood. Within organization 13 no distinction is made between the incremental and the radical innovation process in terms of formalization. The manager of organization 10 points out that throughout the whole development process a special program must be used, which is imposed by the parent company. This program is unfortunately very slow and bureaucratic. In the near future a short version of the program will become available, which will enlarge the innovation abilities. Organization 13 its manager argues that the low degree of formalization keeps the organization flexible.

Climate

In both organizations no distinction is made between the incremental and the radical innovation climate. Organization 13 has a much more open, promotive climate than organization 10, which has a more regulated climate. According to the manager of organization 10, their climate is limited by the parent company. The many rules and prescribed processes limit the freedom of the employees. Besides that, the manager argues that it is important to keep the researchers close to the products so they will not alienate. Within organization 13 a promotive climate is of high importance due to the high percentage of radical innovation. According to the manager employees must have a high degree of freedom and they must feel involved in the innovation activities. Supplementary information about the analysis of the two organizations is provided in appendix C.

6.6.3 Outcome case studies

Although the analyses in the first paragraphs of this chapter show different, the case studies showed that there is a relation between the percentage radical innovation and the internal facilitation on all three aspects: the NPD strategy, the organizational form and the NPD climate. Although the managers have different beliefs about how to facilitate the balance between exploration and exploitation; in all four organizations the configuration of the NPD function is, according to the managers, of influence on the NPD strategy, the organizational form and the NPD climate. An organic structure, a low formalization degree, an open and promotive climate with freedom for the employees contributes to the performance of highly educated employees and keeps the organization

flexible. However, for small adjustments in the existing product portfolio, a more regulated approach will be more efficient.

6.7 Conclusion

As described in chapter five, organizations in the Dutch and Belgian biotechnology sector put more effort in radical innovations, compared to other sectors in Belgium and The Netherlands as automotive, electronics, medical devices, etc. to find a balance between exploration and exploitation. In this chapter a link is made between the percentage radical innovation and the configuration of the NPD function which answered the central question *"How is the combination of exploration and exploitation facilitated internally by organizations in the Dutch and Belgian biotechnology sector"*. This facilitation is described in terms of the NPD strategy, the organizational form (organizational structure and formalization degree), the NPD climate and the ambidexterity of the NPD function. Finally, equal to the methodology in chapter five, two case studies have been carried out for further qualitative research.

In the Dutch and Belgian biotechnology sector, there is an obvious link between the percentage radical innovation and the NPD strategy. A high percentage radical innovation is positively associated with a long-term oriented NPD strategy. The NPD function of organizations with a high percentage radical innovation primary focuses on long-term growth and performance, creating breakthrough new products and does not avoid projects with risky outcomes. Organizations with a high percentage incremental innovation are the opposite; they primary focus on short-term profit and performance and prefer projects with predictable outcomes.

The organizational form is a more complex story. The first element measured is the organizational type in terms of organic and mechanistic structures described by Burns and Stalker. The results show that most organizations in the biotechnology sector, regardless of the percentage radical innovation, work with a predominantly organic structure for the NPD function (except organization 2) and there are three organizations (1, 9, and 17) with a structure which is a combination of mechanistic and organic elements. There is no relation between the structure and the size nor the age of the NPD function; all organizations are working with a predominately organic structure. This is the same for the age of the organization. Organizations in the Dutch and Belgian biotechnology sector do not prefer a specific formalization degree; there is also no correlation between the structure and the formalization degree.

Organizations in the biotechnology sector are working with an open and promotive climate. The climate of those organizations can be characterized as a climate where employees have freedom to define their own work, there is time for employees to develop unplanned new ideas and there is a strong support for further development of new ideas. Again four organizations are outsiders (organization 2, 3, 9, 10), from which three organizations (3, 9, and 10) spend only 3-5% of their activities in radical innovation.

Looking at the combination of NPD strategy, organizational form and NPD climate, no pattern between these elements can be distinguished. The percentage radical innovation is related to the NPD strategy but not to the organizational form or the NPD climate.

The last subject in this chapter is the ambidexterity of the NPD function. The extent to which an organization is ambidextrous is derived from information about team structure, formalization degree and the NPD climate. The organizations in the Dutch and Belgian biotechnology sector are working with functional, lightweight, heavyweight and autonomous team structures; there is no preference for one type of team structure. There are only two organizations which use a different team structure for radical innovation than for incremental innovation. An equal approach for incremental and radical innovation is also found in the formalization degree; twelve out of the seventeen organizations are working with the same degree of formalization for both radical and incremental innovations. Four have a more loose approach for radical innovation, which is in line with the theory of chapter three. Organization eight uses a higher formalization degree for radical innovation than for incremental innovation, which is not in line with the expectations stated in chapter three. Nine of the seventeen organizations distinguish their radical innovation climate from the incremental innovation climate. Three organization (8, 15, and 16, all from group C) score lower on the openness / promotiveness of the climate for radical innovation compared to the incremental innovation climate, which is again not in line with the expectations.

The results on the team structure, formalization degree of the NPD process, and the NPD climate showed that although it would be interesting for organizations in the biotechnology to use a different approach for the two types of innovation (radical and incremental), organizations currently do not make use of an ambidextrous approach.

The case studies showed that there is a relation between the percentage radical innovation and the internal facilitation on all three aspects: the NPD strategy, the organizational form and the NPD climate. Although the managers have different beliefs about how to facilitate the balance between exploration and exploitation; in all four organizations the degree and type of innovation are, according to the managers, of influence on the NPD strategy, the organizational form and the NPD climate.

Chapter 7: Network analysis

In the previous chapter, a link between the percentage radical innovation and the internal configuration of the NPD function has been made. In this chapter the external facilitation of the percentage radical innovation will be exposed by looking at the collaboration agreements in the biotechnology sector. First an introduction will be given about facilities promoting collaboration in this sector. In the second paragraph the different types of collaboration in the biotechnology sector will be studied followed by an elaboration on collaboration in the two case studies in the third paragraph. This chapter will finish with a conclusion on the results found in the first three paragraphs.

7.1 Collaboration in the Dutch and Belgian Biotechnology

Within the biotechnology sector many organizations, institutes and universities collaborate to some extent. Their goal is to make better, more efficient use of shrinking resources to create high-quality, and high technological end-products. As stated before, the biotechnology industry has been identified as the industry with the highest alliance frequency among several industries characterized by high alliance activity [Hagedoorn, 1993]. In chapter three the main reasons for organizations to start with a collaboration agreement, according to Narayanan (2001) and Nooteboom (1999), are mentioned; bundling resources, risk sharing, pooling of capabilities, speed up the innovation process of to increase the flexibility of adapting new technologies. However, to initiate a collaboration agreement, two conditions must be met: (1) the existence of a need and (2) one must find a partner to collaborate with. Finding partners is facilitated through sector associations which are present in the Netherlands and Belgium, mentioned in paragraph 5.1.4. Most of these associations encourage collaboration between the actors. However, the intention of most associations is to bring employees together to form a union to look after their joint interests. In short these associations will be described.

Netherlands

- SenterNovem is an agency of the Dutch Ministry of Economic Affairs. They promote sustainable development and innovation, both within the Netherlands and abroad. A part of SenterNovem, KP6 Genomica and Biotechnology, focuses on organizations and knowledge institutes of every size which want to collaborate with European and Non-European partners.

- Nederlands Instituut voor Biologie (Nibi) is the labour union for people working in biology, which includes biotechnology. Nibi is focussed on making improvements on the labour market, encourage communication, and stimulating research activities related to biology.

- Niaba is the Dutch Biotech Industry Association. With more than 60 members it represents the majority of the Dutch biotechnological companies and related organizations in human and animal healthcare, food, feed, agriculture and environment.

- The centre for Bioscience Genomics (CBSG) is established as a Centre of Excellence under the auspices of the Netherlands Genomics Initiative. The network of scientists now spans four universities, two research institutes and fifteen industrial parties in the Netherlands.

- Holland Biotechnology is a portal site developed to Provide information about the companies and institutes active in the field of life sciences

- The Dutch Biotechnology Industry Office stimulates and moulds the interests of the member associations. It takes care of the daily activities and stimulates and optimises the collaboration between the associations. The member associations of the Dutch biotechnology Industry Office are:
    - BioFarmind; Only companies with Pharmaceutical Biotechnology as their core business can participate in this new Foundation. BioFarmind looks after the interests of these companies and bring the additional value of biotechnology- produced pharmaceuticals on the political agenda.
    - Dutch Vaccines Group (DVG); The Dutch Vaccines Group looks after the interests of the vaccines companies and bring the additional value of vaccines and the research on the political agenda.

- Keygene; is a service provider in the genetic analysis of plants, animals and micro-organisms. Keygene was founded in 1989 by a number of Dutch vegetable seed companies. Their goal is to create synergy and higher efficiency in their molecular genetic research programs and thus improve their breeding effort. As a research and development organization, Keygene is constantly looking for new opportunities to collaborate with other research organizations to fuel its innovative research programs.

- Life Science Cluster Leiden; In this physical location many organizations and research institutes as the University of Leiden and the Medical Centre Leiden are clustered together. In 2006 over 4000 employees are working in this cluster and an increase to 6000 employees is expected before the year 2010 (Life Science Leiden, 2006).

Belgium

- VIB; the Flanders Interuniversity Institute for Biotechnology. It is a non-profit scientific research institute. Its three complementary core activities are: Strategic basic research, an active technology transfer policy to transfer the inventions to consumers and patients, and providing scientific information for the general public. The VIB has brought the universities in Flanders together and encourages collaboration with organizations.

- FlandersBio; is the cluster of Flemish biotech players. FlandersBio is acting as a driving force for the sustained growth of the Flemish biotech industry by stimulating the flow of knowledge, creating a supportive environment, actively

promoting entrepreneurship and improving international visibility of Flanders as biotech region.

As described above, within the Netherlands and Belgium many different associations bring together biotechnology organizations. Within the Netherlands this network of organizations is larger and there are more possibilities than in Belgium, although the VIB and FlandersBio both are relatively large promoters for collaboration.

7.2 Collaboration analysis

In this paragraph the proposition about collaborative arrangements will be tested. The proposition is stated as follows: *Organizations in the Dutch and Belgian biotechnology sector make use of heterogeneous collaboration agreements to balance exploration and exploitation.* In the previous paragraph an introduction is given about collaborative agreements in the biotechnology sector in general and this paragraph will give an overview of collaborative agreements by co-patent analysis.

Co-patents of the research population

Only three of the seventeen organizations of the dataset filed a patent with a biotechnology classification together with another organization or institute between 1993 and 2004. An overview is given in the table below.

Company	# of Co-patents	Co-Owner
2	1	Institution
9	1	Organization
11	1	University

Table 7.1: Number of Co-patents

The total number of patents of the biotechnology data set (17 organizations) is 68, from which 3 patents are co-patents. This is 4%, which implies that there is almost no collaboration. This small number of co-patents is not representative for the biotechnology sector; in the biotechnology sector about 15% of the patents have more than one holder and this number is still increasing [Pyka and Saviotti, 2000]. They state that co-patenting is only a rough indicator for the increase in networking in the biotechnology-based industries, as not all collaborations end up in a patent application.

Further analysis of collaboration in the form of website analysis gives another view; there are many collaboration agreements initiated by organizations from the dataset. Organizations mention a large number of collaboration agreements with other organizations, institutes and universities, but these collaborations do not end up in a co-patent with a biotechnology classification.

In order to provide a good view of the heterogeneity or homogeneity of collaboration agreements in the biotechnology sector, the research is elaborated with an analysis of the biotechnology patents filed at the EPO between 1993 and 2004 by organizations from

Belgium and The Netherlands. Biotechnology patents filed in the name of Belgian or Dutch universities and non-profit organizations are excluded from the analysis.

Between 1993 and 2004, Dutch and Belgian companies filed a total of 1828 biotechnology patents, 343 of these patents are filed under multiple names. This means that 18,8% of the Belgian and Dutch patents have more than one holder, this number is in line with the findings of Pyka and Saviotti (2000).

Several combinations between different types of owners can be distinguished within the 343 co-patents. An overview of these combinations is given in the next figure.

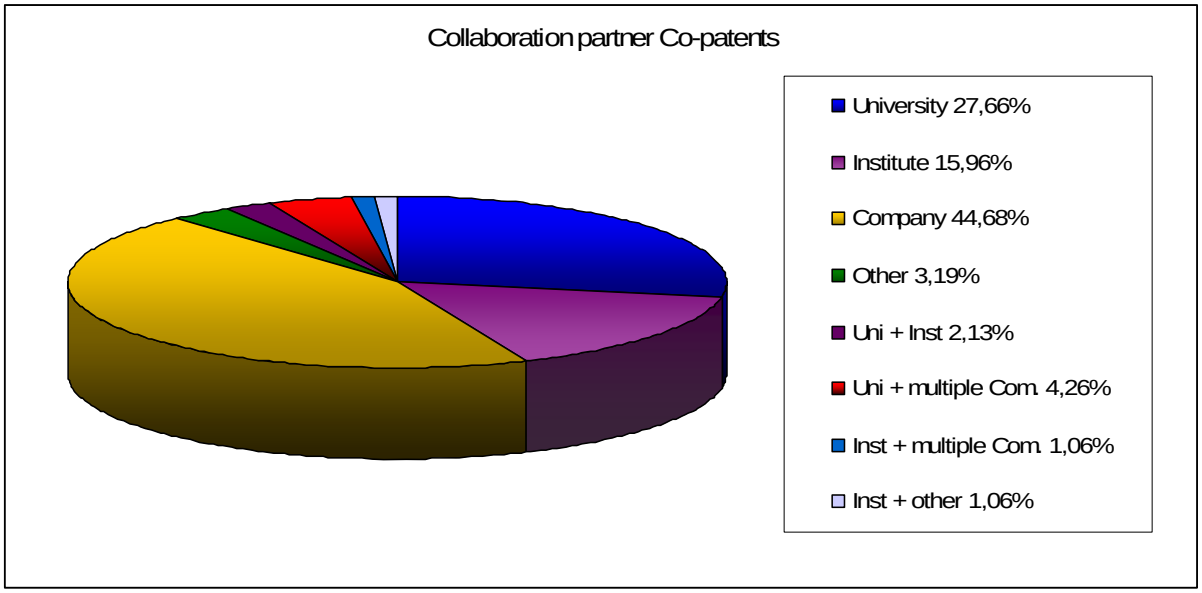


Figure 7A: Type of partners Co-patenting

In 45 percent of all cases the partner(s) is another organization, so in 55 percent universities, knowledge institutes, the government or individuals are involved as partner of a Belgian or Dutch organization filing a co-patent. The first impression is that organizations in the biotechnology sector in Belgium and the Netherlands make use of heterogeneous networks with universities, institutes and with other organizations (suppliers, customers and competitors) in order to stay innovative.

The focus of collaboration agreements is in most cases (for both the red, green and white areas of application) on the development of new products, followed by carrying out fundamental scientific research. To a less extent development of new processes and new research techniques is the foundation for collaboration agreements [TNO report, 2003]. The collaborative partners shape collaboration by carrying out joint R&D projects. Next to these joint R&D projects, collaborating organizations use license agreements as a type of collaboration; one organization pays the other organizations for using their knowledge (e.g. patents).

The TNO report confirms the statement, that organizations in the biotechnology sector mainly make use of heterogeneous collaboration partners. They also did research on collaboration which did not end up in a patent application. They found that 39% of all

collaboration partners are SMEs (Small and Medium Enterprises), 25% are large organizations and 33% are knowledge institutes.

7.3 Case studies

At the end of chapters 5 and 6 organizations 7, 10, 13, and 17 were described based on the data of the NPD questionnaires and interviews with the R&D managers. In chapter 5 the focus was on the relation between the environment and the type of innovation. The focus in chapter 6 was on the internal facilitation of the balance between exploration and exploitation. Within this chapter the focus is on the external facilitation of the balance between exploration and exploitation, and therefore in this paragraph reasons and explanations will be described of the collaborations in which these four organizations are involved. From the former paragraph can be deducted that none of these four organizations have been involved in collaborations which led to the filing of a co-patent with a biotechnology classification. But, as said before, a co-patent analysis will provide only a rough indicator for the collaboration intensity whereas not all collaborations end up in a co-patent application. To enlarge the insight on collaboration this paragraph will elaborate on the collaboration of the four interviewed organizations.

7.3.1 Similar cases

During the co-patent analysis, as described above, is found that organizations 7 and 17 do not make use of collaborative agreements. A website analysis does not provide extra information concerning collaboration agreements of these organizations, yet the R&D managers do. In the following cross table an overview is provided about the two organizations.

		Organization	
		7	**17**
NPD Function	**% Radical innovation**	33%	5%
	% NPD	29%	60%
Current collaboration	**Number of collaborations**	Many (~80)	Moderate (~40)
	Focus	Both explorative and exploitative	Explorative
	Main partners	Universities & Research institutions	Research institutions
	(Inter)National	National and International	
	Type	Heterogeneous	
	Importance	Very high	High
Collaboration in the future		Will be getting more important	

Table 7.2: Crosstable Chapter seven - Similar Cases

Current collaboration

The R&D manager of organization 7 tells that the organization is to a large extent involved in collaborations with many other organization and research institutes. Currently the organization is involved in about 80 different collaborations, from which many are international. The organization is involved in both explorative as exploitative collaborations. He points out that organizations must do what they are best at and leave the rest to others. The manager points out that collaborating with universities and

research institutions can have many advantages whereas they usually come up with many new ideas or provide new insights. The R&D manager of organization 17 points out that they have relatively many collaboration agreements, most of them are explorative. Again this organization is involved in both national as internal collaborations.

Collaboration in the future

Managers of both organizations argue that collaboration in the future will only become more important. Logically, their strategy towards collaboration is therefore a continuous search for more partners to collaborate with. Besides that, one of the managers expects the Dutch government to withdraw most of its investments in many small biotechnology organizations. This opens up a window of opportunities of his organization to take over this role.

