# Knowledge valorisation in Dutch University Hospitals

The role of Technology Transfer Offices

Master of Science graduation thesis
Healthcare Management

Jeroen ter Mate


University of Twente
Enschede, the Netherlands

School of Management and Governance

*Dutch Institute for Knowledge Intensive Entrepreneurship*

# Knowledge valorisation in Dutch University Hospitals

The role of Technology Transfer Offices

**Author:** J. ter Mate (Jeroen)
**Student number:** 0007242
**Cohort:** 2000
**Study:** Healthcare Management

**Supervisors:**

Dr. M. van der Steen (Marianne),
*Senior Research Fellow NIKOS - Dutch Institute for Knowledge Intensive Entrepreneurship,*

*School of Management and Governance, University of Twente*

Prof. dr. S. Kuhlmann (Stefan)
*Professor of Foundations of Science, Technology and Society (STəPS) - Department of Science, Technology, and Policy Studies,*

*School of Management and Governance, University of Twente*

Colloquium date: June 22nd 2010

Deventer, June 2010

# Preface

This thesis presents the results of my research on Technology Transfer Offices at Dutch university hospitals. With this research I complete my Masters Healthcare Management at the University of Twente. Purpose of this research is to give insight in how Technology Transfer Offices act in the knowledge valorisation process within Dutch university hospitals. I have visited seven Technology Transfer Offices connected to Dutch university hospitals to interview key personnel about their tasks and activities.

I have worked more than a year on this thesis and now that it is finished, I would like to thank all the people that helped and supported me during this research. First I would like to thank my graduation committee, dr. M. van der Steen and prof. dr. S. Kuhlmann, for the interesting discussions we have had during our meetings. I would like to thank all the interviewees for their time and for sharing their experiences, opinions and knowledge with me.

I would like to thank dr. B.J.R. van der Meulen for helping me during the first stage of the research. Barend, thank you for your help, advice and for helping me getting my research on track. Thanks to my family, in the Netherlands and Singapore for their support and for reviewing my thesis. Last but not least I thank my wife Vera for her patience, advice and pep talks.

Jeroen ter Mate

Deventer, June 2010

# Summary

**Knowledge valorisation is considered to be the fourth task of university hospitals (UMCs). All UMCs in the Netherlands have assigned this task to a Technology Transfer Office (TTO). TTOs have the task to support the UMC employees in protecting, marketing and commercialising their knowledge.**

Although the subject of knowledge valorisation receives a great amount of attention, there is little literature available on the Dutch knowledge valorisation climate. The international literature on the subject is more comprehensive.

**Framework and interviews**

We construct a framework for knowledge valorisation tasks and activities, based on international literature. Within the framework, we divide the knowledge valorisation process into four phases, Identification (e.g. screening and scouting activities), Protection (e.g. patenting), Marketing (e.g. performing a technology assessment) and Commercialisation (e.g. licensing or creating a spin-off company).

We perform interviews with key personnel from the Dutch UMC TTOs and use the framework for knowledge valorisation to ask questions about the tasks and activities that are assigned to the TTO and the tasks and activities the TTOs really perform. The interviews show that all TTOs perform a basic level of knowledge valorisation activities in all four phases, but that the additional activities vary greatly among the TTOs.

Together with constructing our framework, we found a number of recurring challenges that TTOs face. The two most important challenges identified in literature are the difficulty to find skilled TTO staff and the fact that TTOs usually lack enough funding to perform their tasks effectively. During the interviews, these challenges were often mentioned so Dutch TTOs face the same challenges as their international colleagues.

**Desk research and valorisation indicators**

Furthermore, we have performed a desk research, analysing data from the annual reports published by the UMCs. The goal of the desk research is to quantify knowledge valorisation statistics from literature for Dutch UMCs. Indicators for knowledge valorisation activities are for example the patent portfolio size and the number of patents licensed to third parties.

Our research shows that the UMCs do not transparently report on valorisation statistics in their annual reports. The data UMCs present is incomplete and inconsistent and therefore of little value. The UMCs can achieve a great quality improvement by standardising their reporting on

knowledge valorisation. They should not only report on their patent portfolio but as well on other valorisation activities such as number of spin-offs established.

