School of Economics and Management

Master of European Affairs Programme

# Commercialisation of inventions from a legal and business perspective

**Master Thesis**

Under supervision of:

**Cécile Brokelind**

**Lars Bengtsson**

Written by:

**Ursula Brunner**

Britta Holmströms gata 2:219

222 20 Lund

Lund, 20th May 2005

## Abstract

This thesis is about university spin-offs and the competition in high technology industries. In the light of efforts to increase the competitiveness of the European Union, an effective transfer of cutting edge technology from universities to the industry plays an important role. University spin-offs, start-ups founded to exploit academic inventions, are likely to face considerable market entry barriers. This is among other reasons due to high capital requirements for further technology development and lack of complementary resources. With a combination of relevant literature and empirical investigation, commercialisation of technologies within spin-offs is investigated and analysed. Interviews with founders and CEOs of spin-offs from Lund University provide valuable information about the process itself, the success factors, obstacles, future steps etc. Together with theoretical findings, insights about the development of spin-offs, necessary resources and capabilities as well as commercialisation strategies are gained. Moreover, an alternative way of exploiting a technology is examined: license agreements with established firm. The technology market concept as a legal tool to assess technology transfers between partners is presented and illustrated with case law. Based on insights from the case studies, its applicability on competition in high technology industries is analysed and some weaknesses are revealed.

## Acknowledgements

I would like to thank my interview partners Kerstin Jakobsson, Jonas Sandsten, Rikard Berthilsson and Björn Christofferson for their cooperation. Without them, the access to relevant information would have been much more difficult. I also thank Nicholas Jacobsson for recommending these interview partners.

I appreciated the discussion with Marcus Glader who helped me understand the intersection between business and law better.

A special thank goes to my mentors Cécile Brokelind and Lars Bengtsson for their valuable advice during the last few months, the time they devoted to my thesis and the enlightening discussions we had.

Finally, I am grateful for the support of my family and friends.

Lund, May 2005
Ursula Brunner

# Table of content

# List of Figures



# List of Tables

## List of Abbreviations

| | |
|---|---|
| AB | Aktiebolag (limited company) |
| Art. | Article |
| CEO | Chief Executive Officer |
| Dr. | Doctor |
| EC | European Community |
| ECJ | European Court of Justice |
| ed. | editor |
| e.g. | exempli gratia |
| etc. | etcetera |
| EU | European Union |
| Ibid. | Ibidem |
| i.e. | id est |
| IPR | Intellectual Property Right |
| IT | Information Technology |
| LUAB | Lund University holding company |
| Mio. | Million |
| MMS | Multimedia Message Service |
| Nr. | Number |
| p. | Page |
| PDT | Photodynamic Therapy |
| Ph.D. | Doctor of Philosophy |
| PE | Polyethylene |
| PP | Polypropylene |
| Prof. | Professor |
| R&D | Research and Development |
| SEK | Swedish Kronor |
| TTO | Technology Transfer Office |
| USD | US Dollar |

# 1 Introduction

The capability to innovate is crucial for many firms in order to stay ahead of their competitors, especially in high-technology industries. This is not a new insight; already 60 years ago, Schumpeter opened the debate on the relationship between market power and innovation. He emphasised the need to foster technological progress because he regarded competition based on innovation much more effective than ordinary price competition.[1] Furthermore, innovation is an important driver of competitiveness and economic growth of nations. The European Union is striving for becoming "...the world's most competitive and dynamic knowledge-based economy..." through implementing the Lisbon Strategy.[2] In practice however, the EU is lagging considerably behind its major trading partners in terms of innovation performance and research and development (R&D). According to the European Commission, the underlying problem is lack of competition which can curb innovation and hinder R&D efforts.[3] Consequently, strong competition is regarded as an instrument to achieve higher competitiveness.

Regarding efforts aimed at increasing the competitiveness of the EU, an important issue is the effective transfer of cutting edge technology from universities to industry. In general, start-ups founded to exploit academic inventions can have substantial problems to enter markets with their resulting products and services. The reason is that high technology industries often display considerable barriers to market entry, e.g. high fixed costs, large risk, lengthy product development, legal approval mechanisms or inertia of customers.[4] Due to these barriers and initial lack of resources, start-ups are likely to cooperate with established firms in order to commercialise their technology.

---

[1] Schumpeter (1942): *Capitalism, Socialism and Democracy*, in: OECD (1997): *Application of Competition Policy to High Tech Markets*, OECD Working Papers, Series Roundtables on Competition Policy No.9, Paris, 1997, p.8.
[2] See http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/00100-r1.en0.htm
[3] European Commission (2004): *A pro-active Competition Policy for a Competitive Europe*, COM(2004) 293 final, Brussels, 2004, p.3-4.
[4] Glader, Marcus (2004): *Innovation Markets and Competition Analysis – EU competition law and US antitrust law*, Malmö, 2004, p.2-4.

From a competition law perspective, independent commercialisation is in general preferable because cooperation might have anti-competitive effects. However, it is acknowledged in the EC Treaty that such cooperations can have pro-competitive effects as well: the negative consequences of agreements falling under Art. 81(1) of the EC Treaty can be counterbalanced by technological and economic progress as stated in Art. 81(3). Through pooled resources, shared risk, decreased spending etc., the pace of innovation is likely to increase and new products and services can be launched faster. However, there are still problems with the assessment of innovation-based competition in practice; the question is if ordinary competition rules and procedures can be applied to cases from high technology industries in an appropriate way.

## 1.1 Research problem

Much attention has been given to the fostering of R&D and the capability to generate inventions. Although crucial, this is not the end of the story: new knowledge has to be converted into products and services and the latter have to be launched on the market. According to literature, factors like infrastructure or access to capital might be more important for a successful commercialisation process than R&D itself.[5] This implies disadvantages for small high technology firms: although they have been successful in generating new knowledge, they are likely to lack complementary resources which are needed for the commercialisation of such knowledge. The lack of resources might be even more pronounced in the case of start-ups founded with the aim to exploit an academic invention. Moreover, researchers might not want to get engaged in the commercialisation process because they rather continue with conducting R&D. At the same time, an effective transfer of cutting edge technologies from universities to industry is crucial for further technological progress. The universities are increasingly aware of their “commercial” role and academic entrepreneurship activities like spin-off formation are supported to an increasing extent.

[5] Temple Lang (1996): *European Community Antitrust Law: Innovation Markets and High Technology Industries*, Fordham Corporate Law Institute, New York, 1996, p.41.

At this intersection of research and industry, the **first research question** aims at developing a deeper understanding of the efforts university spin-offs undertake in order to commercialise their technologies:

- Which steps do university spin-offs undertake in order to bring their technology to the market? Which resources are considered the most important and what are the main obstacles?

The formation of spin-offs is not the only way how new technological knowledge can be transferred from a university to the industry; another possibility is to license out the technology. Recently, the EU competition policy rules have undergone a reform whose aim was to put a stronger emphasis on economic analysis and as a result, licence agreements were exempted from Art. 81(1) of the EC Treaty. More specifically, a new block exemption for technology transfer agreements was issued in 2004.[6] The pro-competitive potential of licence agreements is noted in the respective guidelines: they may promote innovation by allowing innovators to earn sufficient returns and lead to the dissemination of technologies.[7] In general, the exchange of technologies between two parties is referred to as "technology market". The definition of this market and its use for the assessment of license agreements is subject to the **second research question**:

- How is a relevant technology market identified and applied in practice? Is this tool appropriate to assess innovation-based competition?

The following chapter describes how these questions are addressed.

[6] Commission Regulation (EC) No 772/2004 of 27 April 2004 on the application of Article 81(3) of the Treaty to categories of technology transfer agreements, OJ L 123/11 (2004).
[7] Guidelines on the applicability of Article 81 of the EC Treaty to technology transfer agreements, OJ C 101/02 (2004), § 17.

## 1.2 Purpose

When discussing the problem of innovators failing to obtain significant economic returns to invention (appropriability problem), both business and legal factors are considered. The analysis is conducted from a firm's perspective. Business literature suggests that internal factors, i.e. the access to certain additional resources and capabilities, are crucial for a successful commercialisation. However, it is also shown that firms are not immune against influences from the institutional environment; in some cases, legal factors like competition rules can influence the outcome of a commercialisation strategy to a considerable extent.

Being aware of the problems that small firms face when commercialising their technology, a specific group, university spin-offs, is investigated. Such firms often develop cutting edge technology which is likely to benefit the whole society and hence the high relevance of this investigation. The first research question aims at mapping the commercialisation activities of spin-offs operating in different industries and at different development stages. Similar studies were done before; the specific purpose here is however to examine the role of resources during this process and the implications for the firms' commercialisation strategies. Although it is not possible to generalise the four case studies, the intention is to discover some common patterns through a comparative analysis.

Cutting edge technologies can not only be transferred from university to industry through the establishment of spin-offs. With the second research question, the analysis is extended to cooperative mechanisms of commercialisation, especially licensing to established firms. Since cooperation might have anti-competitive effects and thus negative effects for consumer welfare, the rules for the assessment of such cooperations are described. More specifically, the definition of technology markets, which serves as a tool to identify the boundaries of competition between firms, is analysed. The main purpose is to investigate, with help of the insights from the case studies, if this concept can be applied to high technology industries where innovation plays an important role in the competition. Moreover, the aim is to understand how innovation and technology markets differ from a legal perspective.

## 1.3 Delimitations

Innovation is a typical cross section subject and the narrowing of the topic down turned out to be rather lengthy. It was soon clear that the process of creating new knowledge would not be subject of this thesis. Consequently, efforts of firms to promote creativity and the ability to invent are not discussed here; the same is valid for policy instruments like direct government funding or fiscal incentives which are targeted to stimulate innovative activities. Instead, the focus lies on the subsequent commercialisation process. However, not all the relevant issues in this context can be treated here. Most notably, the impact of national innovation policies on the commercialisation efforts of university spin-offs is not considered. The role of the various university and public institutions aiming at supporting these firms are only considered to a minor extent in the case studies.

The commercialisation process of large and established firms is not taken into account because it is considered less critical. It is assumed that large firms often possess the necessary resources and face fewer obstacles when trying to exploit new knowledge on the market.

There are different ways how new knowledge from university research can be transferred to the market. Although researchers are mainly engaged in activities like contracted research and industrial consulting, these are not discussed here. It was not the intention of this thesis to compare different commercialisation channels and give recommendations about which one an inventor or the university should apply.

An important body of law in the context of the commercialisation of an invention is intellectual property rights (IPRs). Such rights are a protecting mechanism which allows an inventor to appropriate sufficient returns or a start-up to cooperate with an established firm. However, this area was not specifically taken into account because it is well-researched. It is assumed here that IPRs are necessary, but not sufficient in the commercialisation process: companies will normally use legal instruments like patents or trade secrets to protect their inventions, but they also have to rely on business strategies.

It is not possible here to present a complete picture of academic entrepreneurship in this thesis. Important issues like financing or the influence of the institutional environment were excluded or only mentioned occasionally. Consequently, the role of universities and their policies and the role of other actors like technology transfer offices or venture capitalists are not taken into account.

Competitive concerns in the context of innovation can arise both from agreements between undertakings (Art. 81 of the EC Treaty) and abuse of a dominant position by one or more undertakings (Art. 82 of the EC Treaty). Due to the nature of the commercialisation process and the resulting need to cooperate, the focus lies on the former. Unilateral conduct is not discussed in specific, but only used to illustrate how competition law can influence the appropriation of returns to invention.

From a geographical point of view, the thesis is limited to spin-off commercialisation in Sweden, more specifically Lund University, and to legal issues within the EU.

## 1.4 Outline

*Chapter 2* gives an overview over the research methods chosen; the business and the legal method are discussed separately. In *chapter 3*, the theoretical part is introduced with the description of the appropriability problem, i.e. why firms may fail to appropriate sufficient returns to invention. The different commercialisation strategies which start-ups can apply are discussed. *Chapter 4* is about the commercialisation process of university spin-offs, the main topics are the sequence of activities and the necessary resources. *Chapter 5* contains the empirical investigation: the results of the interviews conducted with entrepreneurial founders and CEOs of spin-offs from Lund University are presented. As a conclusion, the case studies are compared in regard to their commercialisation process, resources and capabilities as well as commercialisation strategies. In *chapter 6*, the rules for assessing licensing agreements are analysed, more specifically the technology market concept. Finally, the thesis is concluded with the most important implications in *chapter 7*.

# 2 Research methods

Since different research methods are used in business administration and law, they are presented in separate chapters.

## 2.1 Method for business investigation

*Choice of literature*

The seminal article of Teece from 1986 was the starting point for this thesis.[8] The reason is that it provides valuable insights for the commercialisation of inventions in small firms. The underlying theory, the resource-based view, is considered to have more explanatory power in this context than other theories, e.g. the market-based view. University spin-offs are likely to lack resources, and this lack is one of the main drivers of their commercialisation strategies. The resource-based view rests upon two basic assumptions concerning sources of competitive advantage:[9]

- Firms within an industry may be heterogeneous with respect to the resources they control
- Resources may not be perfectly mobile and hence heterogeneity can be long lasting

These assumptions fit well with evidence from practice: due to heterogeneity of resources, cooperation between start-ups with technological knowledge and established firms with complementary assets can be frequently observed. The mobility of resources is limited because of the fact that new knowledge has a lower tradeability than physical commodities.[10]

Academic entrepreneurship including spin-off formation is not extensively researched yet. The research in this field is rather fragmented; the studies conducted so far treat different aspects of university spin-offs. Recently, Shane published a book with the

[8] Teece, David (1986): *Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy*, Research Policy, Vol. 15, p.285-305.
[9] Barney (1991): *Firm Resources and Sustained Competitive Advantage*, Journal of Management, Vol. 17 (1), p.101.
[10] Teece, David (1998): *Capturing Value from Knowledge Assets: The New Economy, Markets for Know-How, and Intangible Assets*, California Management Review, Vol. 40 (3), p.68.

aim to integrate the different pieces of information in a general framework.[11] His comprehensive analysis of issues relating to spin-offs served as an underlying theory for the case studies.

*Research method*

Besides the analysis of relevant literature, empirical data was gathered. A qualitative method was applied since a deep inquiry of a smaller number of cases was regarded to be more useful in this context than a broad inquiry of many cases. Moreover, qualitative methods are especially appropriate when a process is studied, in this case the commercialisation process, where the focus is on *how* something happens rather than what the outcome is. Depicting processes requires detailed information and description, they are complex, dynamic and typically not standardised. Case studies are considered particularly valuable in this context: the units of analysis are single companies; their situation, specific problems and development can be investigated in detail.[12]

The data was mainly gathered through qualitative interviews in the time period from middle of March until middle of April. Moreover, additional information from the companies' websites and financial reports if existing were used to complete the picture.

*Choice of study subjects*

Sweden is an ideal to analyse spin-off commercialisation since the country has a long tradition of technological innovation and entrepreneurship. Universities have promoted spin-off activities during the last 20 years and were given a formal responsibility to interact with society when the respective legislation was passed in 1996 and 1998.[13] In a study from 1998, Sweden proved to have the largest involvement in spin-off activity, compared with other EU countries.[14]

[11] Shane, Scott (2004): *Academic entrepreneurship, University Spinoffs and Wealth Creation*, Cheltenham, UK, 2004.

[12] Quinn Patton, Michael (1990): *Qualitative Evaluation and Research Methods*, Second Edition, Newbury Park et al., 1990, p.53-54, 94-95.

[13] European Commission, DG Entreprise (ed.)(2002): *University spin-outs in Europe – Overview and good practice*, Innovation paper No. 21, EUR 17046, Luxembourg, 2002, p.17.

[14] Jones-Evans, Dylan (1998): *Universities, Technology Transfer and Spin-off Activities – Academic Entrepreneurship in different European Regions*, Targeted Socio-Economic Research Project No 1042, final report 1998, p.59.

Among the Swedish universities, the investigation was limited to Lund University. There are two main reasons for this choice: an established structure for promoting academic entrepreneurship exists within and around Lund University and the access to information is easier than at other universities.

The selected spin-offs are a sub-sample of a portfolio with 30 spin-offs, all of them are partly owned by the Lund University Holding company LUAB. The interview partners were chosen with the help of Nicholas Jacobsson, a Business Development Manager from LUAB. He suggested possible companies at different stages of development and operating in different industries. Finally, four spin-offs could be gained as study objects (see table 1).

| **Company** | **Founding year** | **Industry** | **Interview partner** | **Date of interview** |
|---|---|---|---|---|
| SpectraCure | 2003 | Medical devices | Kerstin Jakobsson, CEO | 18th of March 2005 |
| Cognimatics | 2003 | IT, software | Rikard Berthilsson, inventor and founder | 13th of April 2005 |
| GasOptics | 2000 | Industrial equipment | Jonas Sandsten, inventor and founder | 1st of April 2005 |
| Luvit | 1998 | IT, software | Björn Christofferson, CEO | 4th of April 2005 |

**Table 1: Selected companies and interview partners**

The heterogeneity in regard to the characteristics of the spin-offs 1 is chosen on purpose. It will be of particular interest to see if common patterns can be identified, despite these variations. The different founding years imply that the spin-offs nowadays are at different stages of the commercialisation process and hence insights about their development can be gained. Although the main focus of this investigation lies on firm-internal matters like their endowment with resources, external influences are not totally excluded. The nature of the industry is very likely to influence commercialisation activities to a great extent. Other aspects like the institutional environment are held constant though in order to avoid a too large variation.