7.3.2 Extreme different cases

From co-patent analysis, as described above, is found that organizations 10 and 13 do not make use of collaborative agreements. A website analysis provides extra information concerning organization 13, but not for organization 10. Organization 13 its website describes many different collaboration agreements varying from large pharmaceuticals to small research organizations. Besides organizations, organization 13 has collaboration agreements with universities and research institutions. Organization 13 is continuous searching for new partners to set up collaboration agreements; its intention is to share the risks. In the following cross table an overview is provided about the two organizations.

		Organization	
		10	**13**
NPD Function	**% Radical innovation**	5%	90%
	% NPD	12%	83%
Current collaboration	**Number of collaborations**	Very limited (0-5)	Moderate (~20)
	Focus	Exploitative	Explorative
	Main partners	Organizations	Organizations, Research institutions and Universities
	(Inter)National	National and International	
	Type	Heterogeneous	Homogeneous/Heterogeneous
	Importance	Very low	High
Collaboration in the future		More collaboration, especially explorative	The need for collaboration will continue to exist

Table 7.3: Crosstable Chapter seven - Extreme Cases

Current collaboration

In the interview the R&D manager of organization 10 confirmed the analysis. The organization is not involved in explorative collaboration agreements. Developing products together with another organization requires too much energy, besides the knowledge needed is very specific and most of it is available within the organization its boundaries. However, once in a while, they sell products for a supplier, because the organization (the parent company) has a well organized marketing and sales department. These

collaboration agreements are initiated by the suppliers and are attractive for the organization because of the possibility to increase their turnover without spending (much) energy in development and production.

Organization 13 is, as derived from the website, involved in many different types of collaboration. The R&D manager points out that these collaborations are mainly explorative. The organization is both involved in one and two sided collaborations, so from some collaboration agreements just one organization will profit. The organization is rather not involved in joint exploitation, mainly because physical distances are too big, which complicate the communication and collaboration. Besides that, the manager points out that collaboration with universities is often not what is supposed to be; a university its purpose is to *produce* articles, an organization is to *produce* a product or service. These different goals complicate collaboration. Organization 13 its need, in terms of collaboration, is therefore especially explorative agreements with other small research organizations.

Collaboration in the future
Organization 10 its R&D manager would like to see more collaboration agreements, specifically explorative agreements, in the future. Currently the organization is restricted too much by the parent company. However, as described in chapter 5, the organization hopes to extent its NPD activities which will enable initiation of collaboration with other organizations. Large organizations are important for organization 13 because of their possibilities to take over the research and development of those products, which are relatively far in the developed process. The end of the development process is too expensive for such a small organization as organization 13. Besides that the need will exist to collaborate with small research organizations especially on explorative activities.

7.3.3 Outcome case studies
Although none of the four case study organizations have been involved in collaborations which led to the filing of a co-patent with a biotechnology classification, three out of the four organizations are involved in many collaboration agreements, varying from 20 to 80 currently active collaborations. However, when an organization files a co-patent, there must have been intensive collaboration; the intensity of the current collaborations is varying. The managers of all four organizations indicate that the importance of collaborations will only increase in the future.

7.4 Conclusion
This chapter provided an overview of collaboration agreements in the biotechnology sector. First of all a difference is noticed between the Belgian and the Dutch biotechnology sector. The Dutch biotechnology sector is a jungle of institutions – governmental and private, for profit and non-profit - facilitating and promoting collaboration. On the other hand, in Belgium this is more orderly and centralized.

Secondly, despite the high percentage co-patents in the biotechnology sector, only three organizations of the research population filed a co-patent, which is not representative for

this sector. Therefore the research on collaborative arrangements is extended to the complete patent database of biotechnology patents filed by organizations from Belgium and The Netherlands. Between 1993 and 2004, 18,8% of all patents -filed by a striving for profit, non-governmental organization- have multiple owners. In 55% this partner is a university, an institute, the government or others, like individuals. The first impression is that organizations in the biotechnology sector make use of heterogeneous networks; this is confirmed by a study of TNO.

Interviews with (R&D) managers of the four organizations provided a deeper insight in collaborative arrangements in the biotechnology sector. The *similar* case study confirms the importance of collaborative arrangements in the biotechnology sector. Both organizations have a large heterogeneous network of partners all around the world. In the *extreme different* case study there is a difference in opinion about collaboration. The high innovative organization 13 state that collaboration is very important for explorative activities and has research institutes, universities and other organizations as collaborative partners. Collaboration is needed for survival. Organization 10 is the opposite of organization 13. Developing new products together with another organization requires too much energy –energy lost in the collaboration itself and the search for the best partner. Sometimes organization 10 sell products for other organizations, because of their well functioning marketing and sales department, but this form of collaboration is initiated most of the time by the partner and is attractive due to the small amount of energy lost with this type of collaboration.

Chapter 8: Performance analysis

In the previous two chapters, the internal and external configuration of the NPD function of organizations in the biotechnology sector has been described. According to the theory, this configuration, which is typical for an emerging environment as the biotechnology sector, leads to a better performance on product concept effectiveness than on NPD process effectiveness and a high score on strategic flexibility. In this chapter the last two propositions about the performance will be tested following the methodology described in chapter four. The first step will be to give an overview of the scores on performance, the second step will be to check the propositions, followed by the last step, an elaboration on the outcomes of the previous steps. The propositions are stated as follows:

Proposition 4a: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a higher performance on Product Concept Effectiveness than on NPD Process Effectiveness.
Proposition 4b: Organizations in the Dutch and Belgian biotechnology sector associate a high percentage radical innovation with a high Strategic Flexibility on Product Concept Effectiveness.

8.1 Performance in terms of PCE and NPD PE

The scores on the ten different variables can be found in Appendix E1-E5. The end results are presented below in table 8.1 and table 8.2.

Classification	Company	Demand OE	Demand SF	Comp. OE	Comp. SF	PCE OE	PCE SF	PCE
> 75% Group A	13	6,83	6,83	6,00	6,83	6,42	6,83	6,63
	14	6,60	6,67	4,83	5,83	5,72	6,25	5,98
25% - 75% Group B	4	5,17	4,67	3,83	4,17	4,50	4,42	4,46
	5	5,50	3,33	4,67	5,33	5,08	4,33	4,71
	2	4,50	3,83	N.A.	3,40	4,50	3,62	3,91
	11	6,17	4,50	4,00	4,20	5,08	4,35	4,72
	7	6,33	6,83	6,00	6,67	6,17	6,75	6,46
< 25% Group C	1	6,33	6,33	6,17	6,50	6,25	6,42	6,33
	6	6,00	5,83	5,50	5,50	5,75	5,67	5,71
	8	1,33	2,00	N.A.	N.A.	1,33	2,00	1,67
	16	6,00	6,00	6,00	5,20	6,00	5,60	5,80
	15	4,33	5,17	4,67	4,50	4,50	4,83	4,67
	3	4,83	5,00	3,50	2,83	4,17	3,92	4,04
	9	3,67	3,17	4,50	4,33	4,08	3,75	3,92
	10	5,17	3,17	4,33	4,67	4,75	3,92	4,33
	17	5,67	6,00	5,17	5,33	5,42	5,67	5,54
	12	5,00	4,33	4,67	4,50	4,83	4,42	4,63

Table 8.1: Scores on the Product Concept Effectiveness (PCE)

Classification	Company	Speed OE	Speed SF	Productivity OE	Productivity SF	Process Flex. OE	Process Flex. SF	NPD process Eff. OE	NPD Process Eff. SF	NPD Process Eff.
> 75% Group A	13	6,33	4,33	4,00	5,20	5,50	5,00	5,28	4,84	5,06
	14	4,83	4,50	2,80	3,20	N.A.	N.A.	3,82	3,85	3,83
25% - 75% Group B	4	3,17	2,83	2,80	2,80	3,50	4,00	3,16	3,21	3,18
	5	2,83	5,17	2,80	4,60	2,83	4,00	2,82	4,59	3,71
	2	3,50	2,83	4,40	3,00	3,33	3,17	3,74	3,00	3,37
	11	3,50	3,00	N.A.	N.A.	4,80	4,00	4,15	3,50	3,83
	7	5,17	5,67	4,40	4,60	5,50	4,67	5,02	4,98	5,00
< 25% Group C	1	5,00	5,67	5,00	5,60	5,67	5,17	5,22	5,48	5,35
	6	5,83	6,17	4,80	5,60	4,33	5,67	4,99	5,81	5,40
	8	N.A.	N.A.	N.A.	N.A.	N.A.	3,00	N.A.	N.A.	3,00
	16	5,33	4,00	5,00	4,40	4,25	4,00	4,86	4,13	4,50
	15	3,83	4,67	3,60	3,60	4,00	4,20	3,81	4,16	3,98
	3	3,67	3,67	4,60	5,00	5,67	5,50	4,64	4,72	4,68
	9	3,00	4,00	3,60	4,00	4,33	4,00	3,64	4,00	3,82
	10	2,33	2,17	6,20	5,60	4,83	3,33	4,46	3,70	4,08
	17	5,00	4,50	3,60	4,00	4,00	4,33	4,20	4,28	4,24
	12	2,50	N.A.	5,40	4,25	5,00	5,00	4,30	4,63	4,43

Table 8.2: Scores on the NPD Process Effectiveness (NPD PE)

To check the proposition the scores on Product Concept Effectiveness (PCE) and on NPD Process Effectiveness (NPD PE) are compared with each other in figure 8A. Organization eight has been left out of this analysis, because there is not enough data available for a sufficient performance analysis.

Independent Samples Test

	Group	N	Mean	SD
Performance	PCE	16	5,11	0,94
	NPD PE	16	4,27	0,68

	Mean difference	Sig.
Performance	0,84	0,007

Table 8.3: Independent Sample Test Performance

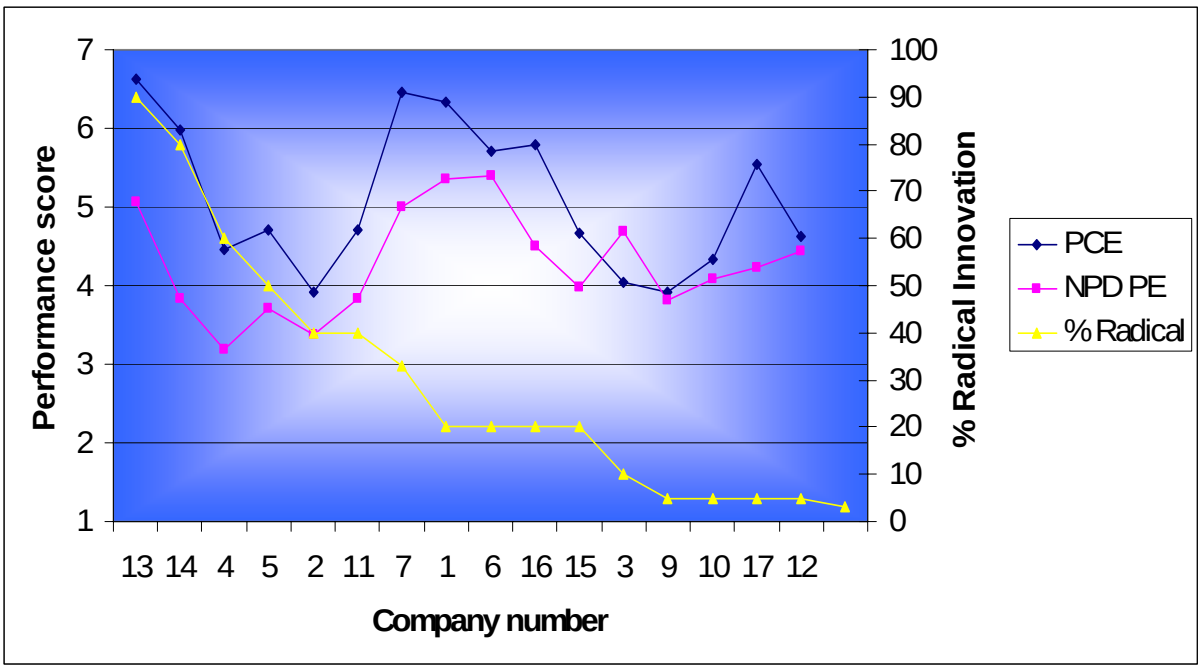


Figure 8A: Performance on Product Concept Effectiveness and NPD Process Effectiveness

Table 8.3 shows that there is a significant difference between the score on PCE and NPD PE. In Figure 8A the scores of each organization are visualized. Only one organization (organization 3) has a higher score on NPD PE than on PCE. Four other organizations (6, 9, 10, and 12) score only a little higher on PCE. A point of interest is that these five organizations are all organizations from group C, the group with radical innovation between 0 – 25%. Organization 6 has 20% radical innovation; the others have 3 - 5% radical innovation.

The next step is to analyse the scores on performance of the variables which determine the PCE and the NPD PE. Therefore, the relative strengths and weaknesses of the organizations are determined (see Appendix E6). This is presented in figure 8B; a green box with a "+" indicates that the variable is a relative strength of the organization, a red box with a "-" indicates that the variable is a relative weakness of the organization.

A first look at this figure confirms the conclusion made earlier; organizations in the biotechnology sector score higher on PCE than on NPD PE. The strengths of the organizations can be found in the left part of figure 8B, these are the variables of PCE. The weaknesses of the organizations can be found in the variables which form the NPD PE, but the scores on process flexibility differ from the scores on speed and productivity, only a few organizations named process flexibility as a strength or a weakness.

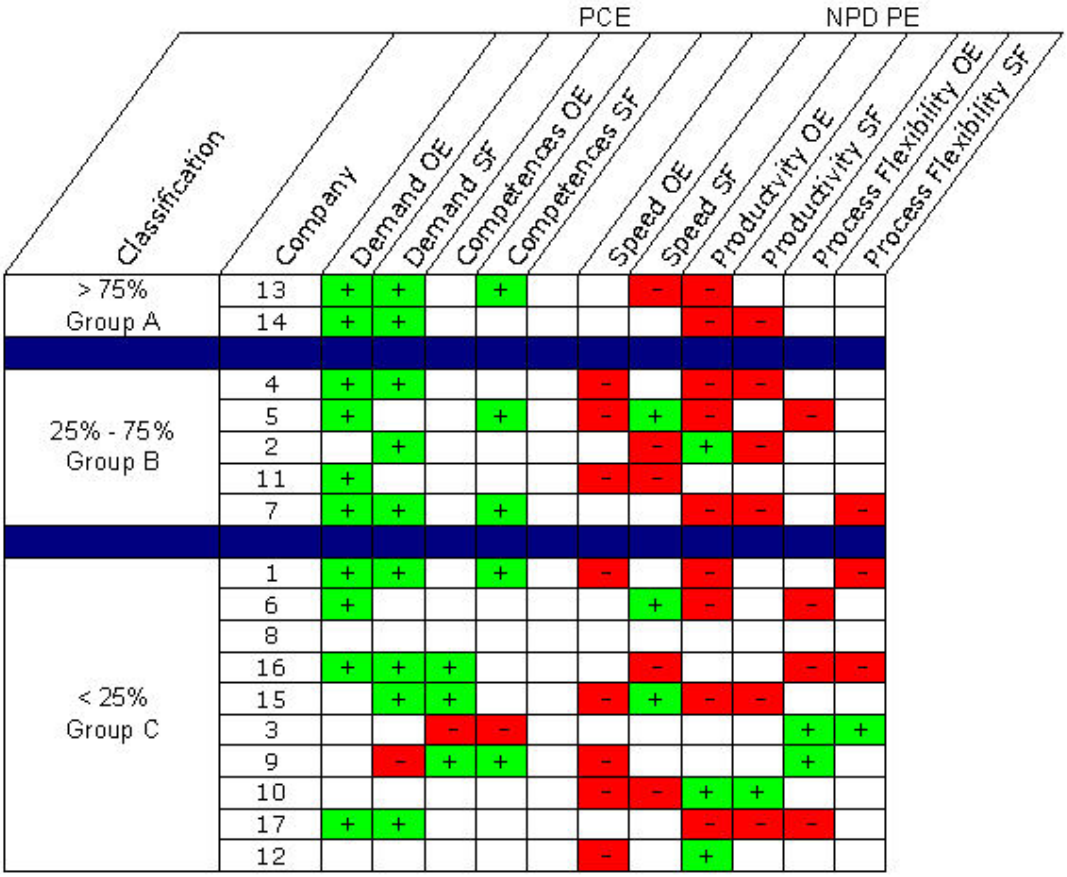


Figure 8B: Strengths and Weaknesses of biotechnology organizations

The differences between the groups A, B, and C are now better visualized. In Group A and B all organizations have at minimum one relative high scoring product concept effectiveness variable. In Group C, organizations 10 and 12 have no high scoring PCE variables, and organization 3 and 9 have even relative low scoring PCE variables. The opposite is the case at the NPD process effectiveness variables. In group A, there is no organization with a high scoring NPD PE variable, in group B only organization 2 and 5 have both one high scoring NPD PE variable, but this is surrounded by relatively low scoring variables and in group C, there are only three organizations with only low scoring NPD PE variables (organization 1, 16, and 17). The average number of high and low scoring PCE and NPD PE variables can be derived per group and this is visualized in figure 8C and figure 8D.