### Critique and recommendations

During the interviews, it became clear that TTOs feel that they should work more closely together in the future in order to improve the quality of the services they provide. Regional cooperation within a networked structure seems to be the most plausible option for cooperation. Furthermore, the TTOs should have a greater focus on their external customers during the marketing phase. As most TTOs are relatively young, a great amount of time is invested in the internal marketing, presenting the TTO to the employees of the UMC. However, as a liaison, TTOs must have a good relation with both the internal and external customers.

A recommendation to the UMCs is to provide the TTOs with structural funding for their activities so they are able to provide all services necessary for effective and successful knowledge valorisation and do not have to focus only on providing services that are profitable for the TTO. Also, the Dutch government, the UMCs and the TTOs should focus more on small and medium sized enterprises as a main source for innovation.

We recommend further research on the subject of national policy on TTOs. This research should study whether the policy and management that applies to knowledge valorisation and TTOs, connect with the expectations from knowledge valorisation and the tasks and activities assigned to TTOs. Also it is interesting to see whether the KU Leuven (often mentioned during the interviews as a good practice), can function as an example for all Dutch TTOs. The KU Leuven TTO is located very near to the Netherlands in a seemingly similar environment, so a comparison can provide valuable information for the Dutch TTOs.

# Thesis contents

# 1. Introduction

**Knowledge is an important factor in today's society (Grant, 1996). Knowledge valorisation, the formal transfer of knowledge resulting from basic and applied research, to the commercial sector for economic benefit (Goorden, 2008), is a key factor in innovation. University Hospitals (UMCs) have always played an important role in the creation and development of knowledge in the field of medical technology. In total, UMCs have three core tasks: 1) providing healthcare, 2) education and 3) performing research. The knowledge that is created and developed at UMCs mostly comes from their research.**

In the last few years, the importance of valorising research has been acknowledged by the Dutch government and the UMCs. To facilitate their employees, UMCs have formed Technology Transfer Offices (TTOs). A TTO is a department or office, usually centralized in an organisation, that aims to support and facilitate the commercialization of research (Rasmussen, 2008). TTOs facilitate the employees of a UMC in valorising their knowledge and function as a liaison between the employees and external parties.

In the Netherlands, knowledge valorisation has been given a new impulse by the Innovation Platform, formed by the Dutch government. This innovation platform has started a broad discussion on how the knowledge valorisation in the Netherlands should be implemented. The result is a report discussing the Dutch valorisation agenda (Interdepartementale Programmadirectie Kennis en Innovatie, 2009).

## 1.1. Knowledge valorisation in university hospitals

The Ministry of Economic Affairs describes life sciences as "a pillar of the Dutch economy" (2003) and UMCs play an important role in the research & development in life sciences. There are eight UMCs in the Netherlands, all connected to a university. A UMC consists of a teaching hospital, providing regular and tertiary healthcare, and a medical faculty, providing medical education.

| Abbreviation | Name | City | Affiliated to university |
|---|---|---|---|
| AMC | Academic Medical Center | Amsterdam | University of Amsterdam |
| EMC | Erasmus Medical Center | Rotterdam | Erasmus University Rotterdam |
| LUMC | Leiden University Medical Center | Leiden | Leiden University |
| MUMC | Maastricht University Medical Center | Maastricht | Maastricht University |
| UMCG | University Medical Center Groningen | Groningen | University of Groningen |
| UMCN | University Medical Center St Radboud | Nijmegen | Radboud University Nijmegen |
| UMCU | University Medical Center Utrecht | Utrecht | Utrecht University |
| VUMC | Free University Medical Center | Amsterdam | VU University |

**Table 1: Dutch university hospitals**

Universities and UMCs have a long history of cooperation with industry. Usually, the knowledge developed at universities was transferred to a company that would commercialize it. The general opinion was that universities and UMCs would create new ideas and develop new knowledge, but should have no role in commercialisation; that would affect their independent position. The passing of the Bayh-Dole act by the US Congress in 1980 is generally considered to be a turning point in this view. The Bayh-Dole act granted ownership to academic institutions to knowledge that was developed using public funding and stimulated academic institutions to valorise their knowledge (Debackere & Veugelers, 2005; Rasmussen, 2008; Siegel & Phan, 2004).