The selected spin-offs are not atypical cases in regard to the industries they operate in; the choice is in accordance with a Swedish study which shows that spin-offs are mainly established in the following industries:

| **Industry** | **Percent of total spin-offs** |
|---|---|
| Biotechnology and medicine | 20% |
| Computers | 16% |
| Electronics | 13% |
| Industrial equipment and machinery | 12% |

**Table 2: Spin-off activity in Swedish industries in 1992**[15]

*Main issues of the interviews*

The interviews were conducted with the help of a semi-standardised questionnaire, and room was left for spontaneous questions. A questionnaire of another study, which examined the commercialisation of Swedish patents, served as an inspiration for some questions.[16] Own considerations and conclusions from the theory were of major importance, especially concerning relevant resources and cooperations with other firms. The main issues were:[17]

- Nature of technology and resulting product, potential competitors
- Activities during process of commercialisation
- Motivation for spin-off formation
- Future steps
- Critical resources for the commercialisation process
- Cooperations with other firms and organisations
- Main difficulties during the commercialisation process
- Access to capital

[15] Based on Shane (2004), supra note 11, p.139-140.
[16] Svensson, Roger (2002): *Commercialization of Swedish Patents – A Pilot Study in the Medical and Hygiene Sector*, Working Paper No.583, The Research Institute of Industrial Economics, Stockholm, 2004.
[17] See also appendix.

Before every interview, the questionnaire was adapted to the specific company and interview partner. During the interviews, some questions turned out to be inappropriate while others emerged. The course of the interviews was different, depending on the respective person: some were dominated by a question-answer interaction, others had a more conversational character. The advantage with this method is its flexibility, different “stories” can be caught and the interviewees can speak about their experiences without being interrupted with questions. However, this flexibility is in a trade-off with the comparability of the results: because of the different foci in the interviews, the identification of common patterns turned out to be more difficult.

## 2.2 Method for legal analysis

Besides discussing relevant business literature and collecting primary data, the effects of commercialisation activities are assessed from a legal perspective. Since the analysis focuses on technology markets, a problem-based approach is chosen.[18]

The identification and analysis of relevant rules, case law, policy statements etc. was rather difficult, at least for some parts. While the intersection between intellectual property rights and competition law is well-researched, the same is not valid for innovation issues and competition law. The choice of case law is mainly based on a recently published dissertation in this field.[19]

The case law serves mainly illustrative purposes. The first case, IMS Health versus NDC Health, shows the objective of competition law in regard to innovation: while intellectual property rights aim at promoting innovation, competition law intends to enhance the dissemination of an innovation throughout society. This objective can be reached by means like technology transfer and licensing. Although agreements between firms, their pro-competitive effects outweigh anti-competitive concerns in general and they are thus subject to a block exemption. The technology market concept is an important tool for assessing licensing agreements. The rules for the market definition are described and illustrated with the second case, Shell/Montecatini.

[18] Glader (2004), supra note 4, p.10.
[19] Which is the one from Glader (2004), supra note 4.

The central question in the legal analysis is if the technology market concept can be applied to innovation-driven industries, i.e. high-technology industries. This is investigated through a comparison between current rules and the competition situation in these industries, based on insights from the four case studies about university spin-offs. Such an investigation contributes to the current discussion if the existing competition rules and procedures can be applied on innovation-based competition. An important doctrinal development in this area is the concept of "innovation markets" which was developed in US antitrust policy in the 1990's.[20] The concept of innovation markets is not central in this thesis though. It is presented as an alternative way to define relevant markets, markets consisting of R&D efforts.

[20] Glader (2004), supra note 4, p.8, 10.

# 3 Generating returns to invention

This chapter discusses the problems which inventors face when commercialising their invention and what strategies they can apply. Intellectual property rights give them the exclusive right to exploit their ideas for a certain time. Consequently, the innovating firm is temporarily protected against competition. This temporary protection can interfere with competition law which views increased competition positively because it puts pressure on the firms to innovate.

## 3.1 Definition of innovation and invention

Many definitions and different understandings of **innovation** exist. Its broadest sense can be understood when looking at the Latin origin of the term: “innovare” means “to make something new”.[21] An important insight which evolved from various innovation studies over the last 50 years it that “innovation is a process, not a single event, and needs to be managed as such”.[22] Early models of this process regarded innovation as a linear sequence of functional activities, either driven by technology push or market pull. This view has evolved towards increasingly complex and interactive models of innovation.

There is a basic distinction between technological and administrative innovation. **Technological innovation** can be defined as a group of activities which leads to the creation, adaptation and adoption of technologically new or improved products and services. Examples for new products are the first microprocessors and video cassette recorders, both had not existed before. An example for an improved product is the introduction of ABS braking or other sub-system improvements in cars: one of a number of integrated technical sub-systems was partially changed.[23] **Administrative innovation** refers to changes in organisational structure and administrative processes; this type is not taken into account here.[24]

[21] Tidd, Joe; Bessant, John; Pavitt, Keith (2001): *Managing innovation - Integrating technological, market and organizational change*, Chichester et al., 2001, p.38.
[22] Ibid., p.50.
[23] OECD (1997): *Application of Competition Policy to High Tech Markets*, OECD Working Papers, Series Roundtables on Competition Policy No.9, Paris, 1997, p.31-32.
[24] Afuah, Allan (2003): *Innovation management – strategies, implementation and profits*, New York et al., 2003, p.14.

Quite often, innovation is confused with invention. The latter is an important, but not the only step in a long process; the invention has to be converted into a product or service that meets customers' needs.[25] Hence, a simple, but practical definition for the purposes of this thesis is the definition from Roberts (1988): Innovation = Invention + Exploitation. He understands invention as a process covering all efforts aimed at creating new ideas and getting them to work and exploitation as a process including all stages of commercial development, application and transfer.[26] As outlined above, the focus lies on the exploitation process and the term **commercialisation of inventions** is mainly used for it. Put simply, it is about "...how to translate promising technologies into a stream of economic returns...".[27]

One should also be aware of the distinction between innovation, technology and intellectual property. Innovation and technology are basically ideas whereas intellectual property is the legal right to exploit them.[28]

## 3.2 Appropriability problem for innovators

Empirical evidence indicates that innovating firms often fail to obtain significant economic returns from an innovation while others (customers, imitators, suppliers) benefit.[29] The underlying explanation for this phenomenon is the existence of a market failure in the technology-based sector of the economy. New knowledge generated by a firm has the attributes of a public good: it is non-rival in use.[30] This characteristic can lead to externalities, so-called spill-over effects: the technical knowledge can leak or spill over from the innovator to competing firms without compensating the former. Thus other firms can free ride on the R&D of the innovating firm; this might even lead to the situation that they overtake the innovator and enter the market with a cheaper copy of the original invention. Consequently, the problem

[25] Afuah (2003), supra note 24, p.13.
[26] Roberts, Edward B. (1988): *Managing invention and innovation*, Research Technology Management, Vol. 31 (1), p.13.
[27] Gans, Joshua S.; Stern, Scott (2003): *The product market and the market for "ideas": commercialization strategies for technology entrepreneurs*, Research Policy, Vol. 32, p.333.
[28] Grindley, Peter; Kahwaty, Henry; Sherry, Edward; Teece, David (2003): *The Prospected EC Technology Transfer Block Exemption Regulation: An Economic Assessment*, LECG Limited, London, 2003, p.5.
[29] Teece (1986), supra note 8, p. 285.
[30] Grindley et al. (2003), supra note 28, p.4.

of generating sufficient returns to invention might inhibit further investment in R&D since the R&D currently undertaken by an innovator is not rewarded enough.[31]

### 3.2.1 Factors influencing the distribution of profits from innovation

Teece (1986) identified several factors which govern an innovator's ability to capture the benefits associated with innovation:[32]

- Nature of technology
- Efficacy of legal protection
- Ownership of complementary assets

The first two factors are the key dimensions of the **appropriability regime**, which is defined as following: "A regime of appropriability refers to the environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation".[33] Put simply, the appropriability regime describes the ease of imitation. Depending on whether it is "tight" or "weak", the implications for the profits to innovation are different, as it can be seen in table 3.

| | **Tight appropriability regime** | **Weak appropriability regime** |
|---|---|---|
| Nature of technology | Easy to protect, e.g. with trade secrets | Difficult or impossible to protect |
| Efficacy of legal protection | Very effective ("Iron clad patent or copyright protection") | Ineffective |
| Profit chances for innovator | High | Low, innovator must turn to business strategies |
| Examples | Formula of Coca Cola syrup | Simplex algorithm in linear programming |

**Table 3: Tight and weak appropriability regime[34]**

According to Teece, "...the innovator is almost assured of translating its innovation into market value for some period of time" under a tight appropriability regime.[35] But even when patent protection is strong, firms are not immune against other influences

[31] Tassey, Gregory (1997): *The economics of R&D policy*, Westport, 1997, p.85-86.
[32] Teece (1986), supra note 8, p.287-290.
[33] Ibid., p.287.
[34] Ibid., p.287-292.
[35] Ibid, p.290.

like competition law. This is subject to the next chapter. Anyway, Teece's assumption is that the weak appropriability regime dominates in general. Hence, an innovator cannot not only rely on legal protection, but has to apply business strategies in order to profit from its invention. If the new technological knowledge is easy to imitate, the success of commercialisation depends on the access to **complementary assets** like manufacturing, manufacturing and distribution. These assets can be categorised in three groups:

- Specialised assets
- Co-specialised assets
- Generic assets

The first category refers to a unilateral dependence, the second category to a mutual dependence between the complementary asset and the innovation.[36] Generic resources and capabilities do not need to be tailored to the respective innovation, they are general purpose assets. It is the access to specialised and co-specialised resources which is crucial for the commercialisation process.

The lack of specialised assets can partly explain why many small entrepreneurial firms fail in the market although they have generated new, commercially valuable technology while large, often less innovative firms survive. Large firms are more likely to possess the relevant resources within their boundaries at the time of new product introduction and can directly exploit their technology. On the contrary, small firms are less likely to possess these resources and have to acquire or build them first.[37]

### 3.2.2 Efficacy of legal protection

The question might occur which one of the two factors – efficacy of legal protection or complementary assets – is more important for the innovator's ability to capture sufficient economic returns. In practice, legal means like patents rarely provide perfect protection. A survey in the USA about the effectiveness of patents and other means of appropriating returns to R&D showed that substantial inter-industry

[36] Teece (1986), supra note 8, p.289.
[37] Ibid., p.301.

differences exist.[38] For instance, patents are considered more effective in chemical industries than in other industries, both for new products and processes. The answers of the 650 individuals representing 130 lines of businesses revealed interesting patterns: overall, non-legal means like sales and service efforts, moving quickly down the learning curve or lead time were seen as being more effective than patents. The respondents considered lead time (for process innovations) and superior sales and service efforts (for product innovations) as the most effective appropriability mechanisms. Patents were viewed as the least effective means. This study was among other countries replicated in Switzerland and arrived at very similar results: patents were considered less effective than other appropriability mechanisms and important inter-industry differences concerning the effectiveness of these mechanisms were found.[39]

The studies investigated possible reasons for the perception that patents offer weak protection for new or improved products and processes as well. The most important constraint on the effectiveness of patents was found to be the ability of competitors to "invent around" patents.[40] Rikard Berthilsson, one of interviewees and founder of Cognimatics (see chapter 5.2), gave an example for this phenomenon: even though his company has a patent for automatic image understanding and face detection, competitors can develop other ways of detecting faces and thus offer similar products or services. Legal limits like compulsory licensing, i.e. when a "duty to deal" is laid upon an owner of an IPR, were considered to be the least important constraints. Nevertheless, other authors argue that compulsory licensing affects long-term innovation incentives: not only holders of patents or copyrights who refuse to license these rights are affected by compulsory licensing, but its impact extends as well to many other licensing situations.[41] Therefore, the impact of legal limits, more specifically the impact of European competition law, on the ability of firms to appropriate returns to invention is presented in the next chapter.

---

[38] Levin, Richard C.; Klevorick, Alvin K.; Nelson, Richard R.; Winter, Sidney G. (1987): *Appropriating the Returns from Industrial Research and Development*, Brookings Papers on Economic Activity, Vol. 3, p.793-798.
[39] Harabi, Najib (1995): *Appropriability of technical innovations – An empirical analysis*, Research Policy, Vol. 24, p.987-988.
[40] Ibid., p.989 and Levin et al. (1987), supra note 38, p.802-803.
[41] Shapiro, Carl (2002): *Competition Policy and Innovation*, STI Working Papers 2002/11, DSTI/DOC (2002)11, p.14.

### 3.2.3 Competition law limiting returns to invention: IMS Health

Intellectual property rights grant exclusive rights of exploitation to the holders of patents, copyrights, trademarks etc. Hence, legal protection mechanisms are a way to reward creative efforts. These exclusive rights are not immune against competition law intervention though.[42] Consequently, there is a trade-off between the objectives of the two bodies of law, which are promotion of innovation and diffusion of innovation, at least in the short term.[43] Which objective the European Court of Justice (ECJ) considers more important, is illustrated with the case IMS Health versus NDC Health. The case is about a copyright for a brick structure and the refusal of its owner to grant a license to a competitor. Such a conduct falls under Art. 82 of the EC Treaty which prohibits the abuse of a dominant position.

*C-418/01, IMS Health versus NDC Health*[44]

The two parties, IMS Health and NDC Health (in the following: IMS and NDC), are engaged in the collection, processing and interpretation of data concerning regional sales of pharmaceutical products in Germany. Since 2000, IMS has used a subdivision of the German territory into 1860 segments (the “1860 brick structure”) for the purposes of its market reports. A working group consisting of firms from the pharmaceutical industry, which are clients of IMS, has made suggestions for improving and optimising this market segmentation. Because of free distribution to pharmacies and doctors, IMS’ brick structure has become the normal industry standard to which clients adapted their information and distribution systems. The company’s competitor, NDC Health, started to use brick structures based on the knowledge of a former IMS manager. These structures were therefore very similar to those from IMS.

In the main proceedings, the German courts upheld the legal protection of IMS’ product: the judges regarded the brick structures as data banks which are protected by German copyright law. Consequently, NDC was prohibited from using its brick structure because of the similarity with the competitor’s product. However, the

[42] EU Technology Transfer Guidelines (2004), supra note 7, § 7.
[43] Shapiro (2002), supra note 41, p.10.
[44] Case Nr. C-418/01, IMS Health GmbH & Co. OHG v. NDC Health GmbH & Co. KG, (2004). Interestingly, J. Temple-Lang whose article about innovation markets and high technology industries is discussed later, acted as a solicitor on behalf of IMS Health Gmbh.

Commission upheld a complaint of NDC who claimed that the refusal of IMS to grant a license for the 1860 brick structure was an abuse of a dominant position according to Art. 82 of the EC Treaty. As a result, IMS was ordered to grant a license for the use of its brick structure to all the other undertakings in the same market.

The question referred for a preliminary ruling was if IMS could refuse to grant a license for the use of its data bank because it had an exclusive right of exploitation or if that constituted an abusive conduct according to European competition law.

In his judgement, the ECJ stated first that the pharmaceutical undertakings are dependent on the brick structure of IMS. They would have to make “exceptional organisational and financial efforts” in order to acquire market reports based on other structures. Hence, other companies could not offer alternative structures on economic viable terms.[45]

Concerning the refusal to grant a license, IMS stressed that such a refusal is an essential element of an intellectual property right. In contrast to that, the Commission argued that the refusal to grant access to an essential input (here: an intangible asset which is protected by copyright) for the production of downstream goods or services would go beyond the essential function of this right. The Commission stressed that a copyright is a property right like any other with which it has “obligations flowing from competition law” in common.[46] The ECJ stated that the mere refusal to grant a licence cannot in itself constitute an abuse of a dominant position. However, the Court went on to say that the exercise of an exclusive right by its owner may involve abusive conduct under exceptional circumstances.[47] In accordance with former case law, three cumulative conditions have to be satisfied for the refusal being treated as abusive:

- The emergence of a new product or service is prevented
- The refusal is unjustified
- Competition on a secondary market is excluded

[45] Case C-418/01, supra note 45, Judgement, § 29.
[46] Ibid., Opinions of the Advocate-General, § 45.
[47] Ibid., Judgement, § 34-35.