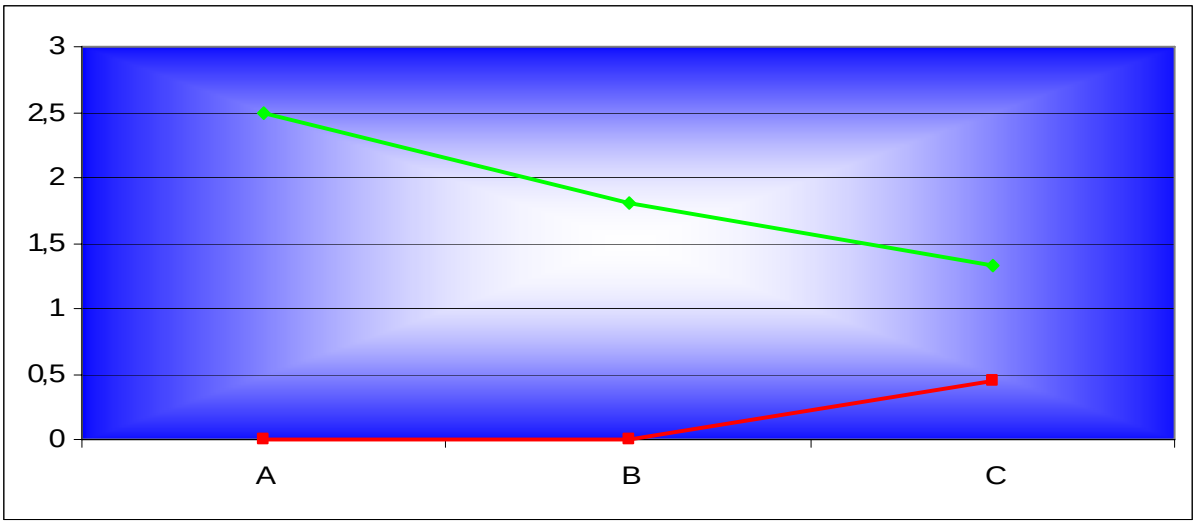


Figure 8C: Average number of high (green) and low (red) scoring PCE variables

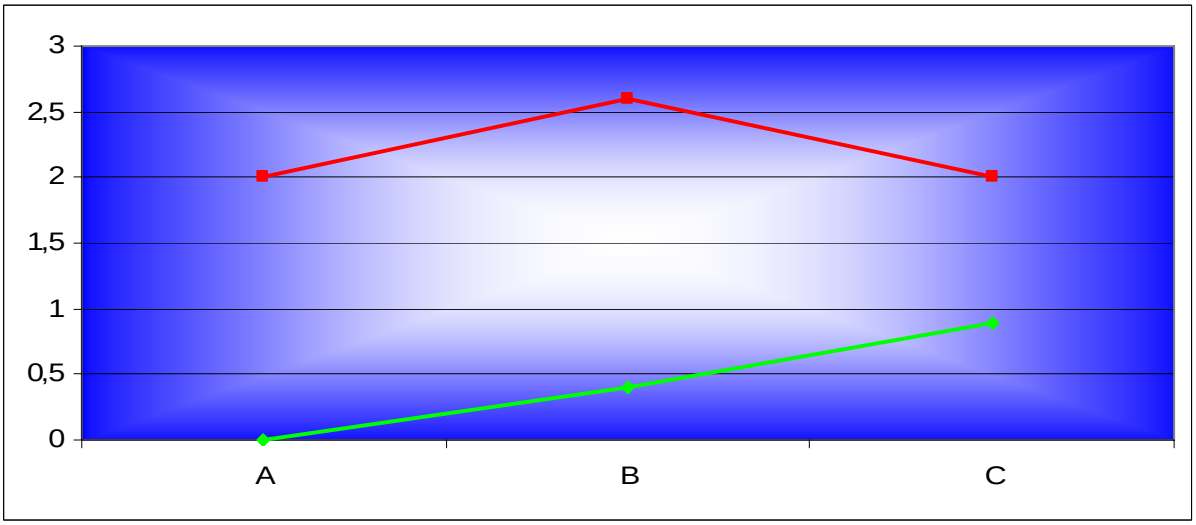


Figure 8D: Average number of high (green) and low (red) scoring NPD PE variables

The two figures show that the difference between PCE and NPD PE is smaller in organizations with a maximum of 25% of radical innovations, but the PCE is still higher than the NPD PE. The variables of the NPD process effectiveness become more important in organizations with a relative low percentage radical innovation. The difference between the performance on PCE and NPD PE is smaller for organizations with a low percentage radical innovation.

8.2 Performance in terms of OE and SF

The next step is to further analyse the scores on Product Concept Effectiveness in terms of Operational Effectiveness and Strategic Flexibility. The results are already presented in table 8.1 in the previous paragraph. The scores of PCE OE and PCE SF are visualized in figure 8E.

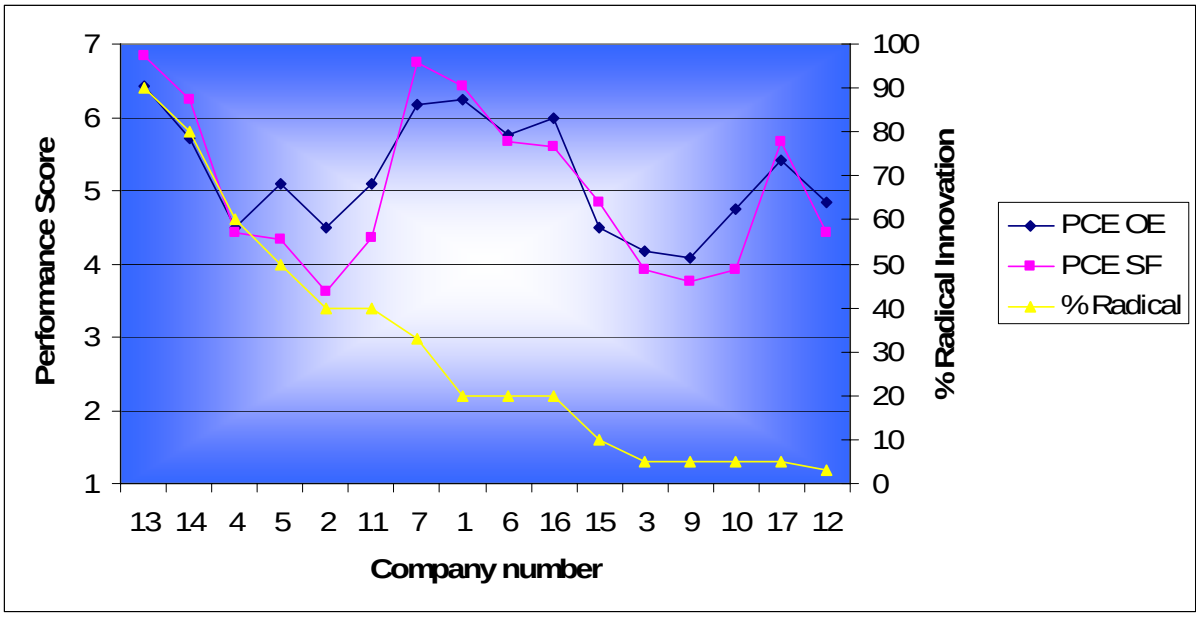


Figure 8E: Performance PCE in terms of OE and SF

Figure 8E does not confirm the last proposition, a high percentage radical innovation is not associated with a high strategic flexibility. The strategic flexibility of organizations in the Dutch and Belgian biotechnology sector is widely dispersed and is not related to the percentage radical innovation.

Furthermore, from figure 8E can be concluded that organizations in the Dutch and Belgian biotechnology sector have the same score on Operational Effectiveness and Strategic Flexibility; organizations with a high score on Operational Effectiveness, also have a high score on Strategic Flexibility and vice versa. The table below shows the results of a bivarate analysis of these two variables.

Bivarate Analysis

Variable	N	Correlation	sig.
PCE OE	17	0,918	0,000
PCE SF			

Table 8.4: Correlation between PCE OE and PCE SF

The correlation between OE and SF is 0,92 and the significance is (very) high (0,000), which statistically proves that a high (low) score on OE is related with a high (low) score on SF and vice versa. The analysis of the strengths and weaknesses of the organizations confirms this view.

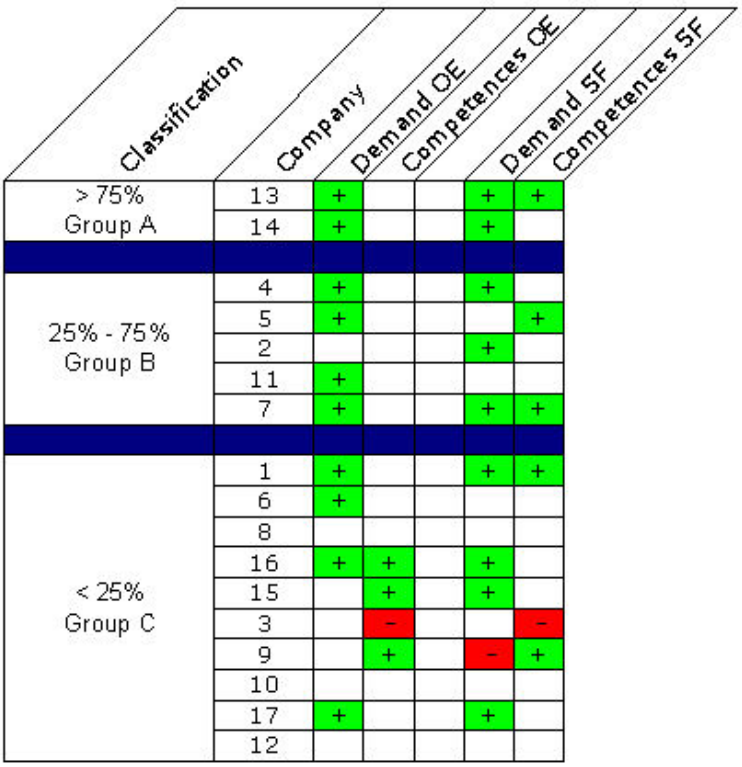


Figure 8F: Strengths and Weaknesses PCE

Irrespective of the percentage radical innovation, there is no difference noticeable between OE and SF in terms of strengths and weaknesses of the NPD function. There is a balance in performance between operational effectiveness and strategic flexibility in all organizations in the Dutch and Belgian biotechnology sector, however the level of performance is not the same in all organizations.

8.3 Case studies

At the end of chapters 5, 6, and 7 organizations 7, 10, 13, and 17 were described based on the data of the NPD questionnaires and interviews with the R&D managers. In chapter 5 the focus was on the relation between the environment and the type of innovation. The focus in chapter 6 was on the internal facilitation, and chapter 7 on the external facilitation of the balance between exploration and exploitation. Within this chapter the focus is on the performance of the NPD function.

8.3.1 Similar cases

Both organization 7 and 17 comply with the fact that organizations in the biotechnology sector perform better on PCE than on NPD PE. According to both R&D managers this is inherent to the way of working in the NPD function and to the long and complicated development process. The two organizations perform relatively less on productivity and future process flexibility. According to the managers this is a result of the low formalization degree and the open, promotive climate required in this high technology working area. Both organizations have a satisfying score on operational effectiveness and strategic flexibility.

8.3.2 Extreme different cases

As described before, organization 10 and 13 are extremely different, which is also the case in terms of their strengths and weaknesses. The strength of organization 10 is the productivity, whereas its weakness is the speed of the development process. According to the manager, the low score on speed is the result of a bureaucratic process, which is implemented by the parent company.

Organization 13 performs relatively less on productivity and future speed, but the R&D manager states that this is not a problem for the organization and the performances on those variables is satisfying. The score on strategic flexibility is too low for organization 10, the future viability is uncertain. The manager of organization 10 declares that this is for a large part the result of the low percentage radical innovation. The organization faces problems to anticipate on future demand.

8.4 Conclusion

In this chapter the link between the typical internal and external configuration of the NPD function of biotechnology organizations and their performance is made. As expected, organizations in the biotechnology sector perform better on Product Concept Effectiveness than on NPD Process Effectiveness. In general the strengths are the performance on *fit with market demands* and *fit with firm competences* whereas the weaknesses are the performance on *speed* and *productivity.* The performance on *process flexibility* (NPD PE) is hardly a strength or a weakness of organizations.

There is also a difference noticed between organizations with a high percentage radical innovation and those with a low percentage radical innovation. The difference between the performance on PCE and NPD PE is smaller for organizations with a low percentage radical innovation. In some cases the process flexibility, the productivity and the speed are even the strengths of an organization. The case studies confirm that the organic way of working, the open, promotive climate, and the low formalization degree results in a higher score on PCE than on NPD PE.

An interesting point is the fact that a high percentage radical innovation does not lead to a high strategic flexibility on PCE. There is no relation found between the percentage radical innovation and the future performance on Product Concept Effectiveness. As stated before, organizations in the Dutch and Belgian biotechnology sector work with a high percentage radical innovation to ensure their future viability, but this is not confirmed with the results of this chapter.

Chapter 9: Conclusion and Recommendations

In the biotechnology sector, it is important for organizations to find a balance between exploration and exploitation in order to function efficiently today while planning and innovating effectively for tomorrow. To ensure their current and future viability, organizations must focus their NPD activities on both incremental and radical innovations. This combination between radical and incremental innovation is facilitated internally and externally. The central question in this report is: *How do organizations in the Dutch and Belgian biotechnology sector shape their internal organizational configuration and their external network to facilitate a balance between exploration and exploitation which ensures their current and future viability?* This chapter provides the overall conclusions in paragraph 9.1 and recommendations in paragraph 9.2.

9.1 Conclusion

To fulfil the research objective, four research questions have been answered, which will be the guideline for this conclusion.

1) *Which combination of exploration and exploitation in terms of the degree and type of innovation is used by organizations in the Dutch and Belgian biotechnology sector?*
   The biotechnology sector is very diverse, organizations working with biotechnology can be found in different industries as the pharmaceutical industry, agriculture, food, and others, each with its own market segmentation. However, they all have one thing in common; the NPD function, and radical innovation in specific, plays an important role. Organizations in the biotechnology sector have relatively more employees working in NPD as part of the total number of employees than organizations in non-biotechnology sectors, such as automotive, lighting, medical supplies, machine building, transport, and electronics; 36 % against 17%. These NPD employees in biotechnology organizations put significant more effort in radical innovations in contrast to their colleagues in non-biotechnology sectors; the biotechnology organizations spend on average 30% on radical innovations, where non-biotechnology organizations spend 11%. In the biotechnology sector, 22% of the sales of the last three years are obtained from radical innovations, in contrast to non-biotechnology sectors where this is only 9%.

   Based on the analyses described above, one can say that organizations in the biotechnology sector balance exploration and exploitation different than organizations in other, non-biotechnology sectors. Exploration plays a more important role in the biotechnology organizations to ensure their future viability, yet there are differences between the organizations within the biotechnology sector.

   The difference in the percentage radical innovation between the organizations can partly be assigned to the perceived uncertainty. The area of application, the size, age or annual sales are not of influence. The perceived uncertainty of organizations in

uncertain market segments is partly the reason for a high percentage radical innovation.

The case studies show that there are multiple explanations for the degree and type of innovation. The organizational strategy, environmental factors and the difference in perception of the managers about the environment are of influence on the configuration of the NPD function. The current degree and type of innovation are mainly determined by the organizational strategy. Although the R&D managers have some influence on it, they are pushed into one direction by their environment; competitors, customers, investors and parent companies all influence the organizations. The perception of the R&D managers about these environmental factors determines mainly the future development of the NPD configuration.

2) *How is the combination of exploration and exploitation facilitated internally by organizations in the Dutch and Belgian biotechnology sector?*
In this report, the NPD strategy, the organizational form (consisting of the organizational structure and the formalization degree), the NPD climate, and the ambidexterity of the NPD function have been analysed.

A high percentage radical innovation is positively associated with a long-term oriented NPD strategy, which means a primary focus on long-term growth and performance, creating breakthrough new products and do focus on projects with risky outcomes. The results show that most organizations in the biotechnology sector, regardless of the percentage radical innovation, the size of the NPD function and the age of the organization, do work with a predominantly organic structure for the NPD function (except organization 2) and there are three organizations (all with less than 25% radical innovation) with a structure which is a combination between mechanistic and organic elements. There is no relation between the formalization degree and the percentage radical innovation. The formalization degree is widely dispersed, varying from no standard approach at all till a fully formally-documented process. The last subject is the innovative climate of the NPD function. Organizations in the biotechnology sector are working with an open and promotive climate. The open, promotive climate is independent from the percentage radical innovation, the size of the NPD function and the age of the organization.

Data about team structure, formalization degree of the NPD process, and the NPD climate showed that, although it would be interesting for organizations in the biotechnology to use a different approach for the two types of innovation (radical and incremental), organizations currently do not make use of an ambidextrous approach. The approach for radical innovation is the same as for incremental innovation, only the NPD climate differs in more than 50% of all organization in the Dutch and Belgian biotechnology sector between radical and incremental innovation.

3) *How is the combination of exploration and exploitation facilitated through inter-organizational linkages by organizations in the Dutch and Belgian biotechnology sector?*
   Collaboration agreements are important for organizations in the biotechnology sector. Within the Netherlands this network of organizations is larger and there are more possibilities than in Belgium, although the VIB and FlandersBio both are relatively large promoters for collaboration. The presence of such associations in both countries confirms the importance of collaboration. For the current dataset a co-patent analysis does not provide a complete overview of the collaboration agreements. Therefore, the research is elaborated with an analysis of all biotechnology patents filed by Dutch and Belgian organizations at the EPO between 1993 and 2004.

   The co-patent analyses showed that 55% of all co-patents are filed by an organization together with a university, a knowledge institute, the government, or an individual. The other 45% is filed together with another organization, e.g. suppliers, customers, competitors. This implies that organizations in the biotechnology sector make use of heterogeneous networks with various partners. The focus of collaboration agreements is in most cases on the development of new products followed by carrying out fundamental scientific research.

   The case studies confirmed the view about the importance of collaboration agreements and the heterogeneity of the partners. Three out of the four organizations work on a large extent together with other organizations, research institutes and universities. The fourth organization confirms that collaboration will be very important for them in the future.

4) *What are the effects of the combination of exploration and exploitation, and the facilitation of this combination, on the performance of the organizations in the Dutch and Belgian biotechnology sector?*
   Organizations in the biotechnology sector score better on *Product Concept Effectiveness* than on *NPD Process Effectiveness,* due to the high percentage radical innovation and the facilitation of the NPD function, described above. The strengths of the organizations are the performances on *fit with market demands* and *fit with firm competences*, whereas the weaknesses are the performances on *speed* and *productivity.* A difference is noticed between organizations with a high percentage radical innovation and those with a low percentage radical innovation. The difference between the performance on PCE and NPD PE is smaller for organizations with a low percentage radical innovation. In some cases the *process flexibility*, the *productivity* and the *speed* are even the strengths of an organization.