The Dutch Federation of University Medical Centers (NFU) has published a number of policy-oriented reports (NFU, 2008, 2009) about knowledge valorisation. In these reports, knowledge valorisation is categorised as one of the main tasks of university hospitals, making knowledge valorisation the fourth task. Furthermore, the reports state that every UMC has established a TTO to help scout interesting findings and to help employees to patent these findings. Dutch TTOs should fulfil an important role in the knowledge valorisation as is described in policy, but there is little data available about the performance on their tasks and activities. The UMCs are required to report on their valorisation activities in their annual report but how they perform compared to one another, is unclear.

## 1.2. Problem analysis

It is generally acknowledged in policy (Interdepartementale Programmadirectie Kennis en Innovatie, 2009) and in practice (NFU, 2008) that TTOs play an important role in the knowledge valorisation process. All Dutch UMCs have recently professionalized their valorisation activities by setting up TTOs to provide knowledge valorisation services. However, there is not much information available about the performance of these 'young' TTOs. It is unclear what their output is and whether TTOs add any value to the knowledge valorisation process. The goals, effective knowledge valorisation and stimulating entrepreneurship, are clear. Whether TTOs succeed in achieving these goals, is unknown.

As there is not much scientific information on the practical implementation of the theoretical tasks and activities assigned to Dutch TTOs, it is hard, if not impossible, to reliably assess their output and judge whether the TTOs can and do add value to the knowledge valorisation process.

## 1.3. Research objective

This thesis is an exploration of the tasks and activities performed by Dutch TTOs affiliated to Dutch UMCs. The research studies all TTOs, eight in total, affiliated to the UMCs in the Netherlands. The goal of our research is to give insight on the TTO tasks and activities and what tasks and activities have priority. Furthermore, we are interested in the challenges TTOs face in their work and lastly how the TTOs perform in light of a framework we construct, based on international literature on the subject of knowledge valorisation.

The main goal of this thesis is to:

***Gain insight in the tasks and activities of TTOs, the challenges TTOs face and to compare the Dutch situation with international literature and national policy***

## 1.4. Research questions

As there is no research on the day to day routine of TTOs affiliated with the university hospitals in the Netherlands, we will perform a research led by the question:

***What are the tasks and activities, challenges and vision of TTOs affiliated to university hospitals in the Netherlands?***

Subquestions that will help answering the main question are:

- What are, according to the literature, tasks that should be performed by TTOs?
- What tasks and activities do the TTOs perform in daily practice?
- What are the challenges, both local and national, identified by TTO staff?
- What is the vision for the future for knowledge valorisation and TTOs in the Netherlands?

## 1.5. Research Strategy

To get a good understanding of the possible tasks and activities that TTOs perform, we construct a conceptual framework based on international literature that describes the knowledge valorisation process. This framework forms the base for a questionnaire to interview personnel (preferably the CEO) from the eight TTOs. The goal of these semi-structured interviews is to identify the current tasks and activities of the TTOs. We will ask the interviewees the tasks and activities the TTO performs, the challenges they meet in their work and what their vision is for the future of knowledge valorisation in the Netherlands. Obviously we are also interested in their achievements.

This thesis is an explorative research with a descriptive, qualitative character. There is little empirical data available on knowledge valorisation by Dutch UMCs and the role of their TTOs, a quantitative comparison for the performance of Dutch TTOs can therefore not be performed.

**Research outline, data collection and results**

This research consists of three parts. In the first part of the research we construct a conceptual framework describing the knowledge valorisation process including the activities that can be performed by TTOs within this process. Secondly we will gather two types of information on knowledge valorisation by Dutch UMCs: we perform a desk research in which we analyze the relevant policy documents and annual reports published by the UMCs. From these data sources, we will extract the guidelines by which TTOs are set up and how UMCs manage their knowledge valorisation activities. The annual reports from the UMCs will likely contain facts and figures about knowledge valorisation activities based on knowledge that is created at the institution. In the third part of this research, we will perform interviews with TTO staff to analyze their current tasks and activities, the challenges TTOs encounter and their vision for the future.

The information from the annual reports and the interview data will be presented in separate paragraphs. We will cluster the interview data per subject.