The first condition is especially relevant in this context: it refers to the balance between the interest of an intellectual property right owner, including his economic freedom, and the interest of protecting free competition. As the Advocate General stated in the case, the latter can only prevail if the refusal to grant a license prevents the requesting company from producing new goods and services for which there is potential consumer demand.[48] If the requesting company merely intends to duplicate the existing goods and services, which are already offered by the owner of the IPR, the refusal to grant a license may not be regarded as abusive. The court followed the Advocate General's opinion concerning this issue. However, no further examination of what a "new product" comprises was conducted. It might also be difficult to foresee if a new product will actually be developed once the license is granted.

The case shows that the ECJ tries to prevent situations which are to the detriment of consumers: if the introduction of new products or services is hindered, there is less choice and most likely, existing products cost more. Furthermore, the judgement has positive implications for imitators: firms like NDC Health who did not generate new knowledge can profit from the efforts of an innovator. However, pressure to innovate further is put upon them, they cannot simply copy an innovator's products or services. They have to produce new products or services based on the license; otherwise the refusal to grant a license is not an abuse of a dominant position. Innovators on the other hand might face negative consequences because they are forced to license their IPRs to other companies and are prevented from extracting the returns to invention themselves. It can be concluded that the judgement supports above all the diffusion of innovation, and less the promotion of innovation.

## 3.3 Commercialisation strategies of technology entrepreneurs

The analysis so far shows that both legal and business factors can influence the appropriation of returns to inventions. This leads to the question how an innovating firm can react to these influences, i.e. which strategy it should deploy for the commercialisation of its inventions.

[48] Case C-418/01, supra note 45, Opinions of the Advocate-General, § 62.

In general, a start-up innovator can either profit from innovation through a competitive or a cooperative strategy. By choosing a **competitive strategy**, the start-up has the intention to launch its technology or product independently. Thus, it must develop or acquire the necessary complementary assets for the commercialisation. The advantage is that incentive alignment and control are facilitated; but time and money constraints can hinder a company from acquiring or building the necessary complementary assets.[49] The main alternative is a **cooperation strategy**: an innovator concludes agreements with other firms who then will bring the technology to the product market. The cooperation can take several distinct forms: out-licensing, joint ventures, strategic alliances or even acquisition of a start-up by an established firm.[50] Such a strategy can have considerable advantages for smaller companies, since the capital expenditures for acquiring the complementary assets can be avoided.[51] Disadvantages are disclosure problems and difficulties to find an appropriate partner.

Gans et al. (2003) have developed a specific framework for start-up commercialisation by refining earlier work of Teece.[52] According to them, many start-up innovators face the situation that the firms who control key complementary assets are the most likely potential product market imitators. Hence the challenges with getting engaged in cooperations are not separated from the imitation problem.

The appropriability regime and the complementary assets (see chapter 3.2.1) are identified as the main drivers of the commercialisation strategy of start-ups. They are referred to as:

- excludability environment
- complementary asset environment

The **excludability environment** stands for the possibilities of a start-up to prevent a cooperation partner from imitating and commercialising its technology. The **complementary asset environment** takes into consideration if the incumbents possess the necessary complementary assets for the commercialisation or not. If

[49] Teece (1986), supra note 8, p.295.
[50] Gans et al. (2003), supra note 27, p.336-337.
[51] Teece (1986), supra note 8, p.293.
[52] ibid. and Gans et al. (2003), supra note 27.

they do, the start-ups face high barriers to market entry. Together, these two factors define four distinct commercialisation environments as shown in figure 1:

**Control of necessary complementary assets**

| Excludability | | Not incumbents | Incumbents |
|---|---|---|---|
| | Weak* | Attacker's advantage | Reputation-based ideas trading |
| | Strong** | Greenfield competition | Ideas factories |

**Figure 1: Four commercialisation environments**[53]

* = Start-up cannot preclude effective imitation of its technology by an incumbent

** = Start-up can preclude effective imitation of its technology by an incumbent

The environment **attacker's advantage** is characterised by poor intellectual property protection and incumbents' control of complementary assets. Hence, competition is likely to be intense, start-ups are attacking the current market leaders by entering the market with new or improved technologies and are thus undermining the positions of market leaders. There are few opportunities for contracting with the current market leaders. Opposite to that, the **ideas factories** environment is characterised by effective protection from imitation and control of the relevant complementary assets by incumbent firms. It is expected that start-up innovators focus on research and commercialise the results through partnerships with downstream market players. A high rate of start-up innovation goes together with the reinforcement of incumbent market power, a pattern that can be observed in the biotechnology industry.

These two environments are in line with the general strategies described above: competition or cooperation. The following two environments do not reinforce either a competitive or a cooperative strategy in a clear way, but reflect a trade-off between excludability and access to necessary resources.

[53] Based on Gans et al. (2003), supra note 27, p.340.

**Reputation-based ideas trading** is an environment characterised by weak protection from imitation and importance of the incumbents' complementary assets for start-up commercialisation. This might lead to an expropriation hazard: due to the weak intellectual property protection, established firms might be tempted to expropriate the technology revealed to them. Consequently, start-ups are discouraged from pursuing a cooperation strategy. Because a market for ideas would be beneficial for both, established firms can choose a "reputation strategy": by developing a reputation for fairness, they can approach start-ups with promising new technologies. In the fourth environment, **greenfield competition**, protection from imitation is effective and the incumbents do not possess the assets necessary for commercialisation. These features imply that start-ups have good opportunities for commercialising their technologies: they can choose between the competition and cooperation strategy approach, both may be effective. [54]

## 3.4 Summary

Some important implications can be drawn from the previous chapters; they will be inputs for the analysis in the following chapters, especially for the case studies in chapter 5.

*Ownership of complementary assets:*

Sometimes, innovators tend to have false and too high expectations of the real value of their invention.[55] The analysed literature implies that new technological knowledge alone might not be enough to have success in the market. The access to complementary assets like marketing and distribution capabilities is a critical factor. Small firms are less likely to possess such assets and might have more difficulties to commercialise their inventions, compared to large firms.

Thus the structure of the firm, especially the scope of its boundaries, determines the distribution of profits from an innovation while the structure of the market is considered less important.[56] This insight is in line with the resource-based theory

[54] Gans et al. (2003), supra note 27, p.339-346.
[55] Sheen, Margaret R. (1996): *Managing IPR in an Academic Environment: Capacities and Limitations of Exploitation*, in: Webster, A.; Packer, K. (1996): Innovation and the Intellectual Property System, London et al., 1996, p. 137.
[56] Teece (1986), supra note 8, p.305.

which concludes that principal drivers of strategy and performance are different endowments of firms with strategic resources.[57]

*Effectiveness of legal protection:*

Theoretical and empirical findings imply that legal means for appropriating returns from R&D have limited effectiveness in general. This is especially true for patents. But it has to be kept in mind that large firms were overrepresented in the studies discussed above and consequently, the results might be biased against small and medium-sized firms. Levin et al. (1987) themselves state that patents might be a relatively effective mean of appropriability for small, start-up ventures and that a patent is probably the most marketable asset of such technologically oriented firms.[58] Moreover, significant inter-industry differences exist.

Limited legal protection against imitation is not the only problem in the context of appropriating returns to inventions; there are also conflicts with other bodies of law. Although intellectual property rights grant the owners exclusive exploitation rights, competition law can limit the scope of these rights, as seen from the case IMS Health versus NDC Health. The ECJ did not decide in favour of the innovator and holder of the copyright, but in favour of the imitator. The reason was the protection of consumers; the judgement signals more support for the competition law objective concerning innovation (diffusion) than for the intellectual property rights objective (exclusive exploitation).

*Commercialisation strategies*

The combination of ownership of complementary assets and effectiveness of legal protection determines or at least reinforces the type of start-up commercialisation strategy. An established firm with products endangered by innovations may have the power to control the market entry of new firms, because it possesses relevant resources for start-up commercialisation.[59] In such a situation, a start-up is likely to cooperate with the established firm in order to get access to the necessary resources, given that its intellectual property rights are strong. In the opposite

[57] Zou, Shaoming; Cavusgil, S. Tamer (1996): *Global strategy: a review and an integrated conceptual framework*, European Journal of Marketing, Vol. 30 (1), p.52-59.
[58] Levin et al. (1987), supra note 38, p.797.
[59] Sheen (1996), supra note 56, p.137.

situation, when the incumbent does not possess the necessary complementary assets and the legal protection from imitation is weak, a start-up is likely to launch its product independently and thus to enter product market as a competitor.

In the real world, such a clear cut distinction between these two main types of commercialisation strategies may exist. Especially in regard to university start-ups, it is unlikely that such companies can build or acquire all the necessary assets for the commercialisation process. Hence, they will have to rely on some form of cooperation, although they aim to enter the market as an independent competitor.

# 4 Commercialisation efforts of university spin-offs

The following chapter serves the purpose to describe and analyse the commercialisation efforts of university spin-offs. Insights from chapter 3 are applied to this specific group of start-ups. First, the activities during the spin-off establishment and development are outlined and second, the most important resources for spin-off commercialisation are identified.

## 4.1 What are university spin-offs?

Yahoo! is an example of a company who is rooted in a university environment: the two founders of Yahoo! were Ph.D. candidates at Stanford University at the time they invented the search engine.[60] **University spin-offs** created by students and employees of academic institutions are a subset of all start-ups. They can be defined as "...a new company founded to exploit a piece of intellectual property created in an academic institution".[61] It must be noted though that university spin-offs are atypical start-up companies: they do not only rely on cutting edge technology, but are also at a very early stage of technology development when they are founded. According to a director of a technology licensing office, the typical university spin-off starts with a technology that has no practical application, no business plan, and no management.[62] The aim of these spin-offs is to transfer inventions from the university to the marketplace. This is expressed in the business idea of Cognimatics, one of the examined companies, which is "...to build a successful company, that through a close connection to the university, can take new results from research to the market efficiently".[63]

Previously, academic entrepreneurship was often equated with the formation of university spin-offs. More recent publications regard spin-offs as one academic entrepreneurship activity; other activities are e.g. contracted research, consulting, patenting/licensing or sales. All these activities lie outside the standard duties of

[60] See http://docs.yahoo.com/info/misc/history.html
[61] Shane (2004), supra note 11, p.4.
[62] Ibid., p.173-174.
[63] See http://www.cognimatics.com/default.htm

academics.[64] Some authors classify spin-offs as a commercialisation channel for innovations originating from universities and other public sector research. Further channels are for example publication, education/training, contract research, industrial consultancy or licensing.[65] Traditionally, universities have commercialised a technology via licensing of intellectual property to large, established firms who develop the technology further into a commercial product.[66] These firms have advantages which facilitate the commercialisation of new technologies: market knowledge, relationships with customers and suppliers, distribution systems.[67] The commercialisation via the formation of spin-offs involves more risk, but is a growing trend.[68]

## 4.2 Process of spin-off establishment and development

The following description of activities during the commercialisation process is divided in two main parts: spin-off establishment and spin-off development.

First of all, it has to be noted that model used below is based on the perception of an American author; the different stages might not always correspond with the situation in European countries. A further criticism concerns the simple sequence of activities; there are no feedback mechanisms like in recent models of the innovation process. However, the model is applied here because it gives a useful overview over the single stages of spin-off creation and development. Later on, it is compared with empirical evidence from Swedish university spin-offs.

[64] Klofsten, Magnus; Jones-Evans, Dylan (2000): *Comparing Academic Entrepreneurship in Europe – The Case of Sweden and Ireland*, Small Business Economics, Vol. 14, p.300.
[65] Hindle, Kevin; Yencken, John (2004): *Public research commercialisation, entrepreneurship and new technology based firms: an integrated model*, Technovation, Vol. 24, p.796.
[66] Powers, Joshua B.; McDougall, Patricia P. (2005): *University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship*, Journal of Business Venturing, Vol. 20, p.294.
[67] Shane (2004), supra note 11, p.103.
[68] Powers et al. (2005), supra note 67, p.294.

### 4.2.1 The process of spin-off establishment

In the following, it is described how a university spin-off is established. This process can be divided in two sub-processes:

- Research and invention creation
- Marketing, licensing and spin-off creation

The first sub-process, **research and invention creation**, is not discussed further, because it is not subject of this thesis. However, it illustrates some of the above mentioned national differences. In the USA, a researcher is expected to disclose his invention to the university if he thinks that he invented a new technology and used university resources for that. After the disclosure, the university Technology Transfer Office (TTO) evaluates the invention in order to determine whether or not it should be protected with a patent or a copyright.[69] When examining research and invention creation in Sweden, one can observe that the role of a TTO is different. This is influenced by regulations in Swedish law: the so-called “lärarundantaget” (teacher’s exception) confers the ownership of patentable inventions to teachers, not to the university. It is an exception because a general rule says that employees do not own their own inventions, but that their employer owns them. The trend in Europe is to take away the teacher’s exception so that universities can become owners of inventions made in the different departments, as it is the case in the USA. That does not mean though that inventors are forced to take part in the commercialisation of their invention.[70]

The second sub-process consists of **marketing, licensing and spin-off creation**. After the decision to seek intellectual property protection, the TTO has to market the invention, i.e. try to find private companies who would license and commercialise it. Again, this is different in Sweden: the founders and managers of a spin-off are responsible for marketing the technology. This is a difficult task since such technologies are typically at an early stage of development and hence constitute an uncertain and risky business.

[69] Shane (2004), supra note 11, p.167-170.
[70] Sojde, Catharina; Eriksson, Per et al. (2003): *VINNFORSK - VINNOVAs förslag till förbättrad kommersialisering och ökad avkastning i tillväxt på forskningsinvesteringar vid högskolor*, Stockholm, 2003, p.44-46.

Universities license their intellectual property rights to existing companies most of the time, but at some occasions, start-ups are created for the exploitation of these IPRs. Some authors view the spin-off formation as a “second-best-solution” because they say that spin-offs are founded when the efforts to license the technology to an established company failed. Hence, the establishment of a spin-off is a consequence of licensing market failure and serves as a complement to licensing the technologies to established firms.[71] It will be seen if evidence from the case studies confirms this view.

### 4.2.2 The process of spin-off development

Once spin-offs have been established, they can rarely start to sell a product or service immediately. Further development of the technology and the identification of target markets are necessary. Figure 2 illustrates the activities that have to be undertaken.

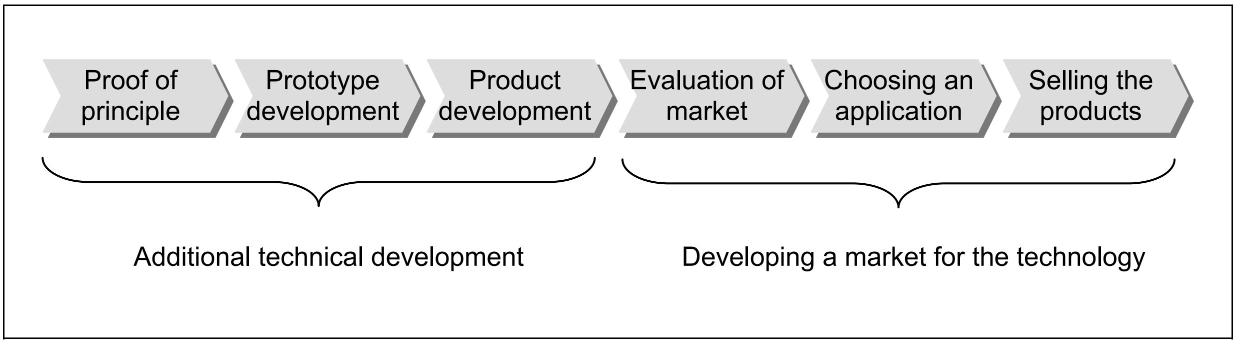


**Figure 2: Activities during spin-off development**[72]

The first three steps constitute the **additional technical development**, which takes considerable time and requires resources. Due to the early stage of technology development, a **proof of principle** has to be conducted after the formation of the spin-off. This serves to prove the commercial value of the technology. The next step is to **develop a prototype**. This activity can be a rather difficult and time-consuming. Examined spin-offs from Massachusetts Institute of Technology spent time periods ranging from just under a year up to several years on prototype development.[73]

[71] Shane (2004), supra note 11, p. 170-177.
[72] Ibid., p..178-222.
[73] Ibid., p. 178-182.

The subsequent **product development** process consists of two main activities:

- Turning the invention into a product or a service
- Making sure that these products or services meet the standards of the commercial environment

Further technical development is necessary because the technology has to be embodied in a commercial product or service. In order to comply with the standards of the commercial environment, the technology has to be changed during the product development process. These changes include activities like improving the performance of the technology, creating tools and technologies that support the original invention or making the use of the technology for an average customer easier.