   There is no relation between the percentage radical innovation and the strategic flexibility of the organization. Organizations with a low percentage radical innovation are as strategic flexible as organizations with a high percentage radical innovation. The question arises if a high percentage radical innovation is needed to ensure their future viability. From the case study is derived that for some organizations a high percentage incremental innovation is sufficient for survival, but this depends on the

definition future. Another point of interest is the fact that there is no significant difference in terms of operational effectiveness and strategic flexibility in organizations in the Dutch and Belgian biotechnology sector. Therefore it is difficult to state whether organizations have found the right balance between exploration and exploitation, but with this report organizations in the Dutch and Belgian biotechnology sector can compare their combination of exploration and exploitation with other used combinations and the accompanying facilitation of this combination.

9.2 Recommendations for further research

This report provides a view on how organizations in the biotechnology balance exploration with exploitation, how this is facilitated internally and externally, and the effect on the performance. While answering these questions, new questions kept raising. These questions are recommendations for further research and are summarized below.

- When the dataset is enlarged with more biotechnology organizations from e.g. all over Europe, are the same patterns recognizable?

- This report focuses on the biotechnology sector as a whole and demonstrated the differences between the organizations. It would be interesting to analyse the areas of application independently, therefore more respondents are needed.

- The research showed that the environment can be accounted as being of influence on the percentage radical innovation. It would be interesting to analyses the factors which facilitate or thwart this level of radial innovation, for example by distinguishing environmental actors as financial, social, scientific, etc.

- In many theories it is stated that a distinction in the approach to facilitate radical and incremental innovation could increase the performance. This report shows that a large part of all biotechnology organizations are working with the same approach in formalization degree, team structure and in a lesser extent climate for both radical and incremental innovation. Why do organizations make no distinction in the approach and is this the same in other comparable emerging sectors as e.g. nanotechnology or ICT?

- The Patterns in NPD questionnaire does not contain questions on network and collaboration, although this is an important aspect in emerging sectors as the biotechnology sector. It will be an enrichment for future analysis to add questions about collaboration agreements to the NPD questionnaire.

- An interesting addition will be to check the results of this report, with the results of the same organizations four years later. What is changed in the balance between exploration and exploitation, the facilitation, and what are the effects on performance?

- This report showed that a high correlation is present between operational effectiveness and strategic flexibility. The question arises if strategic flexibility is the right scale for measuring the future viability of the organization. How is future viability measured in other studies? Is it possible to measure future viability, especially in emerging sectors as the biotechnology sector?

References

Aiken, M., Hage, J. (1971); *The organic organization and innovation;* Sociology, Vol.5, pp.63-82.

Aldrich, H.E. (1979); *Organizations and environments;* Englewood Cliffs, NJ, Prentice Hall.

Altena, J. (2005); *The holistic assessment of new product development organizations and their performance;* Universiteit Twente.

Ashford, N.A. (2002); *Government and environmental innovation in Europe and North America;* American Behavioral Scientist, Vol. 45, pp.1417-1434.

Babcock, J.A. (1981); *Organizational responses to resource scarcity and munificence: Adaptation and modification in colleges within a university;* Pennsylvania, Pennsylvania State University.

Bluedorn, A.C. (1993); *Pilgrim's progress: Trends and convergence in research on organizational size and environment;* Journal of Management, Vol.19, No.2, pp.163-191.

Brentani, de, U., Kleinschmidt, E.J.(2004); *Corporate culture and commitment: Impact on performance of international new product development programs;* Journal of Product Innovation Management, Vol.21, pp.309-333.

Brown, S.L., Eisenhardt, K.M. (1995); *Product Development: Past Research, Present Findings, and Future Directions;* Academy of Management Review, Vol. 20, No. 2; pp. 343–378.

Burns, S.L., Stalker, G.M. (1961); *The management of Innovation;* London, Tavistock.

Chiesa, V., Coughlan, P. (1996); *Development of a technical innovation audit;* Journal of Product Innovation Management, Vol.13, pp.105-136.

Christinsen, C.M. (1997); *The innovators Dilemma: When new technologies cause great firms to fail;* Boston, Massachusetts, Harvard Business School Press.

Clark, K.B., Wheelwright, S.C. (1992); *Organizing and leading "heavyweight" development teams*; California Management Review, Spring 1992; pp.9-28.

Clark, K.B., Wheelwright, S.C. (1993); *Managing new product and process development;* New York, The free press.

Cooper, R.G. (2000); *Product Innovation and Technology Strategy*; Research Technology Management, January- February 2000; pp. 38-40.

Cooper, R.G. et al. (2004); *Benchmarking best NPD practices I;* Research Technology Management, January-February 2004; pp.31-43.

Cooper, R.G. et al. (2004); *Benchmarking best NPD practices II*; Research Technology Management, May-June 2004; pp. 50-59.

Cooper, R.G., Kleinschmidt, E.J. (1995); *Benchmarking the firm's critical success factors in new product development;* Journal of Product Innovation Management, Vol.12 (1995); pp.374-391.

Crozier, M. (1964); *The bureaucratic phenomenon;* Chicago, University of Chicago Press.

D'Aveni, R. (1994); *Hypercompetition: Managing the dynamics of strategic maneuvering,* New York, Free Press.

Daft, R.L. (2001); *Organization theory and design;* Cincinatti, Ohio, South Western Thomson Learning.

DeWeerd-Nederhof, P.C., et al (2005); *Patterns in NPD: searching for consistent configurations. A pilot of Dutch, Finnish and Portuguese cases;* in CD ROM proceedings of the 2005 R&D management conference, Pisa, Italy, 6-9 July 2005.

DeWeerd-Nederhof, P.C., et al (2005); *Assessing operational NPD effectiveness and strategic NPD flexibility for the design of new product development configurations*; in CDRom proceedings of the CINet Conference, Brigthon, UK, 4-6 sept. 2005.

Duncan, R.B. (1972); *Characteristics of organizational environments and perceived environmental uncertainty;* Administrative Science Quarterly, Vol.17, No.3, pp.313-327.

Ekvall, G. (1997); *Organizational climate for creativity and innovation*; European Journal of Work and Organizational Psychology, 1996; Vol.5, No.1; pp.105-123.

Emery, F.E., Trist, E.L.; (1965); *The causal texture of organizational environments;* Human Relations, vol.18, pp.21-32.

Ernst, H., (2002); *Success factors of new product development: a review of the empirical literature;* International Journal of Management Reviews; March 2002, Vol. 4, Issue 1.

Ernst & Young (2000); *Biotechnology report;* Ernst & Young.

Ettlie, J.E., Bridges, W.P., O'Keefe, R.D. (1984); *Organization strategy and structural differences for radical versus incremental innovation*; Management Science, Vol.30, No.6, June 1984; pp.682-695.

Faems, D., Van Looy, B., Debackere, K. (2005); *Interorganizational collaboration and innovation: Toward a portfolio approach;* Journal of Product Innovation Management, Vol.22, pp.238-250.

Gilsing, C. (2005); *The dynamics of innovation and interfirm networks;* Norhthampton, Edward Elgar Publishing.

Ganzel, W. et al (2003); *Domain study "biotechnology"- An analysis based on publications and patents;* Steunpunt O&O Statistieken.

Griffin, A. (1997); *Modeling and measuring product development cycle time across industries*; Journal of Engineering and Technology Management, Volume 14, No.1; pp.1-24.

Griffin, A., Page, A.L. (1996); *PDMA success measurement project: recommended measures for product development success and failure;* Journal of Product Innovation Management, Vol.13, No.6, 478-496.

Griffin, A., Page, A.L. (1993); *An interim report on measuring product development success and failure;* Journal of Product Innovation Management, Vol.10, pp.291-308.

Hamel, G. (2000); *Leading the revolution;* Boston, Massachusetts, Harvard Business School Press.

Hannan, M.T., Freeman, J.H. (1984); *Structural inertia and organizational change;* American Sociological Review, Vol.49, pp.149-164.

Hagedoorn, J. (1995); *Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences;* Strategic Management Journal, Vol.14, pp.371-385.

Hellriegel, D., Slocum, J.W. Jr., (1974); *Organizational climate: Measures, research and contingencies;* Academy of Management Journal, Vol.17, No.2, June 1974; pp.255-280.

Hill, C.W.L., Jones, G.R. (1998); *Strategic Management: An integrated approach;* Boston, NY, Houghton Mifflin Company.

Hulse, J.H. (2004); *Biotechnologies: past history, present state and future prospects*; Food Science & Technology, Vol.15, pp.3-18.

Iansiti, M. (1995); *Shooting the rapids: Managing product development in turbulent environments;* California Management Review, Vol.38, pp.37-58.

Isaksen, S.G., Lauer, K.J. (2002); *The climate for creativity and change in teams;* Creativity and Innovation Management, Vol. 11 (1), March 2002; pp. 74-86.

Isaksen, S.G., Lauer, K.J., Ekvall, G., Britz, A. (2001); *Perceptions of the best and worst climates for creativity;* Creativity Research Journal, Vol.13, No.2, pp.171-184.

Isobe, T., Makino, S., Montgomery, D.B. (2004); *Exploitation, exploration, and firm performance: the case of small manufacturing firms in Japan;* https://mercury.smu.edu.sg/rsrchpubupload/4696/2804paper_IMM.pdf.

Johnson, G., Scholes, K. (1997); *Exploring corporate strategies;* London, Prentice Hall.

Johnson, J.L., Pui-Wan Lee, R. (2003); *Market-focused strategic flexibility: conceptual advances and an integrative model;* Journal of the academy of marketing science, Vol.31, pp.74-89.

Kanter, R.M.(1985); *Supporting innovation and venture development in established companies;* Journal of Business Venturing, Vol.1, pp.47-60.

Katz, R., Allen, T.J. (1985); *Project performance and the locus of influence in the R&D matrix*; Academy of Management Journal, Vol.28, No.1; pp.67-87.

Kessler, E.H., Bierly, P.E. (2002); *Is faster really better? An empirical test of the implications of innovation speed;* IEEE Transactions on Engineering Management, Vol.49, pp.2-12.

Kessler, E.H., Bierly, P.E. (2000); *Internal vs. external learning in new product development: effects on speed, cost and competitive advantage;* R&D Management, Vol.30, pp.213-223.

Koberg, C.S. (1987); *Resource, environmental uncertainty, and adaptive organizational behavior;* Academy of Management Journal, Vol.30, pp.798-808

Koza, M.P., Lewin, A.Y. (1998); *The co-evolution of strategic alliances;* Organization Science, Vol.9, pp.255-264.

Lauer, K.J., Isaksen, S.G., Ekvall, G. (1999); *Situational outlook questionnaire: A measureof the climate for creativity and change;* Psychological Reports, Vol.41, pp.40-84.

Leenders, M.A.A.M., Wierenga, B. (2002); *The effectiveness of different mechanisms for integrating marketing and R&D;* Journal of Product Innovation Management, Vol.19, pp.305-317.

Levinthal, D.A., March, J.G. (1993); *The myopia of learning;* Strategic Management Journal, Vol.14, pp.95-112.

Lichtenhaler, E., Savioz, P., Birkenmeier, B., Brodbeck, H. (2004); *Organizatoin of the early phases of the radical innovation process;* Internation Journal of Technology Intelligence and Planning, Vol.1, pp.100-113.

March, J.G. (2003); *Understanding organizational adaptation;* Society and Economy, Vol.25, pp.1-10.

March, J.G. (1991); *Exploration and exploitation in organizational learning;* Organization Science, Vol.2, No.1, February 1991; pp.71-87.

McDonough III, E.F. (2000); *Investigation of factors contributing to the success of cross-functional teams*; Journal of Product Innovation Management, Volume 17; pp.221-235.

Moenaert, R.K., Souder, W.E., De Meyer, A., Deschoolmeester, D. (1995); *R&D/Marketing communication during the fuzzy front-end;* IEEE Transactions on Engineering Management, Vol.42, No.3, pp.243-258.

Narayanan, V.K. (2001); *Managing technology and innovation for competitive advantage;* Saddle River, NJ, Prentice Hall.

Narver, J.C., Slater, S.F. (2004); *Responsive and proactive market orientation and new-product success;* Journal of Product Innovation Management, Vol. 21, pp.34-347.

Nooteboom, B., Gilsing, v. (2006); *Exploration and exploitation in innovation systems; The case of pharmaceutical biotechnology*, Research Policy, Vol.35, pp.1-23.

Nooteboom, B. (1999); *Management van partnerships;* Schoonhoven, Academic service.

Pfeffer, J., Salancik, G. (1978); *The external control of organizations;* New York, Harper and Row.

Pullen, A. (2006); *Organising product development for high innovation performance in the Spanish medical devices sector;* Enschede, Universiteit Twente.

Pyka, A., Saviotti, P. (2000); *Innovation Networks in the Biotechnology-Based Industries;* Sein-Working paper #7.

Ring, P.S., Van de Ven, A.H., (1994); *Development processes of cooperative interorganizational relationships;* The Academy of Management Review, Vol.19, No.1, pp. 90-118.

Rothaermel, F.T., Deeds, D.L. (2003); *Exploration and exploitation alliances in biotechnolgoy: a system of new product development;* Strategic Management Journal, Vol.25, pp.201-221.

Schoonhoven, C.B., Jelinek, M. (1990); *Dynamic tension in innovative, high technology firms: managing rapid technological change through organizational structure;* in *Managing Complexity in High Technology Organizations*, M.A. Von Glinow and S.A. Mohrman, Eds. New York, Oxford University Press, pp.90-118.

Sosa, M.E., et al (2004); *The misalignment of product architecture and organizational structure in complex product development;* Management Science, Vol.50, No.12, December 2004; pp.1674-1689.

Swink, M. (1999); *Threats to new product manufacturability and the effects of development team integration processes;* Journal of Operations Management, Vol.17, pp.691-709.

Terreberry, S. (1968); *The evolution of organizational environments;* Administrative Science Quarterly, Vol.12, p.377-396

Tidd, J. (2001); *Innovation management in context: environment, organization and performance;* International Journal of Management Reviews; September 2001, pp. 169-183.

Thomke, S.H.(1997); *The role of flexibility in the development of new products: an empirical study;* Research Policy, Vol.26, 105-119.

Thompson, J.D. (1967); *Organization in action;* New York, McGraw-Hill

Tushman, L., O'Reilly III, C.A. (2004); *The ambidextrous organization;* Harvard Business Review, April 2004, pp.74-81.

Ulrich, D., Barney, J.B. (1984); *Perspectives in organizations: Resource Dependence, efficiency, and population;* The academy of Management Review, Vol.9, No.3., pp.471-481.

Veryzer Jr., R.W. (1998); *Discontinuous innovation and the new product development processl;* Journal of Product Innovation Management, Vol.15, pp.304-321.

Wheelwright, S.C., Clark, K.B. (1992); *Creating project plans to focus product development*; Harvard Business Review, March-April 1992; pp. 70-81.

Yam, R.C.M., Guan, J.C. (2004); *An audit of technological innovation capabilities in Chinese firms: some empirical findings in Beijing, China;* Research Policy, Vol.33, pp.1123-1140.

Zaltman, G., Duncan, R., Holbek, J. (1973); *Innovations and organizations;* Wiley, New York.

Appendix A

Bankroet door biotech

Hester van Santen

Na een mislukt biotech-avontuur is Mathieu Noteborn, ontdekker van het potentiële kankermedicijn apoptin, terug aan de universiteit. In een nieuw lab onderzoekt hij in detail hoe kanker en andere ziekten ontstaan.

Van uitkeringsgerechtigde naar hoogleraar in anderhalf jaar: slechts weinigen zullen het biochemicus prof.dr. Mathieu Noteborn nadoen. Tien jaar geleden deed hij aan de universiteit een ontdekking die een nieuw kankermedicijn kon opleveren, werd wetenschappelijk directeur van een biotech-bedrijf en ging failliet. Sinds deze maand is hij officieel terug bij de alma mater: een eigen onderzoeksgroep gaat in detail uitzoeken hoe kanker en andere ziekten eigenlijk ontstaan. 'Ik wilde terug naar de chemie.'

Aanleiding van Noteborns curieuze carrièresprongen is het eiwit apoptin. Tot 1993 was het enkel bekend als virus-eiwit dat bij kippen bloedarmoede veroorzaakt. Noteborn ontdekte echter dat het eiwit in zoogdieren ook tumorcellen aanpakt: als apoptin in een kankercel wordt ingebracht, gaat die cel dood. 'Geprogrammeerde celdood', of apoptose, heet het proces, en het is juist wat kankercellen normaliter node missen. Bijkomend voordeel: gezonde cellen trekken zich niets aan van apoptin, die blijven gewoon leven.

Het lijkt een goudmijn voor farmaceuten, en na een koude start van een paar jaar investeerde de Duitse farmacie-gigant Schering AG in 1999 omgerekend 5 miljoen euro in Leadd, het bedrijf dat Noteborn inmiddels had opgericht met een compagnon die de zakelijke kant zou beheren.

Wetenschappelijk ging het prima met apoptin. De werking ervan werd aangetoond bij menselijke kankercellen in de reageerbuis en in levende muizen; beetje bij beetje ontdekten Noteborn en zijn vijftien collega's hoe apoptin in kankercellen zijn werk deed. Maar het beoogde zakelijke succes bleef uit. Toen het geld van Schering twee jaar geleden op was, stond Leadd – deels in bezit van de Leidse universiteit – ondanks achttien octrooien met lege handen. In april 2003 werd het onderzoeksteam naar huis gestuurd.

Schering werkt ondertussen nog altijd aan een gentherapie op basis van apoptin, maar ook het wetenschappelijke werk kreeg toch een vervolg, zo laat Noteborn zien op een laptop. Op een paar stoelen na is het de enige vorm van interieur in zijn verder nog totaal kale kamer, in de laagbouw van het Gorlaeus. 'Ik ben niet meer zo zielig als twee jaar geleden', zo zegt hij met trots en een vleugje opluchting. Op het scherm verschijnt een schets van de interne samenwerkingen die de biochemicus verwacht binnen zijn

leeropdracht. Lijntjes lopen naar ongeveer alle hippe onderwerpen in de levenswetenschappen: genomics, proteomics, bio-informatics, bio-imaging.