## 1.6. Reading guide

Chapter 1 introduces the subject of research and some definitions. It presents the research questions and objectives, briefly explains how the data is collected and how these are presented. Chapter 2 starts by presenting a conceptual framework for the knowledge valorisation process. This framework is based on a literature review. Furthermore, chapter 2 presents a selection of

this literature. After the literature review, we go further into the four phases of the knowledge valorisation process and the activities involved. Chapter 2 concludes with a paragraph, connecting the literature to our research.

Chapter 3 presents the methods and materials we have used for the research. It explains how the data is collected during the desk research and the interviews. Furthermore, chapter 3 explains the means of data interpretation and discusses our considerations on the way of presenting the results. Chapter 4 presents the results from our research project. It starts by presenting the results from the desk research on patenting and licensing activities by the UMCs. In the second part of the chapter, the interview results are presented. We start with a general introduction, presenting some general information on the TTOs. After the general introduction, we present the results of the interviews in light of the four phases in the knowledge valorisation process. We further elaborate on the challenges the TTOs face, we present the vision for the future of knowledge valorisation in the Netherlands according to the interviewees and lastly we discuss the TTOs that are considered to be best practices.

Chapter 5 concludes on the results that are presented in chapter 4, only chapter 5 summarises the results and connects this to the literature discussed in chapter 2. Recommendations & critique, a reflection on the research and recommendations for future research on the subject conclude chapter 5.

# 2. Theory & framework

**In this chapter we present a framework for the knowledge valorisation process based on international literature. Paragraph 2.1 presents our knowledge valorisation framework. Within this framework, we distinguish four phases and within these phases, we describe TTO tasks and activities.**

This framework is largely based on the review of articles written by K. Sachwitz Apple (2008), P.M. Swamidass & V. Vulasa (2009), K. Debackere & R. Veugelers (2005) and J. Lee & H.N. Win (2004). We discuss these studies in paragraph 2.2, preceded by a short introduction based on a literature review by Rothaermel, Agung & Jiang (2007). In paragraph 2.3, we elaborate on the tasks and activities performed by TTOs. Paragraph 2.4 discusses the position of TTOs withing the mother organisation. Paragraph 2.5 connects the theory to our research question, the framework and our research design.

## 2.1. Tasks from literature – a framework

*"TTOs play an active role in commercialising university research by identifying, protecting, marketing and licensing intellectual property developed by faculty."* (Lee & Win, 2004). This sentence summarises the knowledge valorisation process and emphasizes the importance of TTOs.

Our framework of the knowledge valorisation process consists of four phases. These are 1) Identification; 2) Protection; 3) Marketing and 4) Commercialization[1]. Figure 1 presents the knowledge valorisation process.

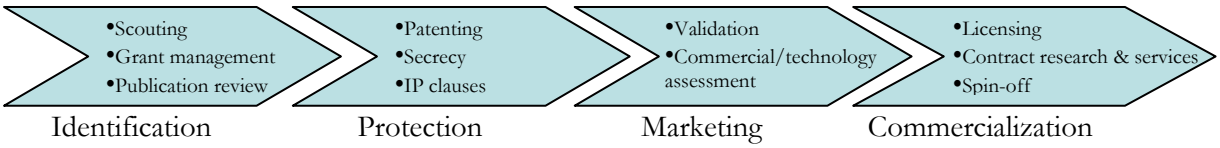



**Figure 1: Knowledge valorisation process**

For every phase, we identify and describe the main tasks that belong specifically to that part of the process in paragraph 2.3. These are scouting, grant management, and publication review for the identification phase, patenting, secrecy and IP clauses for the protection phase, validation and

[1] Lee and Win mention licensing, but as there are more outcome possibilities for valorisation, we choose to use the term commercialisation.

commercial & technology assessments for the marketing phase and licensing, contract research & services and spin-off creation for the commercialization phase.