A general problem in this context is that the inventors and founders of university spin-offs might underestimate the importance of the product development process. Their core competence is research, and they typically lack skills for and the experience in product development. Moreover, a different work approach is required, compared to inventing. The focus shifts from creativity to fine-tuning and iterations. The time and resources needed for product development are other factors which could be underestimated. Some evidence of how long and resource intense this process is will be shown in the case studies. The whole process is accompanied with uncertainty, both concerning technical issues (can the technology be adapted to the commercial environment?) and competence of the founders and employees of the spin-off (do they have the capabilities to turn the technology into a commercially valuable product?).[74]

The next three steps in figure 2 constitute the **development of a market for the technology**. The existence of a “technology push” is obvious at this point: the development of new technologies at universities is rarely based on customers’ needs (“market pull”). Hence, a market for the products and services embodying the new technology has to be identified first. The spin-offs face rather large market uncertainty at this stage; the question is if customer demand exists for their product,

[74] Shane (2004), supra note 11, p. 182-201.

if the demand volume is sufficient, if their product is better than the competitors' alternatives etc. Consequently, a **market evaluation** is necessary to overcome this uncertainty. A critical part is the identification of possible customer needs for the developed technology. This can be a rather difficult task because the creation of the technology was typically not guided by ideas about commercial applications. It can happen that the researchers are very excited about their new technology, but do not look at it with the eyes of customers. It might then turn out that the actual commercial applications are rather limited or have to be discovered yet. For some technologies on the other hand, there might be a considerable amount of potential applications to choose from. Hence, a further step is the **selection of market applications** for the developed technologies. There are several factors which can influence the choice of an application:

- Sales volume
- Value to the customer
- Ability to serve the market
- Competitive advantage

Finally, the **selling of the products and services** can also turn out to be more difficult than expected since the customers have to be persuaded first of the technology's value.[75]

## 4.3 Resource-based view of spin-offs

In the following, insights from chapter 3 are applied to university spin-offs, respectively to their commercialisation efforts. The underlying resource-based view is expected to lead to further insights because a main problem of university spin-offs is that they often lack the necessary resources.

First, important resources for spin-off commercialisation are identified. Second, human resources, more specifically the skills and experiences of inventors and spin-off founders, are discussed.

[75] Shane (2004), supra note 11, p.201-222.

### 4.3.1 Important resources for spin-off commercialisation

The discussion in chapter 3 implied that the innovator's core asset, new technological know-how, might not be sufficient for a successful commercialisation, but that complementary assets are needed as well.

Based on the analysis so far, the aim is to identify potentially important resources for the spin-off commercialisation. The resource classification from Grant (2005) is considered useful in this context. He identifies the main categories tangible, intangible and human resources, which are further divided in the subcategories financial, physical, technological resources, reputation, organisational and human resources. This classification and the resources which are considered important for spin-off commercialisation are shown in table 4.

| **Main category** | **Subcategory** | **Potentially important for spin-offs** |
|---|---|---|
| Tangible resources | Financial resources | Access to capital |
| | Physical resources | Research facilities and technical equipment |
| Intangible resources | Technological resources | Commercial potential of technology, significance of patents |
| | Reputation | Reputation among possible partners, established relationships in the industry (customers, suppliers) |
| | Culture, routines* | Flexibility, trial and error, enthusiasm |
| Human resources | Human resources | Entrepreneurial expertise of inventors, founders and other employees, management skills, motivation |

**Table 4: Classification of critical resources for spin-off commercialisation**[76]

* = Originally, Grant named this subcategory “organisational resources”, but did not give any examples for it. This subcategory is replaced here by the resource “corporate culture and routines”, because of the importance of the latter for start-ups.

University spin-offs need to develop their technology further through activities like proof of principle and prototype development. Consequently, **tangible resources** like access to capital, research facilities as well as technical equipment are important. Capital is either needed directly, for financing the development activities, or indirectly,

[76] The classification of resources is based on Grant, Robert M. (2005): *Contemporary Strategy Analysis*, 5th edition, Cornwall, 2005, p.140.

for building up other resources. **Intangible resources** are important as well: the technology has to have commercial value for the further development of a market. That means that it has to correspond to customers' needs or to create a new demand. Because it is unlikely that spin-offs can commercialise their invention independently, relationships to potential partners are another crucial resource. The culture can be an important aspect considering that spin-offs have to cope with a lengthy development process, a broad range of tasks and uncertainty. **Human resources** play a crucial role in the commercialisation process: entrepreneurial expertise and skills of the inventors and founders are an important source of tacit knowledge and their motivation is a driver for the whole spin-off development.

One resource alone does not lead to competitive advantage; if a spin-off only possesses new technological know-how, success in the market is unlikely. Different resources must work together in order to form organisational capabilities. These capabilities are a firm's capacity to undertake a particular activity, also defined as competence.[77] As seen above, the development of innovative technologies is not enough to launch a product successfully, spin-offs need to have additional capabilities in e.g. marketing and distribution. Such capabilities were defined as complementary assets in chapter 3.

In a recent study, the effects of certain resources on university technology transfer performance were examined.[78] One measure of performance was the number of start-ups formed by the examined American universities. The following resources were proven to have a significant positive influence on start-up formation:

- Level of industry research funding received by an institution
- Faculty quality, i.e. total number of citations that each university received
- Age of Technology Transfer Office
- Venture Capital munificence in the university's geographical area

[77] Grant (2005), supra note 77, p.138-139, 144.
[78] Powers et al. (2005), supra note 67.

Among these resources, the faculty quality was of central importance: the recruitment and retention of top research faculty is critical for entrepreneurial success.[79] Although this study was conducted from a university perspective, it is an indication of the crucial importance of human resources in the context of spin-off development. There are other authors who state that the role played by the individual scientist and inventor will be the core of successful commercialisation.[80] A study that examined spin-off companies at Cambridge University came to similar results: motivation, experience and knowledge of the entrepreneurs can override difficulties like identifying productive opportunities and obtaining the resources for the necessary productive base.[81] Hence, skills and experiences of the entrepreneurial inventors are likely to be critical for a successful commercialisation. That is the reason why they are discussed more extensively than other resources in the following chapter.

### 4.3.2 Motivations and experiences of entrepreneurial inventors

There is little evidence about individual academic entrepreneurs and their behaviour in technology transfer processes.[82] The aspects outlined below are motivations of academic inventors to start up a company and their prior entrepreneurial experiences.

Inventors play an important role during the formation of a spin-off; not only when they start up a company themselves, but also when others are the founders. Especially when the technology in question is still at an early stage of development, and knowledge is tacit, their involvement is crucial.[83] Research in the field of entrepreneurship has shown that individual traits can influence the decision to start up a business.[84] Hence, it is important to understand the underlying motivation of the inventors to undertake this step. The explanations can be classified into two main groups: psychological and career-oriented explanations.

---

[79] Ibid., p.292.
[80] Wright, Mike; Birley, Sue; Mosey, Simon (2004): *Entrepreneurship and University Technology Transfer*, Journal of Technology Transfer, Vol. 29, p.235.
[81] Druilhe, Céline; Garnsey, Elizabeth (2002): *Tracking the Emergence and Progress of University Spin-out Cases*, IEEE International Engineering Management Conference, Cambridge, 2002.
[82] See e.g. Klofsten et al. (2000), supra note 65, p.300 or Wright et al. (2004), supra note 81, p.240.
[83] Shane (2004), supra note 11, p.151-152.
[84] Wright et al. (2004), supra note 81, p.240.

**Psychological explanations** are based on the evidence that entrepreneurs have different psychological attributes than other members of society. The following attributes were found to have influence on the decision to establish a spin-off:

- Desire to bring technology into practice
- Desire for wealth
- Desire for independence

The first attribute refers to the desire of inventors to be involved in the further development of the technology and to bring it personally into practice. Often, researchers perceive a start-up as a more challenging place to work than established companies.[85] The other two attributes can be described as the desire to make money and to stay independent.

**Career-oriented explanations** argue that inventors establish spin-offs at certain times in their careers. Researchers who have achieved a higher rank within the university are more likely to start up companies than others; the same is valid for researchers with a higher level of prior entrepreneurial experience.[86]

In 1998, a survey among researchers from six member states of the EU (Sweden, Spain, Portugal, Finland, UK and Ireland) was conducted in order to examine the process of technology transfer from universities to industry.[87] Academic entrepreneurship was not only investigated from the universities' perspective, but also from the single academic's perspective. Among others, insights in the personal characteristics of the respondents, their previous entrepreneurial experience and the academic entrepreneurship activities undertaken were gained through this survey.

The Swedish respondents were academics from Linköping and Umeå University, Luleå Technical University and Chalmers University of Technology. 80% of the respondents were males; the majority worked as research assistants and was qualified at the Ph.D. level. Half of these academics have previously been employed in a full-time position outside the university sector. Probably even more surprising,

[85] Shane (2004), supra note 11, p.26.
[86] Shane (2004), supra note 11, p.156-162.
[87] Jones-Evans (1998), supra note 14; for the investigation in Sweden see Klofsten et al. (2000), supra note 65.

62% of the respondents had some kind of prior entrepreneurial experience. According to the authors, such a large degree of previous entrepreneurial experience has not been noted in other studies. Most of the academics questioned had been employed within a small business; a quarter of them had even started or owned their own business.[88]

Around 60% of the respondents had some type of contact with industry during a time period of five years. Compared to e.g. Ireland, the academics in Sweden had significantly less contacts with the industry, but the number of Swedish academics who were proactive and reactive in establishing contacts was higher. The survey did also investigate entrepreneurship activities that academics had pursued within their universities. The results revealed that the formation of spin-offs and patenting/licensing belonged to the least popular activities: around 10% of the respondents were involved in such activities while 40-50% had undertaken contract research, consulting, large scale science projects and external teaching.[89] Similar evidence was found in the other countries which were examined.[90]

The authors of the study concluded that many academics "...might be satisfied with undertaking "low-level" activities such as consultancy to gain extra income without the trials and tribulations of starting a new business, having no desire to learn the new competencies required to successfully manage an entrepreneurial venture".[91] This conclusion seems to be somewhat ill-founded because there was no investigation about the reasons why the academics have chosen one entrepreneurial activity or the other. It is not unlikely that more respondents wanted to establish a spin-off, but that some serious obstacles hindered them from doing so. Spin-offs are in general more costly and risky undertakings compared to other transfer mechanisms. Because of appropriability problems mentioned in chapter 3, it might not be a worthwhile activity from a financial perspective. Moreover, to establish a spin-off is rather difficult and demands additional expertise.[92]

[88] Klofsten et al. (2000), supra note 65, p.303-304.
[89] Klofsten et al. (2000), supra note 65, p.305.
[90] Jones-Evans (1998), supra note 14, p.59.
[91] Klofsten et al. (2000), supra note 65, p.307.
[92] Shane (2004), supra note 11, p.287-290.

Another conclusion was that the transfer of technology from university to industry is more effectively done by consultancy and contract research than by encouraging academics to establish new businesses. Nevertheless, the establishment of a spin-off can very well be an effective mechanism for technology transfer in certain circumstances. A main determinant of the efficacy is the technology's characteristics. For example, the establishment of a spin-off by the inventor is more common when the underlying knowledge is tacit than when it is codified. At an early stage of development, when the commercial value of the technology is unproven, it might be difficult to license it out to established firms. In such a situation, the formation of a spin-off and further technology development tends to be more appropriate.[93]

## 4.4 Summary

A summary and implications of the discussion above is provided here.

*Process of spin-off establishment and development*

The process of spin-off establishment and development is modelled as a linear sequence of activities. It has to be kept in mind that these processes might vary to a considerable extent between industries and also between individual spin-offs.

The development phase is considered more important here because it reflects the situation of the examined spin-offs from Lund University (see chapter 5). This process is modelled as a "technology pull"-approach: first, the new technology is developed further and then, the market and the needs of customers are evaluated. The latter step, market development, consists of activities which lie outside the ordinary competencies of researchers. Possible consequences are that such activities are considered difficult, that others are hired for conducting them or that the market development is neglected and the focus remains on the technological aspects.

[93] Ibid., p.103, 110-113.

*Resources and capabilities*

Spin-offs typically possess new technological knowledge, but lack complementary resources. As outlined above, they cannot start to sell their technology directly, but have to conduct further development first. Consequently, access to capital and hence financial resources are a necessary condition for these companies to be able to continue in the subsequent years after establishment. Money is not sufficient though, other resources play an important role as well. Without a commercially valuable technology, relationships to potential partners or marketing capabilities, a successful commercialisation is not likely. These resources are not easy to obtain due to their intangible nature. Often, the access to them depends on the skills of the inventors and founders of the spin-offs.

The further investigation of human resources in the context of spin-off development showed that an inventor's decision to establish a spin-off is based on his intrinsic motivation, but also on the desire to make money. Concerning prior entrepreneurial experience, a survey among Swedish academics revealed that a majority of the respondents had such experiences. The foundation of spin-offs was found to belong to the least popular entrepreneurship activities pursued within universities. That is not surprising since other activities like contract research, consulting or large scale science projects are easier to conduct and less risky. However, that must not mean that researchers are not willing to establish spin-offs.

# 5 Case studies: Spin-offs from Lund University

This part contains the summaries of four interviews which were conducted with founders and CEOs of spin-off companies from Lund University. The aim with these case studies is to illustrate the process of commercialisation, to identify the main difficulties and success factors and to get a picture of the people standing behind the spin-offs.

The case studies are structured as follows: first, a brief introduction about the respective spin-off is given and a summary of the main characteristics. Second, the process of commercialisation is described. This is the main part which is not structured any further; the intention is to render the statements of the interviewed persons as a whole “story”. Important issues like motivation of the founders and cooperation with partners are discussed more in-depth in two case studies: SpectraCure and GasOptics. The reason why this was not done for all four spin-offs is the way how the interviews were conducted. Due to the flexible structure of the questionnaire, the interviewed persons were free to focus on issues which they considered especially important in the context of commercialisation and hence the outcomes differ.

A comparative overview with the main characteristics of the spin-offs is given in table 5 which serves the purpose of enhancing the understanding of the following case studies. The companies are presented in the order which is in accordance with their founding years, starting with the most recently established company.

| | SpectraCure | Cognimatics | GasOptics | Luvit |
|---|---|---|---|---|
| Founding year | 2003 | 2003 | 2000 | 1998 |
| Nr. of employees | 3 | 6 (part-time) | 10 | 19 |
| Industry | Medical devices | IT | Industrial equipment | IT |
| Technology | Interstitial photodynamic therapy for cancer treatment | Technology for automatic image understanding and face detection | Gas Correlation Technology | Combination of IT and learning behaviour |
| Nr. of patent(s) | 4 | Several (provisional) | 1 | None |
| Current phase | Proof of principle | Just launched third MMS service | Product launch in summer | Modification of applications in accordance with customers' needs |
| Interview partner | CEO | Inventor/founder | Inventor/founder | CEO |

**Table 5: Comparative overview: Characteristics of the examined spin-offs**

The spin-offs are in different phases of development, some were recently founded and others have existed for quite a while. The table already indicates that the commercialisation process can vary substantially between firms: SpectraCure and Cognimatics were founded in the same year, but while the former has started to prove the value of its technology, the latter has already entered the market with several services.

## 5.1 SpectraCure: Cancer is attacked

### 5.1.1 About SpectraCure

SpectraCure is a recently founded spin-off company from Lund University and is developing cutting edge technology for interstitial photodynamic therapy. The technology is embodied in a photodynamic therapy instrument which makes it possible to treat tumours, such as prostate cancer. The treatment consists of several steps: first, a light-sensitive substance is injected, then the light-sensitive substance is activated by light of a unique wave length and finally, the photochemical reaction results in formation of tissue oxygen which destroy the cancer cells. A unique characteristic of the technique is dosimetry, i.e. the possibility to monitor and control the treatment in real-time. One of the benefits is the opportunity to adjust the treatment for individual patients.