Wat hij gaat doen, heet officieel *Biologische chemie, in het bijzonder in-vivo biomoleculaire interacties*. 'In de praktijk heb je het dan vooral over eiwit-eiwit interacties. Verkeerde interacties tussen eiwitten spelen een rol bij eigenlijk alle ziektes: kanker, reuma, depressie, Alzheimer, noem maar op. Die wil ik bestuderen in ziekte én gezondheid. Want je kunt alleen herkennen wat er mis is als je de normale toestand kent.'

Hoewel dat nogal algemeen overkomt, verzekert de biochemicus dat zulke studies totnogtoe niet op die manier plaatsvonden aan de Leidse universiteit – in ieder geval niet in zulk detail. 'We gaan ons niet alleen bezig houden met de structuur van een eiwit en zijn interacties, maar ook met localisatie van het eiwit in de cel, en met de dynamica van de reacties die de eiwitten uitvoeren.'

Voor dat werk zet het Leidse chemie-instituut LIC momenteel een heel nieuw laboratorium neer. Volgens Noteborn is er 'een aardig bedrag' in geïnvesteerd. Het Genomics Platform betaalt mee via het Leidse Centre for Molecular Systems Biology, het imaging-deel komt van het Cyttron-project van biochemicus Jan-Pieter Abrahams dat vorig jaar een financiële injectie kreeg uit de landelijke aardgasopbrengsten. Faciliteiten voor weefselkweek, chromatografie, microscopie zijn inmiddels besteld; in april gaan de eerste drie onderzoekers aan het werk. In principe kunnen alle partner-instituten er projecten op het gebied van eiwit-interacties voor aanleveren.

En apoptin? Nadat de biochemicus het eiwit om patent-technische redenen opnieuw gefabriceerd had, gaat het een rol spelen in het eerste onderzoeksproject van de groep van Mathieu Noteborn: zijn oude specialisme van de geprogrammeerde celdood in tumorcellen. Want hoewel hij vijf jaar geleden zeker niet de enige was die daarmee een kankermedicijn wilde ontwikkelen – integendeel, er was sprake van een ware apoptose-hype – weten we nog vrij weinig van het mechanisme van apoptose. 'Ik weet nog dat de *pathway* uit vier of vijf stapjes bestond.' Dat speelt medicijnbouwers nu parten.

Tot in detail moet bekend worden hoe het komt dat een beschadigde cel ervoor kiest om zo te veranderen dat hij niet meer voor apoptose vatbaar is: dan is de cel een kankercel geworden. Omdat apoptin reageert op tumorcellen waarin apoptose is geblokkeerd, is het mogelijk om daarmee de kettingreactie op te sporen die tot deze blokkade leiden. Noteborn: 'Apoptin wordt het lampje waarmee we dat gaan onderzoeken.'

Bovendien ontdekte een van Noteborns promovendi dat een bepaald virus-eiwit cellen in een toestand brengt die sprekend lijkt op de stand van zaken in een ontluikende tumorcel (zie kader). Met behulp van dat eiwit zijn al eiwit-eiwit-interacties in zulke cellen ontdekt. Eigenlijk, vertelt de biochemicus, speelt apoptin dan nog enkel een handige bijrol. 'Misschien denken we over een paar jaar: dat apoptin hebben we nog wel ergens in de koelkast, maar wij zijn alweer verder.'

Appendix B

Question	Subject	Chapter
4	General aspects - Age	5
6	General aspects - Size & Annual sales	5
13	Environmental uncertainty	5
16	Percentage radical innovation	5
17	NPD as part of the sales	5
19	percentage NPD employees	5
20	PCE - Demand	8
21	PCE - Competences	8
22	NPD PE - Speed	8
23	NPD PE - Productivity	8
24	NPD PE - Flexibility	8
25	Process formalization	6
31	Strategy	6
35A	Organic vs. Mechanistic	6
36	Team structure	6
37	Climate	6

Questionnaire

"Patterns in New Product Development"

- Strictly confidential -

"Patterns in New Product Development"

In the questionnaire you will find instructions for each set of questions. We understand that in some cases you may find that the particular question does not entirely fit your case. Whenever such situations happen, please use your best judgment to answer the question and try not to skip it. We sincerely appreciate your efforts in completing all questions.

Please note that individual responses will be strictly confidential and only known to the research team. However, sometimes it is relevant to us to cite a company name. We will always ask written permission in these cases. Please indicate whether you want to stay anonymous in all cases, and/or whether we may contact you again for further collaboration

☐ Yes, I wish to remain anonymous in all cases
☐ Yes, I am happy to be contacted again

Thank you very much for your cooperation!

Your name:	
Your email address:	
Your telephone number:	
Your position within the organization:	
The name of your business unit (if applicable):	
Your mailing address:	

Description of the Strategic Business Unit

1. What is the name of your business unit?

2. What best describes your business unit (tick one)

☐	Independent company	Go to 4
☐	A division / business unit belonging to a parent company	Go to 3
☐	A single location / plant	Go to 3

3. What is the name of your parent company?

4. What is the year of establishment of your business unit?

5. What is the primary geographic region where you do business?

☐	Limited to a single location
☐	Spread out over a single geographic region
☐	Nationwide
☐	International

6. Please answer the next questions about the size of your business unit:

What are total annual sales?		Million EUR
What is the total number of employees in full time equivalent?		FTE

7. How would you describe the primary product mix (tick one)?

☐	High volume/high mix
☐	High volume/low mix
☐	Low volume/ High Mix
☐	Low volume/low mix

Products and Processes

8. Identify the Core Products for which you will answer all questions in the questionnaire.

9. Please indicate the industry sector for this Core Product [SIC code(s)]:

10. What proportion of your customer orders for the Core Products identified are:

% Industrial products (products to be used by other companies for their transformational processes).
% Consumer products (products are intended to the final consumer market and no more transformations).

11. Please indicate the type of process that is used to manufacture your Core Products (Tick one answer):

☐ Engineer to order: Design, purchasing, manufacturing and assembly is done for a designated customer. (Go to 12)
☐ Manufacture to order: Design, raw materials, and components are in stock. (Go to 13)
☐ Assemble to order: Just subsystems and subassemblies are in stock and the final assembly occurs based on a designated customer order. (Go to 13)
☐ Produce to stock: Products are produced and are kept in stock near the customer or at the company. (Go to 13)

12. Please specify the influence of customer demand (Tick one answer).

When an order arrives we start our engineering activities based upon …

☐ … a specific technology.
☐ … pre-defined product families.
☐ … pre-defined product sub-functions and solution principles.
☐ … pre-defined product modules.
☐ … pre-defined generally detailed finished goods.

Environment

13. Each of the following items consists of a pair of statements, which represent two extremes on characteristics of your industrial sector (as filled in for your Core Products) or on your business unit. Please circle the number on the scale that best approximates the actual conditions.

a.	**Safe**, little threat to the survival and well being of the organization.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	**Risky**, one false step can mean my organization's undoing.
b.	**Rich opportunities** in investment and marketing.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	**Few opportunities**, stressful, hostile, hard to keep afloat.
c.	A **dominant organization** that can control and manipulate the environment to its own advantage.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	A **dominating environment** in which our initiatives count for very little against environmental forces.
d.	Our organization **must rarely change** its practices to keep up with the market and competitors.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Our organization **must frequently change** its practices.
e.	The rate at which products are getting obsolete in the industry is **low**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	The rate at which products are getting obsolete in the industry is **high**.
f.	Actions of competitors are **easy to predict**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Actions of competitors are **unpredictable**.
g.	Demand for the product and consumer tastes are **easy to predict**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Demands for the product and consumer tastes are **unpredictable**.
h.	The production technology is subject to **little change**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	The production technology is subject to **much change**..

i.	The nature of the competition is about **the same** for all products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	The nature of the competition **varies a great deal** from one product to another.
j.	The required methods of production are about **the same** for all products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	The required methods of production **vary a great deal** from one product to another.
k.	Customers' buying habits are about **the same** for all products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Customers' buying habits **vary a great deal** from one product to another.

Business Strategy

14. Which of the texts below most closely describes your business unit's approach your Core Product's marketplace?

- [ ] We continuously search for market opportunities and regularly experiment with potential responses to emerging environmental trends. Therefore, we often are the creators of change and uncertainty to which our competitors must respond.

- [ ] We attempt to maintain a stable, limited line of products or services, operating routinely and efficiently through the use of formalized structures and processes. At the same time, we monitor a carefully selected set of promising new product and market developments in different industries.

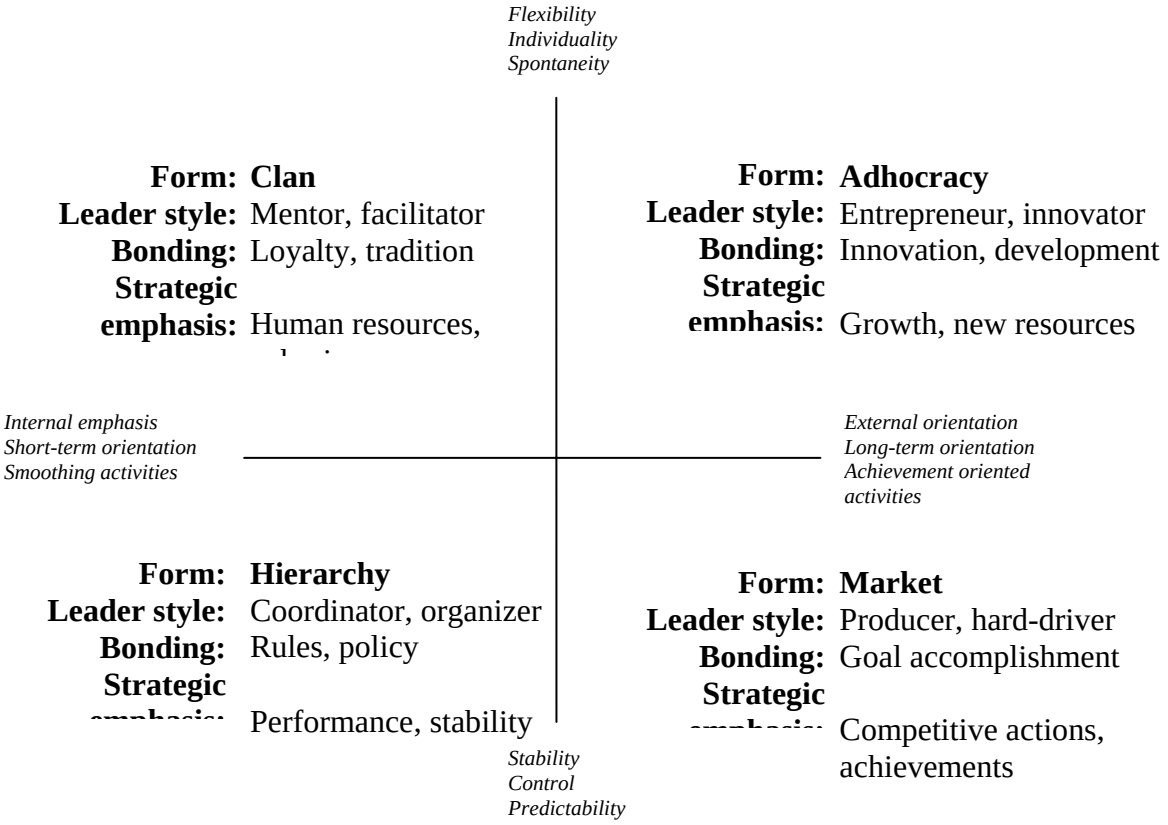
- [ ] We have narrow product-market domains. Our top-managers are experts in their business-limited area of operation but do not tend to search outside of their domains for new opportunities. We seldom need to make major adjustments in our technology, structure, or methods of operation. We devote primary attention to improving the efficiency of our operations.

- [ ] We frequently perceive change and uncertainty occurring in our organizational environments but are unable or unwilling to respond effectively. We lack a consistent strategy-structure relationship, and we seldom make adjustments of any sort until we are forced to do so by environmental pressures.

Business Unit's Culture

15. Please have a look at the picture below visualizing various types of organizational culture. Which of these most closely describes your *business unit's* culture (choose one)?

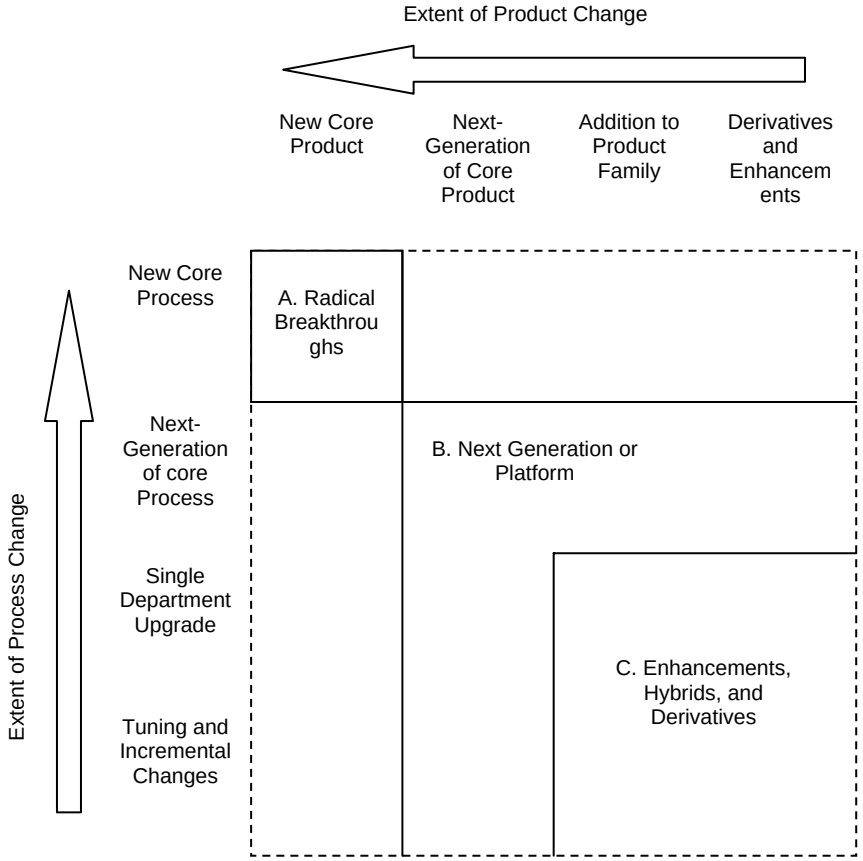
- ☐ **Clan**
- ☐ **Adhocracy**
- ☐ **Hierarchy**
- ☐ **Market**



Description of the New Product Development Function

With the *NPD Function*, the set of activities necessary to initiate, coordinate, and accomplish the product and related production process development activities of the business unit is meant. Please note therefore that the NPD function includes but is not necessarily restricted to the activities of the NPD department.

16. Please estimate the percentage of your organization's total new product development activities accounted for by the Core Products of each of the following three types.



%	A. Radical breakthroughs in core products and processes
%	B. Next generation of core product and / or process
%	C. Enhancements, hybrids, and derivatives of core product and or process
100 %	

17. Please distribute the percentages of your total annual sales (as filled in in question 6) originating from the following types of new products which have been introduced the last **three** years (the total sums up to 100%).

%	Breakthrough new products
%	Next generation new products
%	Addition to Product Family and/or Derivatives/Enhancements
%	Non modified products
100 %	

18. Please indicate below for which part of the NPD function you are responsible (more than one answer is possible):

☐ Radical Innovation (Breakthrough New Products and/or Next Generation)

☐ Incremental Innovation (Addition to Product Family and/or Derivatives/enhancements)

19. Please answer the following questions about the size of your NPD function:

What is your total NPD budget in % of annual sales?	
How is this divided over the different types of NPD activities?	☐ Not divided ☐ Radical Innovation: % ☐ Incremental Innovation: %
What is the total number in fulltime equivalent of employees in NPD?	
How is this divided over the different types of NPD activities?	☐ Not divided ☐ Radical Innovation: FTE ☐ Incremental Innovation: FTE

Operational Effectiveness and Strategic Flexibility of your NPD Function

20. In this section please indicate your level of achievement on objectives concerning the *fit with market demands* achieved by your NPD function and the ability to *anticipate* on them.

		Not at all achieved						Very well achieved	Don't know
a.	Our new products meet customer requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Our new products are delivered on time.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	The cost of our new products is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	The quality of our products is good.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	The impact of our NPD program on our sales level is positive.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	We get good returns from our NPD program relative to our spending on it.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	Our current development projects include new product-market options.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h.	We prefer NPD projects that generate options for future product development	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
i.	NPD is successful in opening new markets to our organization.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
j.	NPD is successful in leading our organization into new product areas.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
k.	Our NPD activities open new technologies to our organization.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
l.	We incorporate solutions to unarticulated customer needs in our new products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

21. In this section please indicate your level of achievement on objectives concerning the *fit with firm competences* achieved by your NPD function and the ability to *build* these competencies.

		Not at all achieved						Very well achieved	Don't know
a.	The degree of manufacturing cost advantage that NPD provides is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Few manufacturing problems occur during production start-up phases.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Only few product design changes are needed to solve manufacturing performance.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	Marketing and NPD often share information.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	Conflicts between marketing and NPD are of a constructive kind.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	Marketing and NPD are more like teammates than competitors.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	Our competence to explore new technological developments from inside the BU is well developed	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h.	We built upon manufacturing competences for the exploration of new technological developments	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
i.	We are very much inspired by marketing for the development of new ideas form inside the BU.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
j.	We can pass lessons learned on across organizational boundaries.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
k.	We can pass lessons learned on over time.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
l.	We are able to enhance our competences by tapping into external sources	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

In the following section please indicate your level of achievement on objectives concerning the *speed* of the processes carried out by your NPD function as well as your ability to *anticipate* on future time constraints.

You may first want to take a look at this figure that shows the concepts of Development Time, Concept To Customer time and Total Time which are used in this question.