> It is important to recognize upfront that university-based technology commercialization processes include discovery, disclosure of discoveries to an UTTO, assessment for patentability, and eventual attempts to transfer and license IP to industry. As such, UTTOs, acting as agents for their institutions, evaluate discoveries, seek patent protection for promising technology, identify potential licensees, and monitor the licensees' use of the technology. Each constituency in this ecosystem—faculty, UTTO, and firms—plays a different and ever changing role during this process. For instance, at the discovery and disclosure stage, research universities rely on employment contracts and an honor system that call for faculty to disclose discoveries to their UTTOs in a timely manner. This suggests that (a) disclosure and subsequent engagements with licensees depend on faculty who self-select into this process; and (b) faculty who self-select to disclose and support commercialization efforts represent only a small subset of the research faculty population.

**Excerpt from: Innovation speed: Transferring university technology to market by Markman et al (2005)**

## 2.2. The knowledge valorisation process and the role of TTOs

*"Most academic researchers consider money as a means of scientific progress, in contrast to businessmen, who consider money as an end in itself and science only as a means to that end"* (Samson, 1993).

Knowledge valorisation is an extensively studied process. This paragraph discusses a number of articles on the subject of knowledge valorisation. Based on these articles we have defined the conceptual framework from paragraph 2.1.

As a preface we mention the Masters thesis by S. Heide (2007). In this thesis, Heide defines 10 knowledge transfer activities. These are: 1) patents and licensing; 2) spin-off and enterprise creation; 3) university-industry networks; 4) international cooperation; 5) European affairs; 6) continuous professional development; 7) alumni affairs; 8) national subsidies; 9) regional subsidies and 10) grants.

The paper explores the shift from a managed to an entrepreneurial economy and asks the question whether the traditional model for TTOs is capable of facilitating this change of economy. Although my thesis does not explore whether the Dutch economy is also transforming or has transformed into an entrepreneurial economy, it is interesting to see whether the traditional TTOs are capable of providing good services in a changing environment or that they need to transform their business model as well.

**A taxonomy of literature**

In 2007, Rothaermel et al. published a comprehensive literature review on university entrepreneurship. This "taxonomy of literature" shows four main research streams, being:

1) Entrepreneurial research university
2) Productivity of technology transfer offices
3) New firm creation
4) Environmental context including networks of innovation

The emphasis of this thesis is on TTOs, so we go a bit more in-depth on the literature from research stream 2, provided by Rothaermel et al., providing a short history of the academic literature. The goal is to provide some insight into the literature available and the problems identified in these articles. Afterwards, we review a number of articles, each focussed on our framework. We discuss shortly the contents of the literature and explain the relevance for our framework. An elaborated discussion of the literature is provided in Annex II

## University entrepreneurship: a taxonomy of literature

*By F.T. Rothaermel, S.D. Agung & L. Jiang (2007)*

TTOs are widely studied as they are seen as the formal gateway between university and companies. Authors publishing on TTOs, often see the productivity of TTOs as a function of a universities' entrepreneurship and their indicators are focussed on commercial output such as e.g. licensing, patenting and equity positions.

Factors impacting the performance of TTOs are structure, staffing and activities that are deployed to establish knowledge transfer. Studies show that the way a TTO is structured has a great impact on its output; if for example a TTO strives for a financial independent position towards the mother institution, the TTO is likely more engaged in equity positions than in licensing agreements. Other factors that can (both positively and negatively) influence the performance of TTOs, are external (e.g. the stage of development a technology is in) or policy oriented. Some studies show that non-cooperating scientists can delay or even fully halt technology transfer.

There are also challenges that are of a more practical nature such as a lack of competent TTO staff, insufficient budgets, balancing between different stakeholders or a combination of these factors. The same studies show that there are a number of solutions for these problems; TTOs form policy on the subject of licensing so it is clear to scientists what will happen after they disclose an invention to the TTO. Furthermore, TTOs tend to form a staff of mixed personnel, coming from the legal, scientific and business sector.

There is great discussion on the subject of TTO performance and which factors define the success of a TTO; e.g. is a TTO successful when it reaches financial independence or when it has great societal impact. In literature, there is some consensus on the indicators measuring the TTO performance and output. Generally accepted measures are: the number of licensing agreements and the revenue from licenses. Alternative measures include the number of invention disclosures and the amount of sponsored research agreements managed by the TTO. The authors of the literature review have the opinion that these different opinions indicate that the role of the TTO is complex. Lastly, the authors identify a possible discrepancy between studies into TTO strategies, which are mostly limited to its legal decisions and TTO routines. The strategies and strategic problems are broadly studied (e.g. the difficulty of finding skilled personnel) but little research has been done into the way TTOs try to solve the problems (e.g. how do TTOs recruit and select their personnel).