SpectraCure's technology is protected with four patents. There are several research teams in the area of interstitial photodynamic therapy worldwide, but SpectraCure is currently the only company developing photodynamic therapy (PDT) methods for cancer treatment with the specific characteristics described above.

| | **Characteristics SpectraCure** |
|---|---|
| LUAB classification | Life Science / Biotech |
| Founding year | 2003 |
| Nr. of employees | 3 |
| Main owner(s) | Karolinska Development, Östersjöstiftelsen and Industrifonden |
| Technology | Interstitial photodynamic therapy for cancer treatment |
| Product | Medical device for Interstitial Photodynamic Therapy |
| Target markets | Cancer, primarily prostate cancer<br>Worldwide |
| Nr. of patents | 4 patents (the aim is to have patents in the key countries, but because of the costs, patents will only be applied for in some selected countries) |
| Role of inventor(s) | Board member and technical advisor |
| Source of capital | Venture capital (government and private) |
| Main cooperation partners | Lund University Hospital<br>Epsilon AB (technical consultant who developed the prototype) |
| Current phase | Start-up company; financed proof of principle-phase (approx. 2 years) with venture capital |
| Future strategy | Exit or continuation and cooperation with other companies through different forms of agreements |

**Table 6: Characteristics of SpectraCure**

### 5.1.2 Commercialisation process

Behind SpectraCure stands an active and inventive researcher, Prof. Sune Svanberg, Head of Atoms Physics at Lund University and member of the Nobel committee of physics. He has published around 500 scientific articles, some books and is registered inventor on 18 patents or patent applications. He developed the PDT technique with integrated dosimetry in real-time together with colleagues from

Lund University. After 20 years of PDT research, the team decided to patent the monitoring technique with feed-back in real-time. In order to get capital for the patent application, the innovator team contacted Lund University's technology transfer office LUAB who then contacted Karolinska Innovations AB. As a result, SpectraCure was founded as a joint venture between Prof. Svanberg, the innovator team, LUAB as well as Karolinska Innovations AB in 2003.

After the establishment of SpectraCure, it was decided to produce the first prototype based on the patented technology. This was done by an external engineering company. Recently, SpectraCure raised an additional amount of 21 Mio. SEK venture capital from two new investors, Swedish Industrial Development Fund (Stiftelsen Industrifonden) and TeknoSeed, and from two existing investors (Karolinska Development I and Östersjöstiftelsen). When asked why the venture capitalists decided to invest in the spin-off, SpectraCure's CEO Kerstin Jakobsson said that they based their decision on the following key criteria:

- Possibility for growth – is it possible to get return to investment?
- Unique business case – is the technique protected and are the market strategy as well as the exit possibilities clear?
- Experienced management team

SpectraCure fulfilled these criteria and got therefore the capital which secures the verification of the technology in form of clinical studies. The proof of principle-phase will take around two years and is aimed at proving that the technology has a commercial value. "It is tough for a small company to negotiate with a big player", said Kerstin Jakobsson; therefore, SpectraCure uses the proof of principle to gain a stronger platform in the negotiations with potential industrial partners.

When asked to summarise SpectraCure's process of commercialisation, Kerstin Jakobsson mentioned the following steps:

- Develop the idea at the university
- Form the company and formulate the business plan with business idea and strategy
- Establish the company and become business-minded

- Verify the commercial value of the technology
- Establish the organisation necessary for commercialisation of the product
- Launch the product

Given that the technique is working and the market exists as expected, Kerstin Jakobsson regarded the knowledge and experience of the persons involved as the most important success factor for the commercialisation process. According to her, it is very important that a start-up company has a good management with the necessary network of skilled people and consultants for accounting, financing, administration, business development, IT, regulatory issues etc. This is also important from a cost perspective: one should be experienced in working together with consultants, because "...some try to sell hours to you". Only a few scientists have a long experience of working with various consultants. Kerstin Jakobsson also emphasised the importance of an experienced board which can support the management. She is very pleased with SpectraCure's board and talks almost every day to at least one of the members. Another important factor is of course a technology that works. Because of the technology's cutting edge character, the business idea has to be valuable, i.e. it has to be known if there is a market for the new technology. Consequently, market knowledge is crucial. Finally, the timing of the commercialisation and some luck can also be considered as important factors.

### 5.1.3 Cooperations

SpectraCure has a very good relation with the innovators from Lund University, the division of Atomic Physics and the Lund University Medical Laser Centre. The technological support from the research team continues.

During the transformation from a university-based to a business-minded company, the focus has to be shifted from research to the way how the idea can be commercialised. This can be a source of tensions because researchers might have difficulties to accept that they have to give up the control over the further development of the technology. In contrast to that, the case of SpectraCure is a good example of how the cooperation between the university and a spin-off can be performed. The research is done at the university, where the knowledge and resources for exploring details exist. SpectraCure on the other hand conducts no research, only development.

SpectraCure has got almost all of the support for the commercialisation process from one of the owners, Karolinska Innovations AB. Kerstin Jakobsson has very good experiences from working together with them, "...they are creating a good atmosphere and contacts... very professional".

## 5.2 Cognimatics: Fun with mobile phones

### 5.2.1 About Cognimatics

Three researchers from Lund University founded Cognimatics in 2003, after more than 10 years of research in the field of cognitive vision. Cognimatics develops and sells software for detecting people and objects in pictures or even detecting certain events in image sequences. The focus lies on three application areas: mobile phones (MMS services), surveillance, and entrance counter. Three MMS services have been launched so far; currently, Cognimatics is developing a system for the surveillance of a parking field in Lund and an entrance counter for a camera manufacturer.

There is a competitor in Malmö, Sweden, who offers an MMS service based on face detection as well. Some others might exist worldwide, but Cognimatics' founder Rikard Berthilsson said that the market is fairly new and that it is difficult to see what is happening in countries like China and Japan. Concerning entrance counter, there are quite a few competitors whose products are based on consultant services and therefore are relatively expensive.

| | Characteristics Cognimatics |
|---|---|
| LUAB classification | IT |
| Founding year | 2003 |
| Nr. of employees | 6 (almost all part-time) |
| Main owner | Founders |
| Technology | Technology for automatic image understanding and face detection |
| Product | 3 MMS services launched so far: “Face Warping”, ”The Scream” and “Total Makeover”<br>Further area: surveillance systems |
| Target markets | Worldwide |
| Nr. of patents | Applied for several US provisional patents |
| Role of inventor(s) | Employees and owners |
| Source of capital | Mostly own capital of the founders<br>Some borrowed capital (Teknikbrostiftelsen) and investment from LUAB |
| Main cooperation partners | Strategic alliance with Schibsted Mobile AS |
| Current phase | Just launched an MMS service (“Total Makeover”) in China. Close to an agreement with a mobile manufacturer with the goal to pre-install the MMS services on the phone. |
| Future strategy | Focus on the market for MMS services. If it is going less well than expected: shift focus to other promising applications like surveillance or entrance counter. |

**Table 7: Characteristics of Cognimatics**

### 5.2.2 Commercialisation process

15 years ago, Rikard Berthilsson started to do research in the field of cognitive vision. It was not planned from the beginning that this research should be taken to the market; the commercialisation potential was discovered during the research process. A master thesis, which a student wrote in cooperation with Ericsson, was the trigger for the development of a product. The initial goal was to find existing software for handwriting recognition; Rikard Berthilsson let the student also test ideas from his own research and based on these tests, he developed a new method of interpreting handwriting. In 1999, he founded the company Decuma together with other researchers. Due to the IT boom at that time, venture capital could be raised without problems. Rikard Berthilsson became the CEO of Decuma which had 25 employees at most. However, the start-up faced heavy-weight competition: Microsoft and Palm had developed their own software for handwriting recognition which already was installed in their operating systems. Hence, to buy Decuma’s software would have

been more costly for them than to rely on their own solutions. Decuma had difficulties to generate enough sales and was recently bought by a Canadian company.

After further research, Rikard Berthilsson founded the second company Cognimatics in 2003, together with Prof. Kalle Åström and Research Fellow Fredrik Kahl. The reason was that the researchers saw market potential in the field of cognitive vision; the goal was to commercialise applications for mobile phones. At the beginning, the researchers invested their own money in the start-up; solutions for face detection were developed. Cognimatics applied for an US provisional patent which only costs around 100 USD. This is not a proper patent and after one year, an application for a real patent, which is much more expensive, has to be filed. According to Rikard Berthilsson, a patent is not a sufficient protection against competitors: there are a lot of ways to detect faces and a patent will not hinder other companies to develop alternative technology and software.

The first MMS service (“Face Warping”) was launched in March 2004, the second (“The Scream”) in 2005; with both of them, pictures of faces can be changed according to certain filters. The product launch was done in cooperation with Schibsted Mobile AS, a Norwegian distributor of wireless entertainment services. Recently, Cognimatics and Schibsted Mobile AS announced a strategic partnership to develop and distribute MMS based entertainment services on the Scandinavian market. Cognimatics is still responsible for the technology and Schibsted for the distribution; however, in contrast to their cooperation before, the ideas and the way of distribution are more intensively discussed and coordinated. Besides Schibsted Mobile in Norway, Cognimatics has a partner in China and a partner in the Middle-East. Recently, Cognimatics’ third MMS service (“Total Makeover”) was launched on the Chinese market.

Not only the applications itself, but also the way how the customers can access them has changed. First, they could download the software to their mobile phones from the Internet. According to Rikard Berthilsson, this did not work that well and it was limited to certain mobiles. Then the MMS service was designed: the customers send an MMS via a distributor to Cognimatics’ server where the picture is changed accordingly and sent back to the customer. Although this works for almost all the mobile phones with the MMS service, it is still not enough to build a company around it. “So far, it hasn’t really taken off”, as Rikard Berthilsson puts it. The third possibility is to pre-install the software directly on the phones. Currently, Cognimatics is conducting negotiations with a mobile manufacturer concerning such a pre-installation.

Besides software for mobile phones, Cognimatics developed applications based on cognitive vision for other fields as well. In November 2004, the first surveillance programme was ready. Recently, the company got the order to develop a system which can analyse pictures from the main square in Lund and recognise how many available parking places exist. The outcome is not certain yet. Furthermore, Cognimatics is developing an entrance counter for a camera manufacturer; such a system would mainly be used in the retail industry. The company’s sales have increased to 1 Mio. SEK, compared to 50’000 SEK from the first year. Cognimatics is planning to move to a proper office in IDEON, the science park of Lund University. Another full-time worker has to be employed soon.

Rikard Berthilsson regarded the following factors as important for the commercialisation process:

- Capability to adapt to the market, change focus
- Ability to try new things in a cost efficient way
- To be fast
- To operate cost efficiently
- Good spirit within the company

The experiences from the former company Decuma helped a lot for the establishment of Cognimatics, according to Rikard Berthilsson. He said that one lesson was not to rely that much on venture capital; the reason is that too many outsiders enter the picture and can easily take over control of the company. On the other side, Cognimatics is developing at a slower pace than Decuma which got a lot of venture capital. Rikard Berthilsson named two main difficulties which occurred during the commercialisation process: lacking resources for development and sales and the time consuming process until the first sales could be generated.

## 5.3 GasOptics: Gases become visible

### 5.3.1 About GasOptics

GasOptics was founded in 2000 by three researchers from Lund University. The spin-off "makes gases visible" with the aid of the so-called Gas Vision System. The system is based on infrared cameras that can immediately detect an invisible gas leak and present, in real time, the flow and concentration of the gas as a coloured plume on computer screens. It is optimised for methane and hence its main application lies within the oil and gas industry (gas leaks at both onshore and offshore installations). Currently, gas leaks are identified with active systems (detectors) which are inferior to GasOptics' gas detection technology. It is too early to identify competitors with similar solutions because the development process is still going on and the product has not been launched yet.

| | **Characteristics GasOptics** |
|---|---|
| LUAB classification | Technique |
| Founding year | 2000 |
| Nr. of employees | 10 (whereof 8 are development engineers) |
| Main owner | Statoil Innovation AS (subsidiary of the Norwegian Statoil AS), 70% shareholder |
| Technology | Gas Correlation Technology |
| Product | Gas Vision System (GVS) |
| Target market(s) | Methane gas detection and hence oil and gas industry<br>Worldwide, home market is Norway (owner Statoil) |
| Nr. of patents | 1 |
| Role of inventor(s) | Board member, employee and part owners |
| Financing | Mostly venture capital, but also inventors' own capital and minor investments of Teknikbrostiftelsen, Stiftelsen Innovationscentrum and LUAB |
| Main cooperation partners | Main partner: Statoil Innovation AS (joint development)<br>Customers, e.g. Räddningsverket |
| Current phase | First pilot installation in November 2004, evaluation of the results and refinement of the system |
| Future strategy | Product launch in summer 2005 |

**Table 8: Characteristics of GasOptics**

### 5.3.2 Commercialisation process

Jonas Sandsten developed a new method for visualisation and quantification of gas flows during his Ph.D. which started in 1995. His supervisors were Prof. Sune Svanberg and Dr. Hans Edner from the Atomic Physics Division of the Lund Institute of Technology. It was clear from the beginning that the outcome of the Ph.D. should be commercialised. Before Jonas Sandsten presented his project and the findings, the three researchers applied for a patent; otherwise, the technology would not have been patentable anymore.

Because Jonas Sandsten had won a prize for his research, the venture capitalist Statoil Innovations AS contacted him for the first time in 1997 and signalled interest. The new method based on gas correlation technology could be used for detecting many different gases; after the contact with Statoil, the researchers identified the detection of methane and hence the oil and gas industry as the most promising market. In the following two years, they developed a commercial application of the gas visualisation method through direct contacts with potential customers like the “Räddningsverket”. This process resulted in a prototype and a business plan. In 2000, Jonas Sandsten, Sune Svanberg and Hans Edner founded GasOptics. The first capital was raised from Teknikbrostiftelsen and LUAB. A year later, a joint development project with the Statoil Gas Processing plant at Kårstø, Norway, was initiated. This cooperation became even tighter after a while: when GasOptics was negotiating an agreement with another party, Statoil Leverantörs Utvecklings Program (LUP), Statoil Innovation intervened and took over. After a complex agreement process which took 1.5 years, the Norwegian venture capitalist became the main owner of GasOptics in 2003. This change of ownership led to a new perspective: everything should be owned by GasOptics; therefore, the patents were transferred from the researchers to the company.

The first installation of the Gas Vision System took place at the Kårstø Gas Processing plant in Norway in November 2004. After the pilot installation, GasOptics has worked with developing the system further and solving problems which occurred. This summer, the product will be launched on the markets in Norway, England and the USA.

According to Jonas Sandsten, the main difficulties which occurred during the commercialisation process are related to technical and market issues as well as to his role as an inventor within the company. He regarded the development of an explosion certified prototype, which works in the field, as one of the most difficult tasks. Another problem was to get good suppliers who are willing to cooperate; the parts needed for the development like infrared optics and detectors are almost only sold for military purposes. To raise sufficient capital was one of the main problems as well. From his perspective as inventor and founder, Jonas Sandsten found it tough to accept the shareholder agreement with Statoil and the fact that others took over. Furthermore, it has not been so easy to keep up the interest during the lengthy development process. 10 years have gone since he started developing the new method for gas visualisation and today, there are still no customers. On the other hand, it was not difficult to find engineers willing to work for GasOptics. According to Jonas Sandsten, the reasons are that the Gas Vision System is an interesting product, that the development is challenging, and that there is the possibility to help minimising environmental harm.

When asked about success factors for the commercialisation process, Jonas Sandsten mentioned the following factors:

- Early cooperation with potential customers
- Industrial mindset and links to industry
- Knowledge and experience of board members
- Ability to work with many different people
- To be able to keep up the interest and not to loose enthusiasm

Regarding the second factor, Jonas Sandsten pointed out that Stefan Nilsson, who became CEO of GasOptics in 2003, brought many and valuable contacts with the industry into the company. One of the founders, Sune Svanberg, had started up other companies before and could therefore give advice on important business and legal issues. The last two factors relate to Jonas' role as an inventor and founder and are discussed in the next chapter.

### 5.3.3 Motivations for establishing a spin-off

One reason why Jonas Sandsten left the research lab and became engaged in the process of commercialisation is related to his background: Before he started with the Ph.D., he was an engineer at HP and other companies. Through these experiences and contacts within the industry, Jonas Sandsten has developed an "industrial mindset", as he puts it. Another reason was that he wanted to make money with his technology while keeping the power over the further development process; hence the engagement in GasOptics seemed to be adequate.

Jonas Sandsten stressed that making money is not the only motivation for commercialising a technology: in the case of gas visualisation, one could also be driven by the environmental aspects or by the challenging task to develop a functioning product. He sees the combination of different driving forces in GasOptics' founding team as a positive aspect.

The relation with mentors is another factor which influenced his motivation. In regard to the company, Jonas Sandsten got most of the support from the two other founders Sune Svanberg and Hans Edner. They were his supervisors during his Ph.D. and gave him also advice about how to start up a company. In regard to personal aspects and Jonas' role as an inventor, other mentors have been very important for him. For example, Tor Aurell from Teknopool AB had a positive influence on Jonas' self-esteem, because "he believed in the whole thing because of me, and he thought that I was the one who could do it".

### 5.3.4 Cooperations

GasOptics has got support from different institutions around Lund University. What Jonas Sandsten was missing is the cooperation between these institutions. He said that there are almost too many, and that it takes time to understand what their goals are, for which reasons they would help a small company etc. According to him, the existence of such institutions does not mean much, it is all about the people working there and what kind of support and advice they can provide.