<table>
<tr><th>Stage</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td>Name</td><td>Concept generation</td><td>Project evaluation</td><td>Development</td><td>Manufacturing development</td><td>Commercialization</td></tr>
<tr><td>Starting activity</td><td>Surfacing of idea</td><td>Developing of specs</td><td>Spending on physical development</td><td>Documentation of process development</td><td>Production trials (End: manufacturing for sales)</td></tr>
<tr><td></td><td></td><td></td><td colspan="3">Development Time (DT)</td></tr>
<tr><td></td><td></td><td colspan="4">Concept To Customer time (CTC)</td></tr>
<tr><td colspan="6">Total Time (TT)</td></tr>
</table>

22. Please indicate your level of achievement on following objectives:

		Not at all achieved						Very well achieved	Don't know
a.	Our new products are launched on schedule.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Scheduled time is in line with total development time (TT).	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Our Development Time (DT) is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	Our Concept to Customer Time (CTC) is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	Our Total Time (TT) is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	The speed of the NPD decision making process is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	We can estimate future requirements on our total development time (TT).	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h.	We are able to adjust our NPD process to future time requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

i.	We can estimate future requirements on the speed of our NPD decision making process.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
j.	We are able to adjust our NPD decision making process to future requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
k.	We are able to forecast the future requirements on the commitment to translating our NPD decisions into actions.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
l.	We are able to adjust the commitment to translating NPD decisions into actions to the requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

23. In this section please indicate your level of achievement on objectives concerning the *productivity* of your NPD function as well as your ability to *anticipate* on future productivity constraints.

		Not at all achieved						Very well achieved	Don't know
a.	We can develop the same products with a lower budget than assigned.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Development costs of our products hardly exceed budgets.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Beyond-budget products do not exceed budgets with a large amount.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	Our development costs are relatively low.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	Realized development hours do not often exceed budgeted hours.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	We can estimate the future internal cost requirements for our development process.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	We are able to adjust our development process to the future cost requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h.	Our ability to predict future development costs is well developed.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
i.	We are well capable to adjust development costs	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
j.	We are able to adjust the number of development hours to future requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

24. In this section please indicate your level of achievement on objectives concerning the *flexibility* of the processes of your NPD function as well as the ability to *anticipate* on future needs for operational process flexibility.

		Not at all achieved						Very well achieved	Don't know
a.	The average time of product enhancement is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	The average time of product redesign is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Our ability to change the design fast, after being confronted with new specs, is well developed.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	The average cost of redesign is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	We can process a change of specs without a lot of extra financial resources.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	Our ability to change specs late is satisfactory.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	We are able to forecast the requirements on the time of redesign.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h.	We are able to adjust the average time of product redesign to future requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
i.	We are capable in forecasting the future requirements on the cost of product redesign.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
j.	We are capable to adjust the average cost of product redesign to future requirements.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
k.	We are able to predict changes in specifications.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
l.	We are able to anticipate on changes in specifications.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

NPD process and roles

25. Please check the box that most closely describes your business unit's incremental development processes. Please tick one answer.

- ☐ No standard approach to new product development.
- ☐ While no formally-documented process is followed, we have a clearly understood path of the tasks to be completed in product development.
- ☐ We have a formally-documented process where one function completes a set of tasks, then passes the results on to the next function which completes another set of tasks.
- ☐ We have a formally-documented process where a cross-functional team completes a set of tasks; management reviews the result and gives the go-ahead for the team to complete the next set of cross-functional tasks.
- ☐ We have a formally-documented process where a facilitating "process owner" helps cross-functional teams move through stages and management reviews.
- ☐ We have a formally-documented process where a cross-functional team uses a staged process with overlapping, fluid stages and "fuzzy" or conditional stage decisions.

26. Please check the box that most closely describes your business unit's radical development processes. Please tick one answer.

- ☐ No standard approach to new product development.
- ☐ While no formally-documented process is followed, we have a clearly understood path of the tasks to be completed in product development.
- ☐ We have a formally-documented process where one function completes a set of tasks, then passes the results on to the next function which completes another set of tasks.
- ☐ We have a formally-documented process where a cross-functional team completes a set of tasks; management reviews the result and gives the go-ahead for the team to complete the next set of cross-functional tasks.
- ☐ We have a formally-documented process where a facilitating "process owner" helps cross-functional teams move through stages and management reviews.
- ☐ We have a formally-documented process where a cross-functional team uses a staged process with overlapping, fluid stages and "fuzzy" or conditional stage decisions.

27. The development of a new product is often described as a series of interdependent and possibly overlapping stages. Below are descriptions of several development activities. Please cross the activity if your business units' new product development process includes this activity. (Tick one or more answers for each type of innovation.)

	Incremental	Radical
Project Strategy Development: Delineate the target market, determine market need, attractiveness.	☐	☐
Idea / Concept Generation: Identify opportunities and initial generation of possible solutions.	☐	☐
Idea Screening: Sort and rank solutions, eliminate unsuitable and unattractive options.	☐	☐
Business Analysis: Evaluate the concept financially, write business case, prepare protocol/development contract.	☐	☐
Development: Convert concept into a working product.	☐	☐
Test and Validation: Product use, field, market and regulatory testing with customers.	☐	☐
Manufacturing Development: Developing and piloting the manufacturing processes.	☐	☐
Commercialization: Launching the new product or service into full scale production and sales.	☐	☐

28. Please indicate for each of the roles described below whether these behaviors can be identified throughout your NPD function.

	Present in NPD? [yes/no]	Limited to one phase					Throughout the whole NPD process
Idea Generator							
- searching for breakthroughs by linking diverse ideas - testing feasibility of ideas	☐ Yes ☐ No	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Champion							
- sells new ideas to others in the organization and gets resources - recognizes, proposes and pushes a new technical idea for formal management approval	☐ Yes ☐ No	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Project Leader							
- provides the team leadership and motivation - plans and coordinates the diverse sets of activities and people involved in moving a demonstrated idea into practice	☐ Yes ☐ No	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

Gatekeeper - collects and channels information about important changes in the internal and external environments - passes information on to others	☐ Yes ☐ No	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐
Sponsor - provides encouragement, guidance, and acts as a sounding board for the project leader and others - guides and develops less experienced personnel in their roles	☐ Yes ☐ No	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐

NPD Strategy

29. How important is the role of the following competitive priorities in your business unit's NPD strategy? Please indicate for each of the indicators if their priority has changed over the last three years and also if you expect their importance to change over the next three years.

	Over the last three years the competitive priority has							Over the next three years the competitive priority will							
	become less important			stayed the same		become more important		become less important			stay the same		become more important		Don't know
Product price	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Product functionality	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Conformance quality	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Time-to-market for new products	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Product design/innovation	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Product customization	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Product range	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Company reputation	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Environmentally sound products	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
Others, namely: _____	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

30. In this section please indicate your level of agreement with each statement about NPD strategy.

		Strongly disagree						Strongly agree	Don't know
a.	The role of NPD in achieving business goals is clearly articulated.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	There is a formally stated NPD strategy.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	We have clearly defined goals for all our individual new products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	Systematic project portfolio management is in place.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	The project portfolios are aligned with the business strategy.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

31. Each of the following items consists of a pair of statements, which represent the two extremes on goals mentioned in your NPD Strategy. Please circle the number on the scale that best approximates the actual content of your NPD strategy.

a.	We primary focus on **long-term growth**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	We primary focus on **short-term profit**.
b.	We primary focus on projects with **risky** outcomes.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	We primary focus on projects with **predictable** outcomes.
c.	We are mainly focused on creating **breakthrough** new products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	We are mainly focused on creating **incremental** new products.
d.	We mainly focus on **long-term performance** of our NPD function.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	We mainly focus on **short-term performance** of our NPD function.

32. In this section please indicate your level of agreement with each statement about NPD technology strategy

		Strongly disagree						Strongly agree	Don't know
a.	We clearly identify technological areas that focus our NPD efforts.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Future technological trends are important in our NPD planning.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Our project portfolio is balanced across technologies.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

33. In this section please indicate your level of agreement with each statement about NPD product strategy

		Strongly disagree						Strongly agree	Don't know
a.	We clearly identify future products as a focus of our NPD efforts.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Future products are explicitly included in our NPD planning.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Our project portfolio is balanced across products.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

34. In this section please indicate your level of agreement with each statement about NPD market strategy

		Strongly disagree						Strongly agree	Don't know
a.	The focus of our NPD efforts clearly relates to target markets.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	Future markets are explicitly addressed in our NPD planning.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	Our project portfolio is balanced across markets.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

NPD structure

35. How are people within the NPD function organized?

☐ Departments
☐ Project teams
☐ Matrix management
☐ Self-managed work teams
☐ Other

35a. Each of the following items consists of a pair of statements which represent the two extremes on characteristics of your organizational structure. Please Tick the number on the scale that best approximates the actual conditions in your organization.

a.	Tasks are broken down into very **specialized** units.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Tasks are broken down into subunits, but the relation to the **organization's task** is much clearer.
b.	Tasks remain **rigidly defined**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Tasks are continuously **adjusted**.
c.	**Specific** definition of responsibility that is attached to the individual's functional role only.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	**Broad** definition of responsibility that goes beyond the individual's functional role.
d.	A **strict** hierarchy of control and authority.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	**Little** hierarchy of control and authority.
e.	The formal leader is assumed to be **omniscient** in knowledge concerning all matters.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	The formal leader is **not** assumed to be **omniscient** in knowledge concerning all matters.
f.	Lines of communication	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Lines of communication

	are dominated by **hierarchy** between superiors and subordinates.							are dominated by **functionality**.
g.	The content of communication mainly consists of **instructions and decisions**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	The content of communication mainly consists of exchange of **information and advice**.
h.	In the set of values commitment to **superiors** is highly valued.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	In the set of values commitment to **tasks** is highly valued.
i.	Employees primarily identify themselves with the **organization itself**.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	Employees primarily identify themselves with affiliations and expertise in the **larger environment**.

36. Please indicate which of the structures pictured and described in the next figure is / are the most common NPD structure(s) within your business unit.

If your NPD function is **divided**, please tick the most common structures for both incremental and radical innovation. If your NPD function is not divided, just fill in the appropriate structure for the whole NPD function.

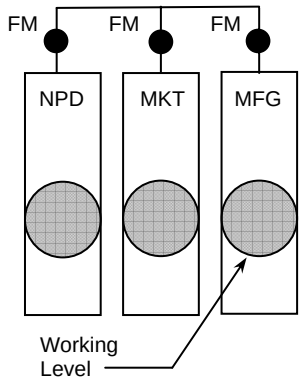
- See the next page for more information on the different Team Structures -

	Functional Team Structure	Lightweight Team Structure	Heavyweight Team Structure	Autonomous Team Structure
Structure for Radical innovation	☐	☐	☐	☐
Structure for Incremental Innovation	☐	☐	☐	☐

(If your NPD function is **not divided**:)

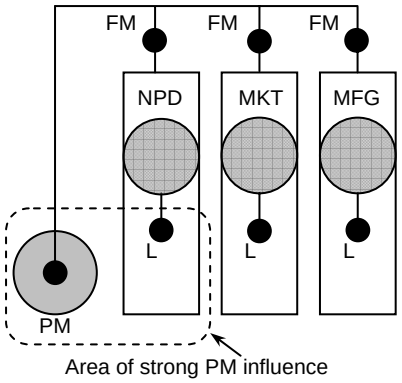
One structure for the whole NPD function	☐	☐	☐	☐

Functional Team Structure



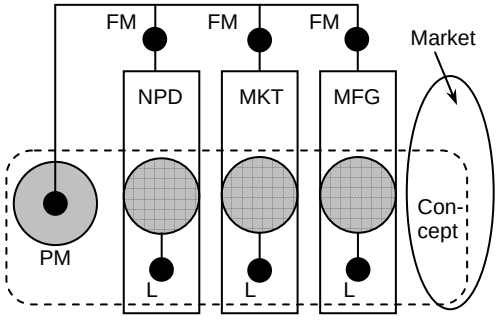
1. People are grouped principally by functional areas.
2. They work under the direction of a Functional Manager (FM).
3. Over time, primary responsibility for the project passes sequently from one function to the next.

Lightweight Team Structure



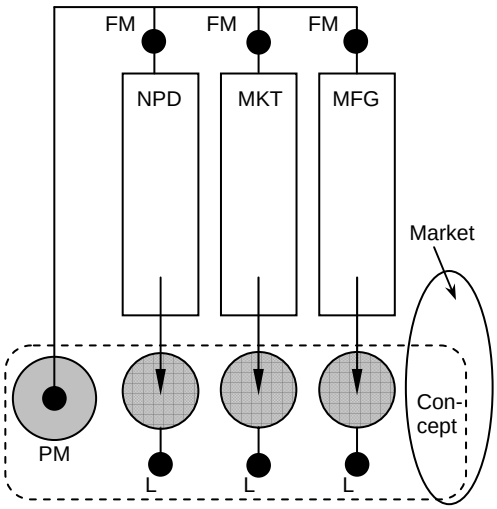
1. Like structure A, those assigned to the team reside physically in their functional areas
2. However, they designate a Liaison person (L) to "represent" it on a coordinating committee.
3. A Project Manager (PM) coordinates the different functions' activities. The Project Manager does not have power to reassign people or reallocate resources.

Heavyweight team Structure



1. Liaisons from the functions still reside in the team.
2. In contrast to structure B, the Project Manager (PM) has primary responsibility for the work of all those involved in the project.
3. However, team members are not assigned to a team on a permanent basis as is the case in structure D.

Autonomous Team Structure



1. Individuals from the different functional areas are formally assigned, dedicated, and co-located to the project team.
2. The Project Manager (PM) is given full control over the resources contributed by the different functional groups.
3. Team members are assigned permanently and the team will be held fully accountable for the results of the project.

NPD climate

37. In this section please indicate your level of agreement with each statement regarding your overall innovative climate

		Strongly disagree						Strongly agree	Don't know
a.	People are emotionally involved in goals set.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	People have freedom to define their own work.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	There is a high level of trust between people.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	There is time for people to develop unplanned new ideas.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	There is a relaxed atmosphere.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	There is a high level of conflict.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	There is a strong support for further development of new ideas.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h	People are involved in debates about differing viewpoints.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
I	High risk taking behavior is tolerated.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

38. If your radical innovation activities are organized separately from your incremental innovation, please indicate to what extent the climate in your more radical NPD differs from the overall innovative climate.

	In our radical NPD…	Strongly disagree						Strongly agree	Don't know
a.	The degree to which people are emotionally involved in goals is higher.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
b.	People have more freedom to define their own work.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
c.	There is a higher level of trust between people.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
d.	There is more time for people to develop unplanned new ideas.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
e.	There is a more relaxed atmosphere.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
f.	There is often a higher level of conflict.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
g.	There is a stronger support for further development of new ideas.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
h.	People are more involved in debates about differing viewpoints.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐
i.	Higher risk taking behavior is tolerated.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐	☐

This is the end of the questionnaire. Thank you again for your cooperation!

Your answers will be treated with full confidentiality and the names of companies, business units, products or individuals will not be released!

Appendix C1

Organization number	Total Employees	NPD employees	% NPD
1	500	120	24%
2	100	15	15%
3	2500	105	4%
4	12000	3000	25%
5	14100	2500	18%
6	900	6	1%
7	1200	350	29%
8	7	5	71%
9	60	20	33%
10	42	5	12%
11	12	5	42%
12	23	5	22%
13	24	20	83%
14	260	260	100%
15	25	5	20%
16	25	25	100%
17	750	450	60%

Appendix C2

Addition to chapter 5; Similar Cases

General aspects

From the general aspects can be derived that both organizations are quite similar in terms of age (older than 50 years of age) and annual sales (between 100 and 1000 million Euros a year). On the aspect of size there is a difference; organization 7 is larger than organization 17; 1200 employees against 750. Both organizations operate in an international environment with respectively 40 and 15 business units scattered out all over the world and have their headquarters based in the Netherlands.

NPD function

As can be noticed from table 5.5, both organizations differ as well in the percentage employees working in NPD as in the percentage radical innovation. Organization 7 which is larger does have 29% of its people working in NPD compared to 60% of organization 17. When these percentages are converted to the actual numbers of employees working in NPD both organizations are quite similar; 348 against 450, organization 17 does even have more employees working in NPD in absolute numbers. There is however a big difference in the percentage radical innovation; 33% for organization 7 against 5% for organization 17.

Environment

As induced in paragraph 5.3 the environment will probably account for this difference. As can be noticed from figure 5I, both organizations 7 and 17 rate their environment as being highly complex, respectively 5,7 and 5,3, and highly unstable, respectively 6,4 and 5,0.

Argumentation from the R&D managers for the current situation

In the market where both organizations are active, many small competitors are active, but only 10 relatively large competitors. According to the manager of organization 7, only the larger organizations are their direct competitors, which make their organization one of the leading firms in the business. Although the limited number of competitors, they are operating in a market which is rapid changing and in which customer demand varies widely. The manager of organization 17 sees smaller organizations, active in their environment, as their direct competitors. Like organization 7, they also have to deal with increasing variety in customer demand. Both managers state that innovations are the only way to retain and/or increase their market position. From the interviews the main conclusion can be drawn that there is a difference in perception of the two managers; the manager of organization 17 believes that the future customer demand can be fulfilled with enhancements in the current product portfolio, or in other words; incremental innovation, whereas the manager of organization 7 believes that radical innovation is the key to future success.

The future according to the R&D managers

Radical innovations in organization 7 are seen within this organization as being very important for its future survival, and is therefore in continuous search for new technologies and ways to shorten the time to market of new products. Organization 17 focuses more on incremental innovations and does feel, to a lesser extent, the urge to shorten the time to market or to search for breakthrough technologies. Within these organizations the uncertainty from their environment expresses itself in three ways:

- Radical innovation in terms of genetic manipulation is not supported by a large part of the population. The technique is not the problem.
- The government (National and EU) restricts the biotechnology too much in their freedom.
- Patents in the biotechnology are a hot item; it is very difficult for an organization to file a good and useful patent and not to make violations on other patents while innovating.