## "Evaluating University Technology Transfer Offices"

*by K. Sachwitz Apple (2008)*

This research form a chapter of the book "Public Policy in an Entrepreneurial Economy". The author starts with introducing TTOs as departments within institutions with a mission to support staff in developing and commercialising their inventions. The classic model for a TTO is a centralized office to which the inventions are disclosed, the TTO then patents it, licenses it out to large companies or the TTO would form a spin-off company. The goal of the research is to evaluate whether this 'classic' model of a TTO is ready for the shift to an entrepreneurial economy. The general model implemented by most of the universities is the Traditional University Technology Development Model. This model is depicted in Figure 2 (Acs & Stough, 2008).

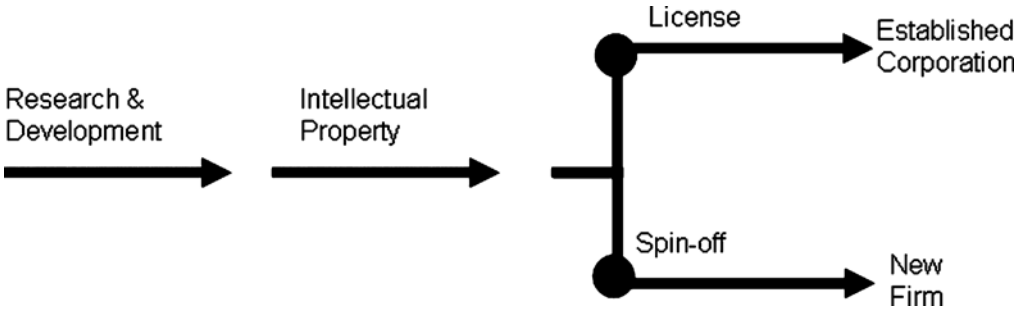



**Figure 2: Traditional University Technology Development Model**

The first step is research and development, performed by the institution's employees. This R&D can lead to intellectual property that, when promising, can be patented. Most universities have delegated the patenting task to a TTO and this means that the institution's employee has to disclose his invention or finding to the TTO. Other models include a dean or head of department that, with external legal counselling, is responsible for the patenting process.

After the patent is granted to the institution, their intellectual property is protected. The institution is now in a position in which it will try to turn this patent into economic value. The two traditional ways of doing so are to license the patent to an established company, allowing that company to develop the innovation; the second possibility is to create a spin-off company to exploit and possibly further develop the invention.

The transformation from a managed to an entrepreneurial economy includes a number of shifts. Three important shifts that are identified in the research are presented in Table 2.

| Managed Economy | Entrepreneurial Economy |
|---|---|
| Large Firm Innovation | Small Firm Innovation |
| Corporation Lifetime Jobs | Individuals Manage Own Career |
| Hierarchy Structure | Networked Structure |

**Table 2: Three shifts in the Entrepreneurial Economy**

The paper evaluates whether universities and their TTOs have adapted to the entrepreneurial economy. The researcher does this by posing three hypotheses based on the three aforementioned shifts. These hypotheses are:

H1: The university TTO is focused on small firm formation
H2: The university TTO policies support individual career management
H3: The university TTO is a networked organisation

H1 is tested by looking at the focus of TTOs; is it on licensing out patents to large companies or do TTOs stimulate the creation of spin-offs? The conclusion based on the case studies is that TTOs are not specifically focussed on spin-off creation and that even for an employee that wants to start a spin-off, the cooperation with his colleagues from the TTO can be a long-term struggle.

H2 implies that the TTO forms policies on how employees of the institution as a whole are stimulated and facilitated to take time off to explore entrepreneurial activities, related to their field of expertise. This policy can be compared with the well established policy for sabbaticals at universities in the US. However, in her research, the author already states that it is not the TTO but the university itself that puts such policy in place. The hypothesis that TTO policies support individual career management is found to be true but minimal.