The venture capitalist Statoil Innovations AS was GasOptics' partner for the joint development project in 2001 and has become its main owner in the meanwhile. Jonas Sandsten emphasised that venture capitalists are important for high technology companies because of the amount of money which is needed for the further development of a technology. GasOptics had to raise more money in order to finance expensive components and thorough market investigations. There were several possible investors, but only Statoil wanted to bring the technology in operations. The others considered the investment too risky because no product existed yet. Jonas Sandsten has quite a critical view on the cooperation with Statoil and sees it as a trade-off: the money problem was solved, but at the same time, the control of the further development was lost, enthusiasm and commitment decreased. Moreover, he described the negotiations with Statoil as not being a healthy process for private persons because of the confrontation with the superiority of Statoil's resources and the time consuming processes.

The cooperation with Statoil has advantages for the relations to other business partners. To get good suppliers was one of the main problems; they were reluctant to do business with GasOptics. The building of trust took quite a long time. This has become much easier since Statoil is the major owner: when getting to know that, the suppliers are immediately ready to enter a contract with GasOptics.

## 5.4 LUVIT: Knowledge over distance

### 5.4.1 About LUVIT

Luvit was founded in 1998 and was listed at the stock exchange in Stockholm two years later. The company develops products and services for e-learning. The main product, a complete Learning Management System called "Luvit Learning Centre", helps teachers and other instructors to design Internet-based courses.

The market for e-learning technology is very fragmented and there are numerous competitors. Luvit's customers are both public institutions and private businesses.

| | Characteristics of LUVIT |
|---|---|
| LUAB classification | IT |
| Founding year | 1998 |
| Nr. of employees | 19 |
| Main owner | Volito AB |
| Technology | Combination of IT and learning behaviour |
| Main product | Software: Luvit Learning Centre |
| Target markets | Southern Sweden |
| Nr. of patent(s) | No patent |
| Role of inventor(s) | Employee |
| Source of capital | Venture capital during IT boom |
| Main cooperation partners | Customers, software consultants |
| Current phase | Important now: shift focus from own products to customers' needs and find most common denominator between the different applications |
| Future strategy | Luvit has to position itself in the application field where it fits best and then to expand to neighbour fields |

**Table 9: Characteristics of Luvit**

### 5.4.2 Commercialisation process

The development of Luvit's e-learning solutions was need-driven: eight, nine years ago, teachers at Lund University discovered that they lacked tools to construct distant courses. At the same time, the rise of the Internet opened up new possibilities. An external software consultant was ordered to develop a solution for the needs of the teachers. Similar processes took place elsewhere: the IT sections were expanded and every university developed its own solutions.

In 1998, Luvit was founded and one of the development engineers became the managing director. To raise capital was not the problem: it was the time of the IT bubble and many investors were eager to put their money into IT start-ups. But Luvit spent a lot of the raised capital and generated high losses. The technical development and design functions were outsourced to IT consultants, and the spin-off had no direct contacts to customers. According to Luvit's current CEO Björn Christofferson, Luvit was not a "real" company at that time, but more an administrative organisation that waited for someone wanting to buy the product.

In 2001, a new CEO was assigned. 25 employees worked at that time for Luvit, 9 of them were sales men. The technical development was still outsourced. An ambitious expansion strategy for European countries, based on a network of partners, was implemented. When Björn Christofferson became CEO in 2003, he changed among other things the structure of the workforce. New engineers were employed, among others one of the original developers of Luvit's e-learning solution. Björn Christofferson explained that it is important to keep knowledge about Luvit's history and the reasons for certain decisions within the company. The sales force was taken away, to sell the products became the task of the management.

Björn Christofferson identified the following stages of Luvit's development:

- Need phase
- Company organisation
- Market strategies and business idea
- Fragmentation of the market
- Shift focus on applications

At the current stage, it is important for Luvit to identify customers' needs and modify the applications accordingly. These needs can differ quite a lot; therefore, the most common denominator has to be identified. This is rather difficult and moreover, the demand side has to catch up with the supply side: there is no clear need for e-learning solutions in the industry yet.

According to Björn Christofferson, the success factors for Luvit's commercialisation process are the following:

- Harmony between the three strategic questions: what do I sell, to whom, and why should the customer buy from me?
- Strong commitment and the will to reach something, especially from the management
- Concentration on a smaller part of the market
- Sales function as a task of the management or someone who understands the customers' needs
- Some luck (e.g. when gaining customers)

Looking back at the starting phase, Björn Christofferson thinks that Luvit should have stopped to develop the technology further and should have focused quicker on applications instead. A smaller part of the market should have been targeted from the beginning. It would have been better to spend money on marketing instead of waiting for customers.

## 5.5 Comparative summary

Not surprisingly, a considerable variation between the commercialisation processes can be observed. This is mainly due to the different stages of technology development and the varying industrial background of the examined spin-offs. In the following, it is investigated how the empirical evidence fits with the theoretical implications from three main areas: spin-off development, resources and commercialisation strategies. Furthermore, the aim is to use the observations and insights from the case studies in order to contribute to the existing theory.

### 5.5.1 Process of spin-off establishment and development

Concerning the activities during the commercialisation process, the main findings from the case studies are:

- The commercialisation process consists of a broad range of activities
- The nature of the technology influences the complexity, length and importance of single activities
- Consequently, the time needed until a product can be launched differs
- Technology push characterises the commercialisation process
- The sequence of activities is not always in accordance with the model
- The Technology Transfer Office is not the driving force during the establishment phase
- The transformation from a research-based to a business-oriented company is an important and sometimes difficult step
- Uncertainty and complexity characterise the spin-off commercialisation

The spin-offs are at different stages of commercialisation: while the recently founded SpectraCure is conducting the proof of principle with the aim to show the commercial value of its technology, Luvit has existed for several years and is focusing on developing the market for e-learning solutions. This illustrates that the commercialisation process consists of a variety of activities which require different skills and resources.

The model for the spin-off development outlined six main activities (see figure 2 in chapter 4.2.2): proof of principle, prototype development, product development, evaluation of market, choosing an application, selling the products. These steps can be identified in the case studies; however, there are considerable differences between the spin-offs in regard to the importance, complexity and length of these steps. The reason for that is, among other factors, the nature of the technology which is developed within a spin-off. A device for treating cancer will require more complex and costly tests and approvals before it can be launched than a software for mobile phones.

The varying complexity influences the time needed to introduce a product on the market. The two IT companies, Cognimatics and Luvit, launched their products shortly after their establishment. Cognimatics for example was founded in 2003 and entered the market with its first MMS service in 2004. The situation is different for the two spin-offs who develop devices. SpectraCure, founded in 2003 as well, has just started with the proof of principle which will last for approximately two years. GasOptics was established in 2000 and the product launch is expected to take place this summer. These differences imply that the founders of the IT companies had a clear picture of how their technologies could be used in practice and that the development phase was rather short. SpectraCure and GasOptics on the other hand spent a considerable amount of time on the further development of their technologies and on the proof of the commercial applicability.

The sequence of commercialisation activities is characterised by a technology push: first, the technology is developed, and second, the market is evaluated. According to the theory, the prototype and product development are conducted before the market evaluation. That is not always the case in the practice though. GasOptics for example examined the market at an early stage and concluded that the oil and gas industry is the most promising target market. Based on this evaluation, the prototype was developed and not vice versa. Luvit is a case where the whole development of the technology was need-driven. Hence, the sequence of activities as modelled in theory does not always reflect the steps in practice. Feedback mechanisms are neither included in the model, but might frequently take place in practice: the technology has to be refined or developed further, new or alternative applications have to be developed, and adaptations for new markets have to be done.

Regarding the process of establishment, the Technology Transfer Office LUAB did not play such a critical role as foreseen by theory. Unlike TTOs in other countries, where universities own academic inventions, LUAB did neither evaluate the invention, decide if it should get legal protection, or look for licensing partners. Instead, its role was that of an important first investor and supporting institution for the spin-offs. It was due to the motivation and the final decision of the researchers that the spin-offs were established. Moreover, this decision was not a consequence of an unsuccessful attempt to license the technology out to an established firm. Other ways of commercialising the technology were not taken into account; to establish a spin-off was regarded as the best way to develop the technology further and finally launch a product on the market.

An important observation from the case studies is that the transformation from a research-based to a business-oriented company is an important step which could create tensions. During the commercialisation, the focus has to shift from technology development to market opportunities. This implies that other skills than R&D become necessary and the researchers are not likely to possess them. For someone who spent a long time on researching and building up the spin-off, it might be hard to accept this change. On the other hand, the development of a spin-off is likely to suffer if the focus is not shifted at the right time from research to business.

Moreover, the case studies revealed that uncertainty is an important aspect of commercialisation. From the technical perspective, it is mainly uncertainty about the outcome of the development process. SpectraCure is currently going through the process of proofing the value of its technology and depending on the outcome, the future strategy will be chosen. From the market perspective, there is uncertainty about the market potential. Due to the cutting edge character of the technologies, a market has to be developed first. It is not clear if there will be sufficient demand for the new products or services. This makes it also difficult to identify existing and potential competitors. Another characteristic of the commercialisation process is the complexity and length of the activities involved. Almost all the interview partners mentioned the problem that the various activities can be very time-consuming. In contrast to other industries, there seems to be no quick way from an idea to a product; the commercialisation in high-technology industries can take several years.

### 5.5.2 Resources and capabilities

The main findings concerning important resources and capabilities for the commercialisation process are:

- Lack of resources occurs at all stages of the commercialisation process
- Commercialisation of cutting edge technology often requires a considerable amount of capital
- Resulting dependencies on partners and/or investors
- Human resources were most often named as success factors for the spin-off commercialisation
- Prior industrial and entrepreneurial experience is essential for the decision to establish a spin-off
- Organisational capabilities like cost efficiency and sales are important for Cognimatics and Luvit
- Relationships within the industry are important for SpectraCure and GasOptics

The theory implied that small firms are less likely to possess complementary assets, like manufacturing and marketing, which are necessary for the product launch. The case of Cognimatics illustrates this: the researchers developed the technology for face detection independently, but did not have the competencies and the underlying resources for the distribution of the new software. University spin-offs do also need additional resources at earlier stages of the commercialisation process. Both SpectraCure and GasOptics had to acquire a considerable amount of money and inputs for development in order to be able to continue with further steps.

It was not investigated in detail which resources the spin-offs lacked. However, two main categories can be identified:

- Access to capital (generic resource)
- Access to capabilities like development, manufacturing, distribution, sales (specialised or co-specialised capabilities)

The theory emphasises the importance of the latter category, specialised and co-specialised assets. But access to capital can be as important: the commercialisation of cutting edge technologies requires often large investments due to the costly and lengthy development process. As expected, the acquisition of capital was considered to be one of the main problems during the commercialisation process. The IT companies though, established in the late nineties, did not have problems to raise capital because of the IT boom at that time.

The need to acquire complementary resources can lead to various dependencies. Spin-offs can depend on investors or on vertical and horizontal business partners who have the necessary manufacturing or distribution capabilities. The case studies revealed that access to venture capital might not always be beneficial for spin-offs, especially from the perspective of their founders: “outsiders” take over the control of the further development of a spin-off. This might be difficult to accept for the founders and can lead to a loss of their commitment and motivation, as it was the case with GasOptics.

Certain resources and capabilities are crucial for a successful commercialisation. Table 10 shows the results of the interviews, i.e. which resources the interview partners considered especially important.

| | Human resources | Organisational capabilities | Reputation |
|---|---|---|---|
| **SpectraCure** | Knowledge and skills of management; experience of the board | | Network of skilled people and consultants |
| **Cognimatics** | | Capability to adapt to the market, fast and cost efficient operations, good spirit within company | |
| **GasOptics** | Knowledge and experience of the board members, ability to keep up interest and motivation | | Early cooperation with customers, links to the industry |
| **Luvit** | Strong commitment, especially from management | Sales function (management task), marketing in general | |

**Table 10: Important resources for the commercialisation in the examined spin-offs**[94]

**Human resources** were mentioned most often as success factors. Besides the skills of inventors and founders, the knowledge and experience of managers and board members is very important: it can (partly) substitute lacking knowledge of the former.

The reasons why Jonas Sandsten left the research lab and founded GasOptics confirm the theory outlined in chapter 4.3.2 quite neatly. Both psychological and career-oriented explanations played an important role for his decision to get engaged in the spin-off. He wanted to make money with the Gas correlation technology and had prior experiences from working as an engineer and hence an "industrial mindset". When comparing the two sets of explanations, the career-oriented explanations seem to be especially important in a university environment. Prior industrial and entrepreneurial experiences play a crucial role when researchers decide to start up a company. A good example is Prof. Sune Svanberg, who founded both GasOptics and SpectraCure: he is an active inventor and has considerable experiences from prior start-ups. Moreover, he is one of the key entrepreneurs within Lund University. Also Rikard Berthilsson could profit from earlier insights of how to establish and run a company when he founded Cognimatics.

[94] Classification of resources is based on Grant (2005), supra note 77, p.140.

In addition to that, intrinsic motivations can explain the desire to found a spin-off. In the case of GasOptics, examples are the ambition to establish a successful company, the challenging development of the technology or environmental aspects. Due to the latter, it was not a problem to find engineers willing to work for GasOptics. Consequently, motivation is not only an important issue for inventors and founders, but also for employees. As seen in the case studies, it can be difficult to keep the motivation up over the long commercialisation process with a lot of changes. Mentorship can be an important support for both business-related and personal questions and issues.

**Organisational capabilities** were considered especially important in both IT companies. This is not surprising since it is related to their stage of development: they have already launched products on the market and need capabilities like distribution and sales. Especially sales capabilities play a critical role for both Cognimatics and Luvit: for the former, the lack of resources in this area was a main difficulty and in the latter, the sales function has become a management task.

**Reputation** refers to intangible resources like reputation among potential partners and relationships with customers and suppliers. Such resources are especially important for SpectraCure and GasOptics since both need support for the further technology development. It is typically the managers and board members who provide contacts with the industry; researchers do not have such contacts in general.

### 5.5.3 Commercialisation strategy

The conclusions presented in this part are connected to the insights gained about the process of commercialisation and resource issues. The relevant findings are:

- A common pattern is the cooperation with established firms
- The extent of cooperation varies considerably
- Two types of strategies were observed in the case studies: independent market entry or support from established firms
- No clear-cut distinction between competition and cooperation exists
- The initially chosen strategy might have to be adapted due to uncertainty about future development

All four spin-offs have undertaken some form of cooperation with other firms, which is characterised by varying degrees of dependence, complexity and duration. There are considerable differences to which extent the spin-offs cooperate with other companies respectively to which extent they remain independent. Cognimatics for instance has done the technology development on its own so far while GasOptics has started a joint development project with a venture capitalist, who has become its main owner in the meanwhile. This is linked to the observations before: depending on the nature of the commercialisation process and the resulting need of resources, more or less cooperation is necessary.

Figure 3 shows how the strategies of the four spin-offs can be classified:

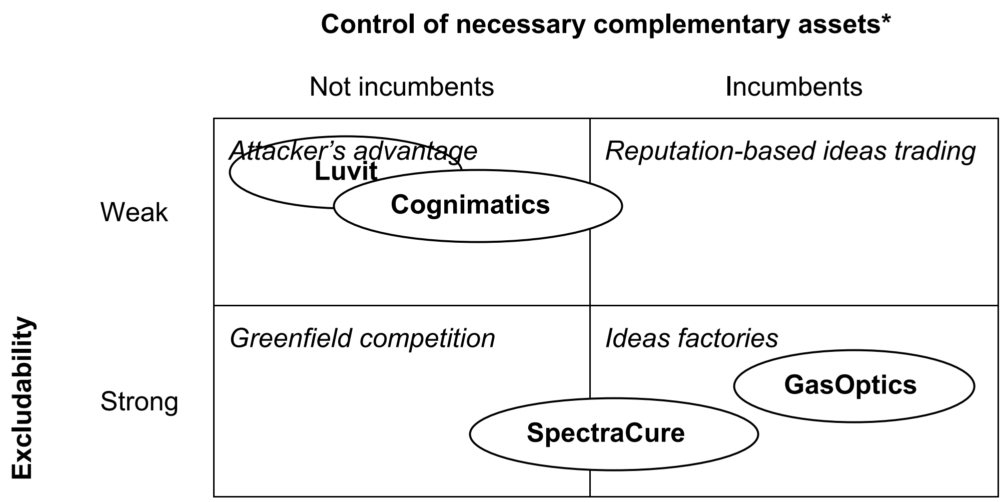


**Figure 3: Commercialisation strategies of the examined spin-offs**

* = specialised assets

### Attacker's advantage

Both Cognimatics and Luvit are not especially dependent on the resources which incumbents possess, and the legal protection is rather weak. This situation corresponds with the strategy "attacker's advantage": both spin-offs entered the market with a new product which they had developed independently. One could argue that Cognimatics' partnership with a distributor does not really fit into the picture, since it shows that Cognimatics had a lack of distribution capabilities and thus needed resources of other firms. However, the cooperation is of a vertical nature and not horizontal, as the framework assumes.