Addition to chapter 5; Extreme different cases

General aspects

From the general aspects can be derived that organizations 10 and 13 are quite similar in terms of age; respectively 4 and 8 years of age. On the aspects of size and annual sales there are some differences; organization 10 is larger than organization 13 (28 employees against 42), and organization 10 has higher annual sales than organization 13 (between 10 and 100mln a year against below 10mln a year). Both organizations operate in an international environment.

NPD function

As can be noticed from table 5.5, both organizations differ as well in the percentage employees working in NPD as in the percentage radical innovation. Organization 10 which is slightly larger does have 12% of its people working in NPD compared to 83% of organization 13. Next to this difference in percentage NPD employees, the percentage radical innovation activity differs in the same way; 5% for organization 10, 90% for organization 13.

Environment

As said before theories on managing innovations state that the percentage radical innovation is positively related with the level of perceived uncertainty from the environment. Organizations in the biotechnology industry classify their environment from very certain to extremely uncertain (paragraph 5.5). Organization 10 rates its environment as extremely complex (7,0 on a scale of 1 to 7) and very unstable (5,0 on a scale of 1 to 7), but spends only five percent of all NPD activities on the development of radical breakthroughs. Organization 13 on the other hand rates its environment being less complex (4,0) and less unstable (4,2) where it spends 90 percent of its activities on the development of radical breakthroughs.

Argumentation from the R&D managers for the current situation

Organization 10

This organization is from origin a Dutch dedicated biotechnology firm, which is taken over by a big foreign life science company because of some interesting exploitable products and technologies. It is the smallest child company of the whole organization. After the take-over, the R&D department lost power and the company had to focus on the exploitation of their products in order to satisfy the parent company, which was in this case inherent to survive. There are still five employees (in full time equivalent) working on development, but they focus on the further development of existing products in order to meet customer demand. The organization is able to survive because of an important cash-cow and the company can be described as an exploitation-oriented company, the strategy of the company is short-term oriented. The products can be divided in three product groups, from which one is at the end of the product life cycle. Speaking in terms of the Boston Consulting Group, the important cash cow is slowly turning into a dog, which means that it is not longer profitable and must be withdrawn from production. The complexity and stability varies for each product group, so it is difficult do characterize the environment as a whole. But in general the environment the R&D manager notes that the environment can be classified as extremely complex and very unstable.

Organization 13

This organization, from origin part of a larger organization, has been split of and therefore operates since eight years completely independent. Its initial purpose is to concentrate exclusively on research. However, currently the organization is both exploring and exploiting, so in addition income is generated by selling products. Exploiting products however is only done to please the investors, short term revenues are created this way. According to the manager the environmental uncertainty is related to the following three aspects:

- Financial; complex and unstable. Investors invest in one specific product, when this project turns out well both the organization and the investor will profit from it, when the project fails, the investor carries the risk. It is very difficult to attract and retain investors.
- Personnel; simple and stable. Employees seldom leave and high educated people are easy to find.
- Scientific level; complex but stable. Within the organization two professors are active and twenty-two people are currently active in research studies, from which half has its PhD.

Next to these three aspects the organization has no competitors. These aspects plus the fact that the organization does not have competitors are the reason the perceived uncertainty from the environment in terms of complexity and stability is quite moderate.

The future according to the R&D managers

Organization 10

According to the R&D manager, the problem with balancing exploration and exploitation is a big issue. The Manager is conscious of the fact that the organization needs to spend more time on explorative activities as searching for radical breakthroughs to survive in

the future, but the parent company is only interested in cash-cows. There is a lack of resources to enlarge the R&D function and through the influence of the parent company this situation remains the same. The manager wants to increase the percentage radical breakthroughs to change their short-term oriented strategy to a long-term focussed strategy. The knowledge of the three product groups is exclusively present within this business unit and therefore they need their own R&D department to search for radical breakthroughs in their technology portfolio; the parent company is not able to search for radical breakthroughs, because of their lack of knowledge.

Organization 13
According to the manager the balance between exploration and exploitation is not an issue at all. In the future the organization will stop selling, and therefore stop exploiting, products, because the revenues are relatively too low. The only reason, as said before, is that investors want short term revenues. Currently a larger investor is attracted and a structural flow of capital for the oncoming 2-3 years has been assured. The focus therefore will remain on radical innovation activities. Incremental innovation activities are also done for investor reasons only.

Addition to chapter 6; Similar Cases

Strategy
The score on strategy of both organizations (7 and 17) does not differ much, respectively 2,75 and 2,50. As can be read in chapter four, this score is the average of four questions about the strategy. Analysing these questions shows that both organizations primarily focus on long-term growth as well as long-term performance. The manager of organization 7 points out that it is for the organization as a whole important that variations of the products (incremental innovations) are already developed, or at least that most of the development has already been done, before the marketing department asks for them. In their business this is crucial for the organization to retain its market share for that particular product. When the development is started after marketing asks for a product a high possibility exists that they are too late, because of the duration of the development process. Besides the incremental innovations, radical innovations are extremely important on the longer term; these radical innovations refer to the way the products are produced. The manager of organization 17 also shares the statement that incremental innovations -variations on the existing products- are very important in their business; market shares can drop from over 90 percent too zero percent within a snap, and vice versa.

Organizational form
Within this chapter the organizational form is expressed in the extent to which an organization is organic, the team structure and the degree of formalization. Concerning the extent to which an organization is organic, there is a significant difference between both organizations; organizations 7 scores 5,33 where organization 17 scores 4,00. This indicates that organization 7 its structure is predominantly organic, where organization 17 its structure is neither predominantly organic nor mechanistic. Relating the

organizational form to the percentage radical innovation leads to a confirmation of the theory that a higher percentage of radical innovation is positively associated with a predominately organic structure. The answers given in the NPD questionnaire indicate that the difference between the organizations is attributable to four (of the nine) aspects; organization 17 its (1) tasks are more broken down into specialized units, (2) tasks are more rigidly defined, (3) a more specific definition of responsibility that is attached to the individual his function role is used, and (4) a strict hierarchy of control and authority is used.

An explicit difference between the organizations is the difference of the facilitation in the form of team structures; autonomous team structures are the most common NPD structure used in organization 7 and functional team structures in organization 17. Both organizations use these structures for incremental innovations as well as for radical innovations. This indicates, based on theory (see chapter three) that in organization 7 the project teams are not required to follow existing organizational practices and procedures, but are allowed to create their own. In organization 17 the different functions coordinate ideas through detailed specifications, and in occasional meetings issues that cut across groups are discussed. Primary responsibility for the project passes sequentially from one function to the next.

The degree of formalization in both organizations considering radical innovation is equal; no standard approach is used. Within organization 7 there is a clear distinction made between the incremental and the radical innovation process, where for the incremental innovation process formally documented processes are used, for radical innovations no standard approach is available. In organization 17 no distinction is made between the two types of innovation; for both types no standard approach is used.

According to the R&D manager, the high extent to which the organization is organic and the predominately mechanistic structure in organization 17 are a result of the relative high level of incremental innovation. About the low formalization degree the manager argues that the degree of formalization is positively associated with the extent of NPD within an organization (As described in chapter 5, in organization 17 60% of the employees are working on NPD).The manager of chapter 7 points out that the degree of formalization is balanced out through the whole NPD-process, when the product is getting closer to production the degree of formalization will be higher. This is exactly the reason why there is such a difference between the formalization degree of incremental and radical innovations.

Climate

In organization 7 no distinction is made between the incremental and the radical innovation climate. The overall climate is rated at 6,14. In organization 17 a distinction has been made; incremental innovation 5,43 and radical innovation 6,00. Comparing these figures shows that organization 7 has a more open, promotive climate than organization 17, in which the climate for incremental innovation is to a lesser extent promotive than for radical innovation. According to the manager of organization 7 the high degree of radical innovation ‘asks’ for an open climate, employees must have

freedom and must be able to define their own work. For organization 17, the manager explains that 80 percent of their research related activities are assignments, in which it is important to have a promotive climate, and 20 percent is free (*spielerei*); this 20 percent stimulates the NPD employees and the reason of the employees being very motivated.

In the following cross table an overview is provided about the two organizations.

Addition to chapter 6; Extreme Cases

Strategy

The score on strategy of the organizations (10 and 13) is the complete opposite; respectively 6,25 and 1,25. As can be read in chapter four, this score is the average of four questions about the strategy. Analysing these questions shows that the strategies differ on all four aspects. Organization 10 focuses on short-term growth & performance where organization 13 focuses on long-term growth & performance. Organization 10 also focuses on projects with predictable outcomes and creating incremental new products where organization 13 focuses on projects with risky outcomes and creating breakthrough new products. Both managers confirm this description. The manager of organization 10 points out that their organization is currently focussed at exploitation of the current products and therefore short-term oriented. The manager of organization 13 points out that their organization is explorative; mainly performing radical innovation activities which are focussed on the long term. Organization 10 is hardly able to transform the short-term oriented strategy in a more long term oriented strategy, which is necessary to survive in the future according to the R&D manager, because of the lack of manpower at R&D and due to the strict orders given by their parent company.

Organizational form

Within this chapter the organizational form is expressed in the extent to which an organization is organic, the team structure and the degree of formalization. Concerning the extent to which an organization is organic, there is a significant difference between both organizations; organizations 10 scores 4,89 where organization 13 scores 6,89. This indicates that organization 10 its structure is predominantly organic, where organization 13 its structure is highly organic. The answers given in the NPD questionnaire indicate that the difference between the organization is attributable to three (of the nine) aspects; organization 10 (1) uses a more specific definition of responsibility that is attached to the individual his function role, (2) a strict hierarchy of control and authority is used, and (3) the formal leader is more assumed to be omniscient in knowledge concerning all matters.

Another difference between the organizations is the difference of the facilitation in the form of team structures; lightweight team structures are the most common NPD structure used in organization 10, and functional team structures in organization 13. The functional team structure for organization 13 is remarkable considering the very high percentage radical innovation. The manager of organization 13 agrees with himself about the fact that this structure is the best structure for his organization, although consultancies have told him different.

Both organizations use these structures for incremental innovations as well as for radical innovations. This indicates, based on theory (see chapter three) that in organization 10 people are assigned to the team remain physically in their functional areas but each functional area has a liaison person that represents the functional area. In organization 13 the different functions coordinate ideas through detailed specifications, and in occasional meetings issues that cut across groups are discussed. Primary responsibility for the project passes sequentially from one function to the next.

The degree of formalization in both organizations is, like the extent to which an organization is organic and the team structure, the opposite; in organization 10 a formally documented process is used for both the incremental and the radical innovation process, in organization 13 no formally documented process is followed although the path of the tasks to be completed is clearly understood. Within organization 13 no distinction is made between the incremental and the radical innovation process in terms of formalization. The manager of organization 10 points out that throughout the whole development process a special 'five-pace program' must be used, which is imposed by the parent company. This program decides in an early stage whether or not the innovation will be a success. Relatively few innovations pass this stage, but once they have passed, many resources are dedicated to bring that certain innovation to a success. This five-pace program is unfortunately a very slow and bureaucratic program. In the near future a short version of the program will become available, which will enlarge the innovation abilities. Organization 13 its manager argues that the low degree of formalization keeps the organization flexible.

Climate

In both organizations no distinction is made between the incremental and the radical innovation climate. The overall climate is rated respectively for organization 10 and 13; 3,71 against 6,57. This induces that organization 13 has a much more open, promotive climate than organization 10, which has a more regulated climate. According to the manager of organization 10 its climate is limited by the parent company. The many rules and prescribed processes limited the freedom of the employees. Besides that, the manager argues that it is important to keep the researchers close to the products so they will not alienate. Within organization 13 a promotive climate is of high importance due to the high percentage of radical innovation. According to the manager employees must have a high degree of freedom and they must feel involved in the innovation activities. In the following cross table an overview is provided about the two organizations.

Appendix D1

Company	A	B	C	D	Average
1	3	5	4	2	3,50
2	6	4	2	4	4,00
3	7	6	5	6	6,00
4	2	5	1	1	2,25
5	1	1	4	4	2,50
6	2	6	7	2	4,25
7	1	4	4	2	2,75
8	6	4	5	5	5,00
9	4	3	5	4	4,00
10	6	6	6	7	6,25
11	3	3	2	3	2,75
12	6	6	6	2	5,00
13	1	2	1	1	1,25
14	2	3	1	1	1,75
15	2	4	6	6	4,50
16	4	4	4	4	4,00
17	2	3	3	2	2,50

Table D1.1: Scores on the NPD-Strategy questions

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	17	1	7	3,41	2,06
B	17	1	6	4,06	1,48
C	17	1	7	3,88	1,93
D	17	1	7	3,29	1,90
Valid N (listwise)	17				
Cronbach's Alpha	0,777				

Table D1.2: Descriptive statistics of the NPD strategy questions

Appendix D2

Company	A	B	C	D	E	F	G	H	I	Average
1	4	3	4	4	4	5	5	5	3	4,11
2	2	5	2	2	1	2	2	2	4	2,44
3										N.A.
4										N.A.
5										N.A.
6	6	4	5	6	5	7	6	6	5	5,56
7	4	5	6	6	4	7	7	7	2	5,33
8	5	6	6	6	3	5	6	7	6	5,56
9	2	5	4	2	6	4	4	5	5	4,11
10	6	5	3	2	4	6	6	6	6	4,89
11	4	6	2	6	3	6	6	6	2	4,56
12	4	6	6	6	6	6	6	6	4	5,56
13	7	7	7	6	7	7	7	7	7	6,89
14	2	6	5	5	5	6	6	7	4	5,11
15	6	6	6	6	2	6	4	7	3	5,11
16	5	6	6	6	6	7	6	7	4	5,89
17	2	3	3	4	3	6	6	6	3	4,00

Table D2.1: Scores on the organizational form measured in terms of organic and mechanistic elements

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	14	2	7	4,21	1,72
B	14	3	7	5,21	1,19
C	14	2	7	4,64	1,65
D	14	2	6	4,79	1,67
E	14	1	7	4,21	1,72
F	14	2	7	5,71	1,38
G	14	2	7	5,50	1,34
H	14	2	7	6,00	1,36
I	14	2	7	4,14	1,51
Valid N (listwise)	14				
Cronbach's Alpha	0,871				

Table D2.2 Descriptive statistics on the organizational form

Appendix D3

Company	A	B	C	D	E	G	H	I	total
1	6	7	7	5	6	7	6	6	6,29
2	6	3	3	2	3	4	6	3	3,86
3	4	3	2	2	3	3	3	2	2,86
4	4	6	6	3	6	3	5	2	4,71
5	6	5	6	4	6	5	6	6	5,43
6	5	5	6	5	6	6	5	4	5,43
7	6	6	7	6	6	6	6	5	6,14
8	6	7	7	7	7	7	7	6	6,86
9	6	4	4	4	2	4	4	5	4,00
10	5	5	3	4	4	2	3	1	3,71
11	6	6	6	5	6	5	6	3	5,71
12	5	6	6	6	4	5	3	3	5,00
13	6	5	7	7	7	7	7	7	6,57
14	6	4	6	6	3	6	7	7	5,43
15	4	6	5	4	3	6	6	4	4,86
16	6	6	5	6	6	6	6	6	5,86
17	4	4	6	6	6	6	6	5	5,43

Table D3.1: Scores on the overall innovative climate

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	17	4	6	5,35	0,86
B	17	3	7	5,18	1,24
C	17	2	7	5,41	1,54
D	17	2	7	4,82	1,55
E	17	2	7	4,94	1,64
G	17	2	7	5,18	1,51
H	17	3	7	5,41	1,37
I	17	1	7	4,41	1,84
Valid N (listwise)	17				
Cronbach's Alpha	0,901				

Table D3.2: Descriptive statistics of the innovative climate questions

Company	A	B	C	D	E	G	H	I	Total Rad.
1	7	7	7	6	5	6	6	6	6,29
2	4	4	4	3	4	4	5	3	4,00
3	7	7	7	6	6	6	7	7	6,57
4	6	6	4	5	4	5	4	5	4,86
5									N.A.
6	6	6	6	6		6	6	7	6,00
7									N.A.
8	6	5	6	6	4	7	7	5	5,86
9									N.A.
10									N.A.
11									N.A.
12									N.A.
13									N.A.
14									N.A.
15	4	4	5	4	4	4	4	4	4,14
16	4	5	3	5	4	4	5	6	4,29
17	6	6	6	6	6	6	6	6	6,00

Table D3.3: Scores on the radical innovation climate

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	9	4	7	5,56	1,24
B	9	4	7	5,56	1,13
C	9	3	7	5,33	1,41
D	9	3	6	5,22	1,09
E	8	4	6	4,63	0,92
G	9	4	7	5,33	1,12
H	9	4	7	5,56	1,13
I	9	3	7	5,44	1,33
Valid N (listwise)	8				
Cronbach's Alpha	0,946				

Table D3.4: Descriptive statistics of the radical climate questions

Appendix D4

Bivarate Analysis

Variable	N	Correlation	sig.
NPD Strategy	17	0,044	0,867
Age			

Table D4.1: Correlation between the NPD Strategy and the Age

Bivarate Analysis

Variable	N	Correlation	sig.
NPD Strategy	17	0,400	0,111
Size (NPD)			

Table D4.2: Correlation between the NPD Strategy and the Size

Bivarate Analysis

Variable	N	Correlation	sig.
Structure	14	-0,161	0,583
Size (NPD)			

Table D4.3: Correlation between the Structure and the Size

Bivarate Analysis

Variable	N	Correlation	sig.
Structure	14	0,071	0,809
Age			

Table D4.4: Correlation between the Structure and the Age

Bivarate Analysis

Variable	N	Correlation	sig.
Formalization degree RAD	15	0,284	0,350
Size (NPD)			

Table D4.5: Correlation between the Formalization degree RAD and the Size

Bivarate Analysis

Variable	N	Correlation	sig.
Formalization degree RAD	15	0,400	0,140
Age			

Table D4.6: Correlation between the Formalization degree RAD and the Age

Bivarate Analysis

Variable	N	Correlation	sig.
Formalization degree INC	16	0,304	0,252
Size (NPD)			