H3 states that university TTOs that adapt to the entrepreneurial economy, are networked organisations. The elaboration of this definition shows that traditional TTOs do not meet this definition as they are central departments within the organisation, funnelling all knowledge valorisation activities; they are in no way spread out through the hospital or the external environment, lacking contact with their customers. Hence, H3 is found to be false.

Based on the analysis and results, the author makes three recommendations. These are that TTOs should focus more on small firm creation as an important source of effective and fast knowledge valorisation. Second, universities should improve their policies to stimulate employees into developing entrepreneurial activities that do not directly contribute to their research activities. Third, the total structure of universities should be changed from a hierarchal organisation to a networked organisation. Research shows that this type of organisation works better in an

entrepreneurial economy. In the hierarchal organisation, the TTO works like a funnel which, at times, can become clogged.

The author acknowledges the fact that the research is based on a few case studies and in the recommendations for further research she suggests to broaden the research by a quantitative research, performing interviews with both TTO staff and university employees, also exploring their opinions on the suggestions for improvement the author has made.

**Relevance to our research**

The author presents the classic technology development model. The division of our knowledge valorisation model into four phases is based on the same phases in technology development. Research & development from within the institution has to be identified as potential intellectual property. This IP then has to be protected, usually by patenting. The technology development model does not mention the marketing phase, which is part of our knowledge valorisation model. However, in the recommendations, the author states that TTOs should focus more on small firm creation; usually a vehicle to further develop a technology and prepare it to be commercialised. As this is essential to the knowledge valorisation process, we feel the addition of the marketing phase to our model is legitimate.

Given the available information, we do not expect that Dutch TTOs have already made the shift from a traditional TTO to an entrepreneurial form. However, we will use the indicators mentioned for an entrepreneurial TTO into account when assessing the TTOs during our interviews.

## "Why university inventions rarely produce income? - Bottlenecks in university technology transfer"

*By P.M. Swamidass & V. Vulasa (2009)*

This research paper focuses on the United States, home to the Bayh-Dole act and it investigates the bottlenecks in university technology transfer. The article starts with a quote from dr. Das, CEO of Transwitch. He states that "*high-technology is … one of the most difficult things to market*". According to the authors, a second reason is that it takes time to successfully license or market the inventions and patents from a university because they do not immediately create business value such as cash flow. The third reason a university inventor does not have any ties to parties that may be interested in the technology. This means the development and marketing of the invention or patent needs to be done from scratch after disclosure to the TTO[2].

### Introduction

A reason for not having a strong stream of revenue according to Trune & Goslin (1998) may be that most university technology transfer programs exist for less than 10 years and are not yet able to be self-supporting. This is a serious threat to the existence of TTOs as this sort of department is the first to find itself on a reduced budget when the university faces a budget deficit.

The authors describe three models of technology flow: The first model is the current, traditional flow under the Bayh-Dole regime where the university is owner of the patents on inventions made by its employees and the TTO is responsible for the commercialisation. The second model is different as the inventor (being the employee) becomes owner of the patent and may further commercialise it through the TTO. The university however does not get any revenue from this model. The third model, based on 'open science', implies that neither universities nor their employees patent their inventions. In this model, there is no valorisation and therefore no TTO involved. The research explores the TTO effectiveness under the current regime in which the university becomes owner of the inventions and patents. The legislation and policy in the Netherlands is similar to the US regime as the institution is owner of patents and inventions of its employees. This makes the article is relevant to our research.

### Rationale of the research

[2] The article uses the abbreviation UOTT for the University Office of Technology Transfer. For consistency reasons, we will use the TTO abbreviation which has the same meaning.

There are many indicators for the success of university technology commercialisation. Examples are the number of disclosures to the TTO, patent applications filed, number of patents issued, number of licenses granted, license income, number of spin-offs etc. All these indicators follow from the total number of disclosures. These disclosures in turn, are the result of university policies, the IP environment and the perception of the fairness and simplicity of the process by the staff 'inventors'.

Research on the data coming from the annual survey performed by the Association of University Technology Managers (AUTM) shows that the income from licenses expressed as a percentage of the research expenditure has grown from 1.7% in 1994 to 2.9% in 2004. This means an annual growth of 6% per year. However, the license income still is a small percentage of the total expenditure on research. The growth of staffing at TTOs has grown 11% per year in the same period. This means that the increase in staff is twice the increase in license income. The reasons for this may be that TTOs appoint staff without marketing skills or TTO personnel do not work effectively. The research investigates whether a staffing shortage is a performance-limiting constraint as identified by several other studies.