**Ideas factories**

GasOptics' technology is rather well-protected through patents; at the same time, the spin-off is dependant on external resources due to the early stage of the technology and the need to develop it further. According to the framework, these factors result in the scenario "ideas factories". In practice, GasOptics cooperates closely with Statoil, a venture capitalist and development partner. SpectraCure's technology is effectively protected through patents as well. Complementary assets like manufacturing capabilities owned by established firms might not be so important at the current stage, but are likely to become more important in future. Therefore, its position is between greenfield competition and ideas factories.

The framework for start-up commercialisation, developed by Gans and Stern, is considered applicable to spin-off companies. However, one has to be aware that spin-offs are likely to lack a number of necessary resources and capabilities and hence, they are not likely to manage the commercialisation independently. Even if the development of the technology is possible without cooperation, this might not be the case for the market entrance. That means that even if a spin-off chooses to enter the market independently, instead of working together with established firms, it might have to enter some kind of cooperation with business partners in order to access the necessary resources.

The situation of SpectraCure exemplifies that the initial strategy might be subject to changes during the commercialisation process, especially because of the uncertainty. SpectraCure aims at gaining a partner and is therefore voluntarily conducting the proof of principle in order to strengthen its bargaining position. Depending on the outcome of this testing phase and the market opportunities, SpectraCure can either go on with the help of a partner or will be sold to another firm.

# 6 Technology transfer instead of market entry

The case studies illustrated the direct way of exploitation: the researchers set up a start-up with the aim to embody the technology in products or services and to enter the respective market.[95] Alternatively, university technologies can be commercialised by licensing intellectual property to large, established firms.[96] This is the indirect way of exploitation and is referred to as "technology market", since technologies are transferred between partners. This concept is examined in the following chapters.

## 6.1 Technology market concept

### 6.1.1 Business and legal understanding of technology markets

From a business and economic perspective, markets for technology are the main alternative to in-house exploitation. In general, a market is seen as a place where demand and supply meet. Market transactions typically involve an exchange of a good for money.[97] On a market for technology (or "market for ideas"), the objects of exchange are technologies. The way technology is transferred between parties ranges from licensing of intellectual property to complicated collaborative agreements.[98] A market for technology provides both sellers and buyers with appropriate possibilities; an example is Statoil Innovation who got access to the Gas correlation technology by acquiring the majority ownership of GasOptics.

From a legal perspective, technology markets are explicitly defined as consisting of "...the licensed technology and its substitutes, i.e. other technologies which are regarded by the licensees as interchangeable with or substitutable for the licensed technology, by reason of the technologies' characteristics, their royalties and their intended use".[99] The methodology for defining technology markets is presented and illustrated with a case in the following chapter.

[95] However, this is not done independently.
[96] Powers et al. (2005), supra note 67, p.294.
[97] Arora, Ashish; Fosfuri, Andrea; Gambardella, Alfonso (2001): Markets for Technology and their Implications for Corporate Strategy, Industrial and Corporate Change, Vol. 10 (2), p.422.
[98] Ibid., p.423.
[99] EU Technology Transfer Guidelines (2004), supra note 7, § 22.

### 6.1.2 Rules for technology market definition

Independent commercialisation is preferable from a competition law perspective; according to the European Commission, the main goal of antitrust rules is "...to make certain that companies compete rather than collude".[100] However, the transfer of technologies per se is not considered anti-competitive. On the contrary, technology transfer agreements and the licensing of new technologies are in general viewed positively because they ensure dissemination of successful innovations in the economy and thus enhance productivity and growth.[101] A revised Technology Transfer Block Exemption was issued in 2004, resulting from a reform of the EU competition rules.

Some technology transfer agreements can have effects which are to the detriment of competition. The definition of technology markets is used as a tool for assessing possible negative effects.[102] The methodology for defining technology markets follows the same principles as for defining product markets: basically, other technologies which could be substitutes for the technology in question have to be identified.[103] Technology is regarded as an input for either a product or a production process, thus both the product and the technology market are relevant for the assessment.[104]

The procedural rules for defining relevant markets name three sources of competitive constraints for firms:

- Demand substitutability
- Supply substitutability
- Potential competition

[100] European Commission (2004): *A pro-active Competition Policy for a Competitive Europe*, COM(2004) 293 final, Brussels, 2004, p.6.
[101] Ibid., p.11.
[102] It is also used for R&D agreements, see Guidelines on the applicability of Article 81 of the EC Treaty to horizontal cooperation agreements , OJ C 3/02 (2001), § 48-49.
[103] EU Technology Transfer Guidelines (2004), supra note 7, § 19-22.
[104] Ibid., § 20.

For the definition of the relevant market, "...demand substitution constitutes the most immediate and effective disciplinary force on the suppliers of a given product..." and is hence the most important factor to assess.[105]

Case law to illustrate the application of the technology market concept is rather rare. The reference case for the definition of technology markets is Shell/Montecatini which is discussed in the following.[106] The case is important because it provides useful insights about the application of the technology market concept.[107] This concept is not only used for assessing license agreements, but also for R&D agreements.

*Case No. IV/M. 269, Shell/Montecatini*[108]

The case was about a proposed joint venture between the companies Shell and Montedison in the polyolefin sector. It was planned to set up the joint venture Sophia, owned 50% by Shell and 50% by Montedison. The latter would have transferred all of its polyolefin interests world-wide, including production and marketing assets, intellectual property rights and R&D facilities, as well as all upstream and downstream activities to the joint venture; Shell would have contributed with the major part of its worldwide Polypropylene (PP) and Polyethylene (PE) business.[109] Based on that, the Commission concluded that Sophia would have the necessary assets and resources for performing all the functions of an autonomous economic entity in the polyolefin sector.[110]

Since there was an overlap of the parties' activities concerning production and sale of PP and the PP technology, the Commission focused its analysis on the effects of the concentration in these markets. It defined not only the downstream market (PP product market), but also the upstream market (PP technology market). The former is not further discussed here; for the purpose of a better understanding of the case, it

[105] Notice on the definition of relevant market for the purposes of Community competition law, OJ C 372/5 (1997).
[106] EU Horizontal Cooperation Guidelines (2001), supra note 103, § 48, Temple Lang (1996), supra note 5, p.28, Glader (2004), supra note 4, p.108-109.
[107] Because the joint venture in question was a full-function joint venture, the case was analysed under the Merger Regulation.
[108] Case No. IV/M. 269-Shell/Montecatini, OJ L 332/48 (1994).
[109] Ibid., §§ 4-5.
[110] Ibid., § 11.

can be noted that PP belongs to the category of polyolefin which is a family of thermoplastics indirectly derived from oil or natural gas. The plastics processing industry uses PP for a large number of applications, e.g. film, fibres, automotive components or garden furniture.[111] The Commission started to define the relevant technology market by describing how PP is produced: through the polymerisation of propylene. This process involves several elements like raw material, propylene, a suitable catalyst for the polymerisation, the technology and know-how for the use of such a catalyst, and the process technology as well as the know-how necessary to design and use equipment in which polymerisation takes place. These elements have advanced a lot in the last 30 years.

For the further analysis, the Commission used the elements which are summarised in table 11:

| **Elements** | **Main statement / relevance for technology market** |
|---|---|
| Intellectual property rights<br>§§ 31-32 | Ownership of patents may be a barrier to new entry into the technology market |
| Market structure § 33 | The licensing of PP technology takes place in a market which is separate from the one for the production of PP |
| Supply side § 34 | Basic service (technical knowledge and updates about refinements of technology) and associated service (technical support, customer assistance or engineering services) |
| Demand side §§ 35-38 | Existing customers: PP manufacturers without their own PP technology<br>Potential customers: Companies with in-house R&D, new entrants in the PP industry or existing licensees who want to expand their current PP activity |
| Demand for licenses<br>§ 39-40 | A substantial increase in the demand for technology licenses worldwide is forecasted because of the growing PP world market |
| “Process-plus-catalyst” package § 41-42 | PP technology is typically licensed as a package, consisting of a polymerisation process and a catalyst |
| Older versus advanced process technology § 42 | The older slurry processes were widely used in the industry until the 1980s. Today, they are replaced by more advanced gas-phase and bulk processes |

**Table 11: Elements used for the definition of the PP technology market**

[111] Case No. IV/M. 269-Shell/Montecatini, supra note 109, §§ 23-24.

The last two factors are technology-specific, while the others are in line with the principles for the ordinary (product) market definition.[112] After considering these factors, the technology market was defined on the basis of the "process-and-catalyst" package and the more advanced process technologies. The Commission concluded that "...the licensing of advanced PP technology and other associated services as defined above constitute a distinct product market upon which the effects of the proposed joint venture should be assessed. This is an upstream market in relation to the market for the production and sale of PP. Dominance in the PP technology market would enable a PP technology provider to exercise market power with regard to an essential element of PP production".[113] The worldwide market was identified as the relevant geographical market for PP technology.

Once the relevant markets are defined, the market shares of the parties have to be calculated in order to have an indication of their market power. There are two ways of doing that:

- Calculation of shares based on licensing income from royalties
- Calculation of shares based on sales of products which incorporate the licensed technology

The first approach refers to each technology's share of total licensing income from royalties, hence its share of the market where the competing technologies are licensed. But this is considered being a more theoretical way and therefore, the Technology Transfer Block Exemption suggests an alternative approach in Art. 3(3). According to this rule, the market share on the downstream product market is relevant. All the sales in the relevant product market are taken into account, whether the product embodies the licensed technology or not. According to the guidelines, this alternative approach is a good indicator of the technology's strength. Sometimes, it might be necessary to apply both approaches for assessing the market strength of the licensor.[114]

[112] Commission Notice on the definition of relevant market (1997), supra note 106.
[113] Case No. IV/M. 269-Shell/Montecatini, supra note 109, § 44.
[114] EU Technology Transfer Guidelines (2004), supra note 7, § 23.

## 6.2 Technology market analysis in high-tech industries

In an established market, where technologies are mature and often licensed between firms, the technology market definition seems to be an effective tool. The question is if this traditional way of defining relevant markets is appropriate for the assessment of competition in dynamic and innovative industries. This question reflects the general debate about the applicability of competition rules and procedures to innovation-based competition. Some argue that competition policy has to be adapted to the situation in high-technology industries, others think that the established rules and procedures are still valid in these industries.[115]

The university spin-offs presented in chapter 5 are examples of companies operating in such industries, they develop or use cutting edge technology.[116] Telecommunications, aerospace, biotechnology, computers and computer software as well as related industries are usually understood as high-technology industries. They are characterised by the following features:[117]

- Technological change is more rapid than in most other industries
- Due to technological change, R&D plays a crucial role
- High barriers to market entry for small firms may exist
- The outcome of R&D is uncertain: large amounts of money can be spent without leading to the desired results
- Dominance in the market shifts due to "leap-frogging": after a while, the technology of the existing market leader is displaced with a new one

There is no established approach for investigating what these features of high-technology industries imply for the technology market definition and whether this definition has to be changed. Some possible influences are identified in the following, with help of both the insights from the case studies and the literature.

---

[115] Newberg, Joshua A. (2000): *Antitrust for the Economy of Ideas: the Logic of Technology Markets, Harvard Journal of Law and Technology*, Vol. 14 (1), p.84-137.
[116] See http://en.wikipedia.org/wiki/High_technology
[117] Temple Lang (1996), supra note 5, p.2, 4, 40.

The discussions with the founders and CEOs of the university spin-offs revealed that the identification of competing technologies and/or products can be quite difficult. Due to the cutting edge character of the technologies, the worldwide market is relevant. For example, Rikard Berthilsson from Cognimatics did not know if there were companies in China who had developed and commercialised a competing technology for face detection.

The interviews also revealed that it is not sure, especially at an early stage of development, if the R&D conducted elsewhere will actually lead to substituting technologies. Still, there is a rather big chance that other firms involved in R&D might enter the market as new competitors in the near future. However, they are not regarded as competitors according to the legal technology market definition. The reason is that they do not license a technology yet, and potential competition is in general not taken into account.[118]

If a firm has entered the market with a cutting edge technology for which competitors do not exist yet - should the innovator then be treated like a monopolist in an ordinary industry? According to the guidelines, new technologies that have not yet generated any sales are accredited with a zero market share. However, when the sales begin, the technology will start to accumulate market share and hence will become dominant.[119] But that does not always reflect the real competition; as described above, it might not last long until other companies enter the market with possible substitutes. Moreover, these market entries might be difficult to foresee because of the uncertainty of R&D.

Thus assuming that market power or dominance of firms will erode more quickly in high-technology industries than in other industries, market shares as a measure of dominance have to be treated with caution. The Commission is aware of that and will therefore take potential competition into account when assessing agreements outside the scope of the Technology Transfer Block Exemption, i.e. the ones exceeding the

[118] EU Technology Transfer Guidelines (2004), supra note 7, § 66.
[119] Ibid., § 70.

market ceilings.[120] In these individual analyses, the Commission will "...also have regard to the number of independently controlled technologies in addition to the technologies controlled by the parties to the agreement that may be substitutable for the licensed technology at a comparable cost to the user...".[121] In the absence of hardcore restraints, Art. 81 of the EC Treaty is unlikely to be infringed when there are four or more independently controlled technologies which may substitute the licensed technology.[122]

When R&D is expensive, markets tend to be concentrated. In these cases, the market share ceilings are rather low and the parties of a licensing agreement might easily exceed them.[123] This is not automatically illegal and the individual analysis including the analysis of potential competition is applied then. However, it is unlikely that there are as many as four technologies which can substitute a newly developed technology.

Hence, the technology market concept reveals some weaknesses when applied on competition in high-technology industries, where R&D and innovation are crucial. The question is how such innovation-based competition should be taken into account. Two basic approaches are possible:

- Assessment of innovation as an aspect of the current technology market
- Assessment of innovation in a separate innovation market

The first approach refers to the ordinary way how the Commission analyses the impact of license agreements: it will "...normally confine itself to examining the impact of the agreement on competition within existing product and technology markets".[124] With this approach, innovation is seen as a source of potential competition which has to be taken into account when assessing the effects of a license agreement on the technology and product market.

[120] 20% combined market share if the parties are competitors, 30% market share each if they are non-competitors; EU Technology Transfer Block Exemption (2004), supra note 6, Art.3.
[121] EU Technology Transfer Guidelines (2004), supra note 7, § 24.
[122] Ibid., § 131.
[123] Korah, Valentine (2004): *An introductory guide to EC Competition law and pratice*, Oxford, 2004, p.331.
[124] EU Technology Transfer Guidelines (2004), supra note 7, § 25.

The case Shell/Montecatini is once more used in order to illustrate a competition assessment where innovation is a part of an existing market.

After defining the relevant Polypropylene technology market, the Commission went on to analyse the effects of the joint venture between Shell and Montedison on this market. Two leading technologies, Shell's Unipol and Montedison's Spheripol, were identified and the Commission came to the conclusion that the rivalry between them was the main source of competition in the market. After the concentration, the two technologies would no longer be sufficiently independent of each other.[125] This conclusion was based on a number of factors: market shares, competitive advantages of the two technologies in question, strengths of their owners, position of competitors, development of demand for licenses etc. The Commission stated that the established position of the two technologies on the market and the licensees' familiarity with them put other licensors at a competitive disadvantage.[126]

When analysing the competitive situation, the Commission did not only take providers of existing alternative technologies, but also potential entrants into account. The latter group consisted of a number of companies who were engaged in R&D in the PP sector at that time. However, these companies focused on product differentiation and not on the development of new products and processes, which could supersede the existing ones. The Commission also looked at some other companies which were developing a new generation of catalysts (part of the technology package), so-called metallocenes. However, such considerations about potential entrants did finally not affect the assessment in this case, the reason was that "...the potential of metallocenes cannot be precisely determined and in any case it is not expected to be fully exploited in the short to medium term".[127]

After further analysis, the Commission reached the conclusion that the joint venture would create a dominant position and impede competition in the technology market significantly. The arrangement was approved in the end though, after the parties had modified the original scope of their joint venture.

[125] Case No. IV/M. 269-Shell/Montecatini, supra note 109, § 60.
[126] Ibid, § 71.
[127] Ibid., § 85.

The case Shell-Montecatini illustrates how companies which conduct R&D for the development of substituting technologies can be considered as potential entrants. Although the investigation of potential competition had no effect on the Commissions' assessment in the end, the case shows how the technology market concept could be used in future cases. The influence of potential entrants can be taken into account; the threat of such entrants makes the technology market more competitive and hence leads to further efforts to develop new technologies. However, this is not an easy task and requires a lot of expertise in the respective technology areas.