Table D4.7: Correlation between the Formalization degree INC and the Size

Bivarate Analysis

Variable	N	Correlation	sig.
Formalization degree INC	16	0,490	0,858
Age			

Table D4.8: Correlation between the Formalization degree INC and the Age

Bivarate Analysis

Variable	N	Correlation	sig.
NPD Climate	17	-0,270	0,918
Size (NPD)			

Table D4.9: Correlation between the NPD Climate and the Size

Bivarate Analysis

Variable	N	Correlation	sig.
NPD Climate	17	0,147	0,574
Age			

Table D4.10: Correlation between the NPD Climate and the Age

Appendix E1

Company	A	B	C	D	E	F	Average
1	6	5	6	7	7	7	6,33
2	4	5	4	6	4	4	4,50
3	6	4	4	6	5	4	4,83
4	7	6	4	7	4	3	5,17
5	5	2	7	7	5	7	5,50
6	6	6	6	6	6	6	6,00
7	7	6	5	7	6	7	6,33
8	1	2		1			1,33
9	5	3	2	6	2	4	3,67
10	6	2	5	6	5	7	5,17
11	5	6	6	7	7	6	6,17
12	5	2	7	5	6	5	5,00
13	7	6	7	7	7	7	6,83
14	7	6	6	7		7	6,60
15	6	5	4	5	3	3	4,33
16	6	6	6	6	6	6	6,00
17	6	5	5	6	6	6	5,67

Table E1.1: Scores on Demand OE

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	17	1	7	5,59	1,46
B	17	2	6	4,53	1,66
C	16	2	7	5,25	1,39
D	17	1	7	6,00	1,46
E	15	2	7	5,27	1,49
G	16	3	7	5,56	1,50
Valid N (listwise)	15				
Cronbach's Alpha	0,752				

Table E1.1A: Descriptives on Demand OE

Company	G	H	I	J	K	L	Average
1	6	7	7	7	6	5	6,33
2	6	4	3	3	4	3	3,83
3	7	5	4	4	6	4	5,00
4	5	4	3	3	6	7	4,67
5	7	3	3	3	1	3	3,33
6	6	6	6	6	5	6	5,83
7	7	7	7	7	7	6	6,83
8	2	3	1	1	1	4	2,00
9	4	5	4	3	1	2	3,17
10	1	4	2	2	5	5	3,17
11	5	6	4	5	3	4	4,50
12	5	4	3	3	4	7	4,33
13	7	6	7	7	7	7	6,83
14	6	6	7	7	7	7	6,67
15	4	5	5	5	6	6	5,17
16	7	7	6	5	6	5	6,00
17	6	6	6	6	6	6	6,00

Table E1.2: Scores on Demand SF

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
G	17	1	7	5,35	1,77
H	17	3	7	5,18	1,33
I	17	1	7	4,59	1,94
J	17	1	7	4,53	1,94
K	17	1	7	4,76	2,11
L	17	2	7	5,12	1,58
Valid N (listwise)	17				
Cronbach's Alpha	0,901				

Table E1.2A: Descriptives on Demand SF

Appendix E2

Company	A	B	C	D	E	F	Average
1	7	6	6	6	6	6	6,17
2				4			4,00
3	5	6	2	3	3	2	3,50
4	5	5	1	4	4	4	3,83
5	4	2	3	7	6	6	4,67
6	6	4	3	7	6	7	5,50
7	7	5	5	6	6	7	6,00
8							
9	6	3	4	5	5	4	4,50
10	7	5	5	2	3	4	4,33
11	3	5	4	5	2	5	4,00
12	5	3	7	3	5	5	4,67
13	7	4	4	7	7	7	6,00
14	4	3	4	7	5	6	4,83
15	5	4	6	6	3	4	4,67
16	5	4	6	7	7	7	6,00
17	5	4	4	6	6	6	5,17

Table E2.1: Scores on Competences OE

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	15	3	7	5,40	1,24
B	15	2	6	4,20	1,15
C	15	1	7	4,27	1,62
D	16	2	7	5,31	1,66
E	15	2	7	4,93	1,58
F	15	2	7	5,33	1,50
Valid N (listwise)	15				
Cronbach's Alpha	0,603				

Table E2.1A: Descriptives on Competences OE

Company	G	H	I	J	K	L	Average
1	7	7	6	6	6	7	6,50
2	3		3	3	3	5	3,40
3	2	2	5	2	1	5	2,83
4	6	4	3	3	3	6	4,17
5	6	4	4	6	6	6	5,33
6	6	7	5	5	5	5	5,50
7	7	7	7	6	6	7	6,67
8							
9	6	5	2	4	3	6	4,33
10	6	7	2	4	4	5	4,67
11		3	5	5	5	3	4,20
12	5	5	3	4	5	5	4,50
13	7	7	6	7	7	7	6,83
14	6	6	4	6	6	7	5,83
15	5	4	2	5	5	6	4,50
16		2	6	6	7	5	5,20
17	5	6	5	5	6	5	5,33

Table E2.2: Scores on Competences SF

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
G	14	2	7	5,50	1,45
H	15	2	7	5,07	1,83
I	16	2	7	4,25	1,61
J	16	2	7	4,81	1,38
K	16	1	7	4,88	1,67
L	16	3	7	5,63	1,09
Valid N (listwise)	13				
Cronbach's Alpha	0,877				

Table E2.2A: Descriptives on Competences SF

Appendix E3

Company	A	B	C	D	E	F	Average
1	5	5	5	5	5	5	5,00
2	4	4	3			3	3,50
3	4	4	3	3	4	4	3,67
4	2	4	3	3	3	4	3,17
5	3	3	2	2	2	5	2,83
6	7	6	6	6	6	4	5,83
7	6	6	5	4	4	6	5,17
8							
9	3	3	3	3	3	3	3,00
10	2	2	2	3	3	2	2,33
11	3	5	2	3	3	5	3,50
12	2	2	5	2	2	2	2,50
13	7	7	6	6	6	6	6,33
14	6	5	5	5	5	3	4,83
15	4	3	3	5	3	5	3,83
16	5	5	5	5	5	7	5,33
17	5	5	4	5	5	6	5,00

Table E3.1: Scores on Speed OE

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	16	2	7	4,25	1,69
B	16	2	7	4,31	1,45
C	16	2	6	3,88	1,41
D	15	2	6	4,00	1,36
E	15	2	6	3,93	1,33
F	16	2	7	4,38	1,50
Valid N (listwise)	15				
Cronbach's Alpha	0,928				

Table E3.1A: Descriptives on Speed OE

Company	G	H	I	J	K	L	Average
1	6	6	5	6	6	5	5,67
2	3	2	3	3	3	3	2,83
3	4	4	3	4	4	3	3,67
4	4	5	2	2	2	2	2,83
5	5	3	5	6	6	6	5,17
6	6	6	6	6	7	6	6,17
7	6	4	6	6	6	6	5,67
8							
9	5	5	4	4	3	3	4,00
10	3	2	2	2	2	2	2,17
11	3	3	3	3	3	3	3,00
12		5					5,00
13	6	4	4	4	4	4	4,33
14	5	5	4	5	4	4	4,50
15	5	4	4	5	5	5	4,67
16	5	6	2	2	5		4,00
17	5	6	4	4	4	4	4,50

Table E3.2: Scores on Speed SF

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
G	15	3	6	4,73	1,10
H	16	2	6	4,38	1,36
I	15	2	6	3,80	1,32
J	15	2	6	4,13	1,51
K	15	2	7	4,27	1,53
L	14	2	6	4,00	1,41
Valid N (listwise)	14				
Cronbach's Alpha	0,943				

Table E3.2A: Descriptives on Speed SF

Appendix E4

Company	A	B	C	D	E	Average
1	5	6	5	4	5	5,00
2	4	4	6	4	4	4,40
3	4	5	6	5	3	4,60
4	2	2	6	2	2	2,80
5	2	4	4	1	3	2,80
6	4	5	5	6	4	4,80
7	6	4	5	3	4	4,40
8						
9	3	3	4	2	6	3,60
10	4	7	7	7	6	6,20
11						
12	6	6	6	6	3	5,40
13	4	3	4	6	3	4,00
14	2	3	2	5	2	2,80
15	3	5	3	4	3	3,60
16	3	6	7	4	5	5,00
17	4	4	4	2	4	3,60

Table E4.1: Scores on Productivity OE

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	15	2	6	3,73	1,28
B	15	2	7	4,47	1,41
C	15	2	7	4,93	1,44
D	15	1	7	4,07	1,79
E	15	2	6	3,80	1,26
Valid N (listwise)	15				
Cronbach's Alpha	0,737				

Table E4.1A: Descriptives on Productivity OE

Company	F	G	G	I	J	Average
1	6	5	6	6	5	5,60
2	3	3	3	3	3	3,00
3	5	4	4	6	6	5,00
4	4	4	2	2	2	2,80
5	5	4	4	6	4	4,60
6	6	6	4	6	6	5,60
7	5	4	5	3	6	4,60
8						
9	4	4	4	3	5	4,00
10	4	6	6	6	6	5,60
11						
12	3		4	6	4	4,25
13	5	6	5	4	6	5,20
14	6	1	5	2	2	3,20
15	3	3	3	4	5	3,60
16	7	5	6	2	2	4,40
17	4	4	4	4	4	4,00

Table E4.2: Scores on Productivity SF

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
F	15	3	7	4,67	1,23
G	14	1	6	4,21	1,37
H	15	2	6	4,33	1,18
I	15	2	6	4,20	1,66
J	15	2	6	4,40	1,55
Valid N (listwise)	14				
Cronbach's Alpha	0,721				

Table E4.2A: Descriptives on Productivity SF

Appendix E5

Company	A	B	C	D	E	F	Average
1	6	6	6	5	6	5	5,67
2	3	5	3	4	3	2	3,33
3	6	5	6	6	6	5	5,67
4	4	3	6	3	3	2	3,50
5	2	2	4	2	3	4	2,83
6	5	6	3	3	5	4	4,33
7	5	6	7	6	5	4	5,50
8							
9	4	4	4	4	5	5	4,33
10	4	3	5	6	6	5	4,83
11	4	5	5		5	5	4,80
12	5	5	5		5	5	5,00
13	5	5	6	5	6	6	5,50
14							
15	4	3	5	3	4	5	4,00
16			6	3	2	6	4,25
17	4	4	4	4	4	4	4,00

Table E5.1: Scores on Process Flexibility OE

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
A	14	2	6	4,36	1,08
B	14	2	6	4,43	1,28
C	15	3	7	5,00	1,20
D	13	2	6	4,15	1,34
E	15	2	6	4,53	1,30
F	15	2	6	4,47	1,19
Valid N (listwise)	12				
Cronbach's Alpha	0,859				

Table E5.1A: Descriptives on Flexibility OE

Company	G	H	I	J	K	L	Average
1	6	5	5	5	5	5	5,17
2	3	3	4	3	3	3	3,17
3	6	6	6	6	4	5	5,50
4	2	2	6	6	3	5	4,00
5	5	4		5	3	3	4,00
6	4	6	6	6	6	6	5,67
7	5	5	4	4	5	5	4,67
8	3	3				3	3,00
9	4	4	4	3	5	4	4,00
10	2	2	4	5	3	4	3,33
11	4	4	4	4	4	4	4,00
12	5	5			5	5	5,00
13	5	5	5	5	4	6	5,00
14							
15		4	3	4	5	5	4,20
16	3	4	4	4	3	6	4,00
17	4	4	4	4	4	6	4,33

Table E5.2: Scores on Process Flexibility SF

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	SD
G	15	2	6	4,07	1,28
H	16	2	6	4,13	1,20
I	13	3	6	4,54	0,97
J	14	3	6	4,57	1,02
K	15	3	6	4,13	0,99
L	16	3	6	4,69	1,08
Valid N (listwise)	12				
Cronbach's Alpha	0,812				

Table E5.2A: Descriptives on Flexibility SF

Appendix E6

Explanation Tables
First column: Performance variable
Second column: Performance score (1-7)
Third column: Deviation from Average
Last row: Average from column two and three

A variable is qualified as a strength (or a weakness) when the deviation from the average is equal to or higher than the average of column three.

Company	13	
Productivity OE	4,00	1,69
Speed SF	4,33	1,35
Process Flex SF	5,00	0,69
Productivity SF	5,20	0,49
Process Flex OE	5,50	0,19
Competences OE	6,00	0,31
Speed OE	6,33	0,65
Demand OE	6,83	1,15
Demand SF	6,83	1,15
Competences SF	6,83	1,15
	5,69	0,88

Company	14	
Productivity OE	2,80	2,11
Productivity SF	3,20	1,71
Speed SF	4,50	0,41
Competences OE	4,83	0,07
Speed OE	4,83	0,07
Competences SF	5,83	0,93
Demand OE	6,60	1,69
Demand SF	6,67	1,76
Process Flex OE		
Process Flex SF		
	4,91	1,09

Company	2	
Speed SF	2,83	0,72
Productivity SF	3,00	0,55
Process Flex SF	3,17	0,39
Process Flex OE	3,33	0,22
Competences SF	3,40	0,15
Speed OE	3,50	0,05
Demand SF	3,83	0,28
Productivity OE	4,40	0,85
Demand OE	4,50	0,95
Comptetences OE		
	3,55	0,46

Company	4	
Productivity OE	2,80	0,89
Productivity SF	2,80	0,89
Speed SF	2,83	0,86
Speed OE	3,17	0,53
Process Flex OE	3,50	0,19
Competences OE	3,83	0,14
Process Flex SF	4,00	0,31
Competences SF	4,17	0,47
Demand SF	4,67	0,97
Demand OE	5,17	1,47
	3,69	0,67

Company	5	
Productivity OE	2,80	1,31
Speed OE	2,83	1,27
Process Flex OE	2,83	1,27
Demand SF	3,33	0,77
Process Flex SF	4,00	0,11
Productivity SF	4,60	0,49
Competences OE	4,67	0,56
Speed SF	5,17	1,06
Competences SF	5,33	1,23
Demand OE	5,50	1,39
	4,11	0,95

Company	7	
Productivity OE	4,40	1,18
Productivity SF	4,60	0,98
Process Flex SF	4,67	0,92
Speed OE	5,17	0,42
Process Flex OE	5,50	0,08
Speed SF	5,67	0,08
Competences OE	6,00	0,42
Demand OE	6,33	0,75
Competences SF	6,67	1,08
Demand SF	6,83	1,25
	5,58	0,72

Company	11	
Speed SF	3,00	1,27
Speed OE	3,50	0,77
Competences OE	4,00	0,27
Process Flex SF	4,00	0,27
Competences SF	4,20	0,07
Demand SF	4,50	0,23
Process Flex OE	4,80	0,53
Demand OE	6,17	1,90
Productivity OE		
Productivity SF		
	4,27	0,66

Company	1	
Speed OE	5,00	0,74
Productivity OE	5,00	0,74
Process Flex SF	5,17	0,58
Productivity SF	5,60	0,14
Speed SF	5,67	0,08
Process Flex OE	5,67	0,08
Competences OE	6,17	0,42
Demand OE	6,33	0,59
Demand SF	6,33	0,59
Competences SF	6,50	0,76
	5,74	0,47

Company	3	
Competences SF	2,83	1,59
Competences OE	3,50	0,93
Speed OE	3,67	0,76
Speed SF	3,67	0,76
Productivity OE	4,60	0,17
Demand OE	4,83	0,41
Demand SF	5,00	0,57
Productivity SF	5,00	0,57
Process Flex SF	5,50	1,07
Process Flex OE	5,67	1,24
	4,43	0,81

Company	6	
Process Flex OE	4,33	1,19
Productivity OE	4,80	0,72
Competences OE	5,50	0,02
Competences SF	5,50	0,02
Productivity SF	5,60	0,08
Process Flex SF	5,67	0,14
Demand SF	5,83	0,31
Speed OE	5,83	0,31
Demand OE	6,00	0,48
Speed SF	6,17	0,64
	5,52	0,39

Company	9	
Speed OE	3,00	0,86
Demand SF	3,17	0,69
Productivity OE	3,60	0,26
Demand OE	3,67	0,19
Speed SF	4,00	0,14
Productivity SF	4,00	0,14
Process Flex SF	4,00	0,14
Competences SF	4,33	0,47
Process Flex OE	4,33	0,47
Competences OE	4,50	0,64
	3,86	0,40

Company	10	
Speed SF	2,17	2,01
Speed OE	2,33	1,85
Demand SF	3,17	1,01
Process Flex SF	3,33	0,85
Competences OE	4,33	0,15
Competences SF	4,67	0,49
Process Flex OE	4,83	0,65
Demand OE	5,17	0,99
Productivity SF	5,60	1,42
Productivity OE	6,20	2,02
	4,18	1,14

Company	12	
Speed OE	2,50	2,02
Productivity SF	4,25	0,27
Demand SF	4,33	0,18
Competences SF	4,50	0,02
Competences OE	4,67	0,15
Demand OE	5,00	0,48
Process Flex OE	5,00	0,48
Process Flex SF	5,00	0,48
Productivity OE	5,40	0,88
Speed SF		
	4,52	0,55

Company	15	
Productivity OE	3,60	0,66
Productivity SF	3,60	0,66
Speed OE	3,83	0,42
Process Flex OE	4,00	0,26
Process Flex SF	4,20	0,06
Demand OE	4,33	0,08
Competences SF	4,50	0,24
Competences OE	4,67	0,41
Speed SF	4,67	0,41
Demand SF	5,17	0,91
	4,26	0,41

Company	16	
Speed SF	4,00	1,02
Process Flex SF	4,00	1,02
Process Flex OE	4,25	0,77
Productivity SF	4,40	0,62
Productivity OE	5,00	0,02
Competences SF	5,20	0,18
Speed OE	5,33	0,32
Demand OE	6,00	0,98
Demand SF	6,00	0,98
Competences OE	6,00	0,98
	5,02	0,69

Company	17	
Productivity OE	3,60	1,16
Productivity SF	4,00	0,76
Process Flex OE	4,00	0,76
Process Flex SF	4,33	0,43
Speed SF	4,50	0,26
Speed OE	5,00	0,24
Competences OE	5,17	0,41
Competences SF	5,33	0,57
Demand OE	5,67	0,91
Demand SF	6,00	1,24
	4,76	0,67