The second approach mentioned above is the innovation market concept; it plays a central role in the current discussion about the application of competition rules in the context of innovation. It is not the aim here to reflect upon this concept; the intention is merely to distinguish innovation markets from technology markets.

## 6.3 Technology markets and innovation markets

Neither products nor technologies are bought or sold on a market for innovation, but innovative products are prepared to be sold at some point in future.[128] The EU competition rules do not contain an explicit definition of innovation markets, they are seen as consisting of competing R&D efforts. In the USA on the contrary, the innovation market approach has been institutionalised through the 1995 Antitrust Guidelines for the Licensing of Intellectual Property. Innovation markets are defined as consisting of "...the research and development directed to particular new or improved goods or processes, and the close substitutes for that research and development".[129]

Innovation markets are one of the three types of relevant markets which are defined in the EU Horizontal Cooperation Guidelines; the other two are product markets and technology markets (both referred to as "existing markets"). R&D cooperations might affect competition in innovation; that is the case if such cooperation is devoted at developing new products and/or technologies which either replace the existing ones or create a new demand. A way to assess their effects on competition in innovation is

[128] Davis, Roland W. (2003): Innovation Markets and Merger Enforcement: Current Practice in Perspective, Antitrust Law Journal, Vol. 71 (2), p.679.
[129] US 1995 IP Guidelines, § 3.2.3, in: Glader (2004), supra note 4, p.79.

to identify R&D poles and the way how they are affected by the R&D cooperations. That requires that the identification of R&D poles is possible at an early stage, as it is the case in the pharmaceutical industry. R&D poles are R&D efforts directed at the development of new products or technologies and their close substitutes. The goal of the analysis is to ascertain if enough R&D poles will be left after the agreement.[130]

The distinction between technology and innovation markets is not a mutually exclusive classification. Table 12 gives a comparing overview over technology and innovation markets and their overlaps.

| | **Technology market** | **Innovation market** |
|---|---|---|
| "Products" | Licensed technology with its close substitutes | R&D efforts |
| Classification according to EU Horizontal Cooperation Guidelines | Competition in existing markets (together with product markets) | Competition in innovation |
| Overlap | Licensed technology base for R&D efforts | R&D input for new technology |

**Table 12: Overlap between technology and innovation markets**

The overlap stems from the fact that R&D can be a base for licensed technology and vice versa. On one hand, licensed technology may be an input for R&D efforts directed to the development of new products and processes. An example is when an established firm licenses a new technology from an innovative start-up and develops it further with the goal to launch new products in future. On the other hand, innovation markets are upstream markets for inputs to technology markets. Hence, the analysis of the innovation market as input market can be an alternative approach to define markets (R&D efforts instead of technology) as well as a supplement to the potential competition doctrine (upstream market that has impact on downstream markets).[131]

[130] EU Horizontal Cooperation Guidelines (2001), supra note 103, § 43-52.
[131] Glader (2004), supra note 4, p.217.

# 7 Conclusion

This chapter refers back to the research questions in chapter 1 and provides a concluding overview. First of all, some conclusions about the applied research method are drawn.

## 7.1 Research method

Interviews have proven to be the right way of examining the commercialisation process in spin-off companies. The reason is that this method allowed digging deep and getting a comprehensive picture of the issues in question. The flexible interview technique was advantageous for the data collection and thus for the amount of information gained. At the same time, it resulted in some disadvantages for the data analysis because it was more difficult to structure and compare the statements.

A lesson for future research is to get more clarity about the areas for which data has to be collected and to carefully choose the interview partners. This is crucial for the outcome, i.e. the type of information gained. For example, when taking to a CEO of a spin-off, it can not be expected that he or she knows that much about a researcher's motivation to establish a spin-off.

A potential problem with the chosen spin-offs is that there is some kind of "survivor bias". Although not every spin-off has entered the market yet, they have come quite far. The investors are convinced of their success potential, otherwise they would not have invested that much money. In order to investigate some important issues, e.g. the nature of obstacles during the commercialisation process, it might be useful to rely additionally on cases about spin-offs where the commercialisation was given up.

## 7.2 Research questions

The case studies about spin-offs from Lund University reveal that there is a considerable variety between the individual commercialisation processes. It is difficult or impossible to identify a sequence of activities which is valid for all of them. The reason is that the nature of the technology and the industry in question influence the importance, complexity and length of these activities to a large extent.
Common features of the commercialisation of cutting edge technologies are the uncertainty and the long duration. These features have implications for the amount of necessary resources: both considerable capital investments and complementary capabilities are needed in order to launch such technologies on the market. This implies that there are substantial barriers for start-ups to enter high technology markets as well as that the markets are concentrated. Access to capital can be especially difficult for small technology-based firms because investors might not want to invest in uncertain and risky businesses.

In such a situation, the knowledge and experience of people involved in a spin-off can become a crucial success factor. Experienced and knowledgeable founders and managers are a security for investors. The board can act as an important support by providing valuable knowledge about the industry. When a spin-off aims at entering a cooperation with industrial partners, the management can contribute with contacts in the industry and the necessary business expertise. Researchers do typically lack such networks and skills.

Access to capital is very important, however, it is not sufficient for success: first, a large investment in technology development does not necessarily lead to the desired outcome and second, other resources and capabilities may become more important at a later stage of commercialisation, e.g. market knowledge. Hence, measures aimed at supporting university spin-offs should not be limited to providing better access to venture capital. As seen above, human resources play a crucial role; the question is how the access to this resource can be facilitated. What makes a researcher leave the lab and get engaged in the spin-off formation? Why does a manager join a spin-off? If the motivation of the persons involved is mainly explained by career-oriented aspects like prior entrepreneurial experience, direct and effective support might be difficult to provide, at least in the short term.

Due to the abovementioned barriers to market entry, university spin-offs often enter cooperations with established firms. If such a cooperation is of horizontal nature, anti-competitive concerns are likely to arise. In such cases, the European Commission fears that the number of competing technologies and market participants is reduced and hence the competitive pressure to innovate decreases. On the other hand, the pro-competitive effects of such agreements are recognised, and they are treated accordingly in the law.[132] Without the support of an established firm, a university spin-off might not be able to commercialise its technology; this would be to the detriment of consumers. It can be seen that there is quite a delicate balance between pro- and anti-competitive effects and a case-to-case analysis seems indispensable.

The technology market definition, which is used as a tool to assess license agreements, follows the same principles as the product market definition. Having the characteristics of high technology industries in mind, the assessment of potential competition is essential since high market shares might not reflect the actual competition. At the same time, such an assessment might fail due to practical limitations: these markets are typically difficult to oversee and investigate.

Anti-competitive concerns stemming from abusive conduct are less problematic in this context: university spin-offs are small, often niche players and have not been in the market for a long time. Moreover, the European Court of Justice has expressed the opinion that dissemination of innovation can be more important than protecting the IPR owners' exclusive right of exploitation. It is not excluded though that small firms can become dominant in high technology markets, the chance is even bigger than in ordinary industries. When the market entry barriers are not too high or small firms are able to overcome them with a smart combination of resources and support from partners, they might overtake established players with their new technologies.

[132] R&D agreements as well as licence agreements are subject to block exemptions.

The insights gained in this thesis have some implications for the efforts to enhance the competitiveness of the EU. The support of spin-off formation and the establishment of an entrepreneurial culture at universities are important factors: the transfer of cutting edge technology from universities to the market can be facilitated through them. It is also positive from a competition law perspective: spin-offs which enter the market increase the competition and thus the pressure to innovate. However, the design of supporting mechanisms and transparent rules might be difficult because spin-off commercialisation can vary considerably. In some situations, other ways of commercialisation like licensing might be more effective because building up a university spin-off is a lengthy process.

# Annex: Interview questions

The questionnaire was semi-structured, some relevant issues and questions were:

1) Company
*Description of technology, product, company*
*Are you the only company with such a product or are there competitors / substitutes?*
*Is the invention patented?*
*Owners, employees*

2) Process of commercialisation
*Describe the process of commercialisation within the company!*
*Why was the spin-off founded?*
*What happens next?*
*What do you regard as the success factors for the commercialisation process?*

3) Links to other institutions
*With which organisations around Lund University did you cooperate during the commercialisation process?*
*Which services did you get from them, which not?*
*Who are your main business partners?*

4) Obstacles during the process of commercialisation
*What are the main difficulties during this process?*
*Do you lack skills or knowledge in certain areas?*
*How was the commercialisation financed?*

## Bibliography

Afuah, Allan (2003): Innovation management – strategies, implementation and profits, New York et al. 2003.

Arora, Ashish; Fosfuri, Andrea; Gambardella, Alfonso (2001): Markets for Technology and their Implications for Corporate Strategy, Industrial and Corporate Change, Vol. 10 (2), p.419-451.

Audretsch, David B.; Baumol, William J.; Burke, Andrew E. (2001): Competition policy in dynamic markets, International Journal of Industrial Organization, Vol. 19, p.613-634.

Barney, Jay (1991): Firm Resources and Sustained Competitive Advantage, Journal of Management, Vol. 17 (1), p.99-120.

Davis, Roland W. (2003): Innovation Markets and Merger Enforcement: Current Practice in Perspective, Antitrust Law Journal, Vol. 71 (2), p.677-703.

Druilhe, Céline; Garnsey, Elizabeth (2002): Tracking the Emergence and Progress of University Spin-out Cases, IEEE International Engineering Management Conference, Cambridge, 2002.

Encaoua, David; Hollander, Abraham (2002): Competition Policy and Innovation, Oxford Review of Economic Policy, Vol. 18 (1), p.63–79.

Gans, Joshua S.; Stern, Scott (2003): The product market and the market for “ideas”: commercialization strategies for technology entrepreneurs, Research Policy, Vol. 32, p.333-350.

Geroski, P.A. (2003): Competition in Markets and Competition for Markets, Journal of Industry, Competition and Trade, Vol. 3 (3), p.151-166.

Glader, Marcus (2000): Research and Development Cooperation in European Competition Law, Lund 2000.

Glader, Marcus (2004): Innovation Markets and Competition Analysis – EU competition law and US antitrust law, Malmö 2004.

Grant, Robert M. (2005): Contemporary Strategy Analysis, 5th edition, Cornwall, 2005.

Grindley, Peter; Kahwaty, Henry; Sherry, Edward; Teece, David (2003): The Prospected EC Technology Transfer Block Exemption Regulation: An Economic Assessment, LECG Limited, London 2003.

Jones-Evans, Dylan (1998): Universities, Technology Transfer and Spin-off Activities – Academic Entrepreneurship in different European Regions, Targeted Socio-Economic Research Project No 1042, final report 1998.

Harabi, Najib (1995): Appropriability of technical innovations – An empirical analysis, Research Policy, Vol. 24, p.981-992.

Hindle, Kevin; Yencken, John (2004): Public research commercialisation, entrepreneurship and new technology based firms: an integrated model, Technovation, Vol. 24, p.793-803.

Klofsten, Magnus; Jones-Evans, Dylan (2000): Comparing Academic Entrepreneurship in Europe – The Case of Sweden and Ireland, Small Business Economics, Vol. 14, p.299-309.

Korah, Valentine (2004): An introductory guide to EC Competition law and pratice, Oxford 2004.

Korah, Valentine (1996): Technology transfer agreements and the EC Competition rules, Oxford 1996.

Levin, Richard C.; Klevorick, Alvin K.; Nelson, Richard R.; Winter, Sidney G. (1987): Appropriating the Returns from Industrial Research and Development, Brookings Papers on Economic Activity, Vol. 3, p.783-820.

Newberg, Joshua A. (2000): Antitrust for the Economy of Ideas: the Logic of Technology Markets, Harvard Journal of Law and Technology, Vol. 14 (1), p.84-137.

OECD (1997): Application of Competition Policy to High Tech Markets, OECD Working Papers, Series Roundtables on Competition Policy No.9, Paris, 1997.

Powers, Joshua B.; McDougall, Patricia P. (2005): University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship, Journal of Business Venturing, Vol. 20, p.291-311.

Quinn Patton, Michael (1990): Qualitative Evaluation and Research Methods, Second Edition, Newbury Park et al. 1990.

Reimers, Richard (1998): Competitive strategy, in: Reimers, R. (1998): The Financing of Projects as Competitive Means, Master Thesis, Göteborg University 1998.

Roberts, Edward B. (1988): Managing invention and innovation, Research Technology Management, Vol. 31 (1), p.11-29.

Shane, Scott (2004): Academic entrepreneurship, University Spinoffs and Wealth Creation, Cheltenham, UK, 2004.

Shapiro, Carl (2002): Competition Policy and Innovation, STI Working Papers 2002/11, DSTI/DOC (2002)11.

Sheen, Margaret R. (1996): Managing IPR in an Academic Environment: Capacities and Limitations of Exploitation, in: Webster, A.; Packer, K. (1996): Innovation and the Intellectual Property System, London et al. 1996.

Sojde, Catharina; Eriksson, Per et al. (2003): VINNFORSK - VINNOVAs förslag till förbättrad kommersialisering och ökad avkastning i tillväxt på forskningsinvesteringar vid högskolor, Stockholm 2003.

Sullivan, Patrick H. (1998): Profiting from Intellectual Capital, Extracting Value from Innovation, New York et al. 1998.

Svensson, Roger (2004): Commercialization of Patents and External Financing during the R&D-Phase, Working Paper No.624, The Research Institute of Industrial Economics, Stockholm 2004.

Svensson, Roger (2002): Commercialization of Swedish Patents – A Pilot Study in the Medical and Hygiene Sector, Working Paper No.583, The Research Institute of Industrial Economics, Stockholm 2004.

Tassey, Gregory (1997): The economics of R&D policy, Westport 1997.

Teece, David J. (1986): Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy, Research Policy, Vol. 15, p. 285-305.

Teece, David J. (1998): Capturing Value from Knowledge Assets: The new Economy, Markets for Know-How, and Intangible Assets, California Management Review, Vol. 40 (3), p.55-79.

Teece, David J. (2000): Managing Intellectual Capital, Oxford 2000.

Temple Lang, John (1996): European Community Antitrust Law: Innovation Markets and High Technology Industries, Fordham Corporate Law Institute, New York 1996.

Tidd, Joe; Bessant, John; Pavitt, Keith (2001): Managing innovation - Integrating technological, market and organizational change, Chichester et al. 2001.

Wright, Mike; Birley, Sue; Mosey, Simon (2004): Entrepreneurship and University Technology Transfer, Journal of Technology Transfer, Vol. 29, p.235-246.

Zou, Shaoming; Cavusgil, S. Tamer (1996): Global strategy: a review and an integrated conceptual framework, European Journal of Marketing, Vol. 30 (1), p.52-69.

*URLs*

Lisbon European Council, Presidency conclusions:
http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/00100-r1.en0.htm

SpectraCure's Homepage: http://www.spectracure.com/

Cognimatics' Homepage: http://www.cognimatics.com/

GasOptics' Homepage: http://www.gasoptics.com/

Luvit's Homepage: http://www.luvit.se/

Yahoo's history: http://docs.yahoo.com/info/misc/history.html

High technology definition: http://en.wikipedia.org/wiki/High_technology

# Cases and official documents

*Cases*

European Court of Justice

C-418/01, IMS Health GmbH & Co. OHG v. NDC Health GmbH & Co. KG, (2004).

European Commission

Case No IV/M.269 – Shell/Montecatini, OJ L 332/48 (1994).

*Commission Regulations and Notices*

Commission Regulation (EC) No 772/2004 of 27 April 2004 on the application of Article 81(3) of the Treaty to categories of technology transfer agreements, OJ L 123/11 (2004).

Commission Regulation (EC) No 2659/2000 of 29 November 2000 on the application of Article 81(3) of the Treaty to categories of research and development agreements, OJ L 304/7 (2000).

Notice on the definition of relevant market for the purposes of Community competition law, OJ C 372/5 (1997).

Guidelines on the applicability of Article 81 of the EC Treaty to technology transfer agreements, OJ C 101/02 (2004).

Guidelines on the applicability of Article 81 of the EC Treaty to horizontal cooperation agreements , OJ C 3/02 (2001).

*Commission Communications*

European Commission (2004): A pro-active Competition Policy for a Competitive Europe, COM(2004) 293 final, Brussels 2004.

European Commission (2001): Final Report to the European Parliament and to the Council according to Article 8 of the Council Decision (94/78/CE, Euratom) establishing a multiannual programme for the development of Community statistics on research, development and innovation, COM(2001) 489 final, Brussels 2001.

*Others*

European Commission, DG Entreprise (ed.)(2001): Corporation tax and innovation: Issues at stake and review of European Union experience in the nineties, Innovation paper No. 19, EUR 17035, Luxembourg 2001.

European Commission, DG Entreprise (ed.)(2002): University spin-outs in Europe – Overview and good practice, Innovation paper No. 21, EUR 17046, Luxembourg 2002.