On the subject of spin-offs[3] the authors refer to research showing that spin-offs can be more successful means of knowledge valorisation then licensing or publication in scientific journals. However, the AUTM data show an average annual growth in number of spin-offs per university of 0.14 per year. The authors state that spin-offs are the vehicle mostly used to further develop technology that is not yet ready for the market, meaning that there is no interest from a commercial party in the technology without further developing it first.

**"The opportunity and the challenge"**

The authors discuss the result of the passing of the Bayh-Dole act and that research shows that TTOs are more successful in knowledge valorisation since this legislation is in place; the relative number of patent applications from universities grows much faster than that from the private sector. The difference between patents from university and that of industry is, that companies mostly apply for patents relevant to their business and can be used by the company itself. Universities will have to search for a third party that is interested in the patents in their patent portfolio. The authors conclude this part of literature review with the fact that literature is divided on whether TTOs should be self supportive and therefore should work on a for-profit

[3] Called 'new startups' by the authors

basis or should receive structural funding from the university. As mentioned before, chances are that TTOs are among the first departments to be impacted by budget cuts.

"**Inadequate capacity to market inventions**"

The authors discuss the emerging consensus among researchers on the point of TTOs lacking the competencies and resources to be efficient and effective in their work. Although many universities recognize the importance of establishing TTOs, these TTOs were usually not adequately equipped to perform their tasks. The Bayh-Dole act was therefore effective concerning the quantity of TTOs established but not so much improved their quality.

The emphasis when looking for TTO personnel is rarely on marketing skills but mostly on patent law and technical expertise. This lack of marketing skills is less important when there are already contacts between the researcher/inventor and a third party. However, if these contacts do not exist, the marketing of a technology from scratch can be a serious challenge for TTOs.

**"Under-funding of TTOs"**

Technology commercialisation is a long-term process and it takes 7 to 12 years on average to successfully complete a commercialisation process of an invention. This long time between start and result is similar for TTOs. First success can only be expected after at least 7 years. This is a long time in which the TTO is vulnerable for budget cuts. The risk for budget cuts is even higher when TTOs have yet to generate income.

Resources within universities are allocated to processes based on the added value they bring to the core tasks of a university. Chances are that if a TTO is only judged on their net cost or profit, the non-financial benefits (e.g. providing graduation and career opportunities for students) universities are forgotten.

**Results and conclusions**

The survey shows that the TTOs have an average staff size of 4.3 FTE and about 75% report that they currently have a staff shortage. 46% have no legal staff. The technology transfer performance shows a clear cut between TTOs with little provisional patent applications (0-25 annually; 61% of TTOs) and TTOs with many provisional applications (150-300; 13%). Together with the licensing statistics, the researchers suspect significant internal infrastructural differences

between high-end and low-end performing TTOs. Regression models show only a few significant results for the relation between performance and staff capacity, one of which is a positive association between patents applied for and the number of legal employees. The budget allocated by universities is found to be adequate by 25% of the respondents; all other respondents feel they need a larger budget to adequately perform their tasks..

The research paper concludes without a judgement on whether TTOs have any added value in the knowledge valorisation process at universities. The paper does recognize the under-funding of TTOs as a serious threat to the knowledge valorisation and calls the effect of low budgets on marketing of inventions 'disproportional'. Another conclusion is that there is no ready market for the inventions from universities and these inventions need extra attention to be made ready for the market. This process consumes significant amounts of time and budget. The results suggest that most TTOs do not actively transfer technology to external parties but are waiting for external parties to knock on the door for a license, transforming the TTO into a Patent Licensing Offices.

The authors suggest that federal granting agencies should earmark a small portion of the funding for commercialising inventions. Not necessarily through TTOs but for example through external agencies or by training staff in the subject of commercialisation. Another example of a strong incentive for technology transfer appears to be the pre-invention ties between inventors and companies. It decreases the time needed for commercialisation as supply and demand are more balanced.

**Relevance to our research**

We agree with the authors that the best sources of information are the TTOs themselves. Because of the results from this research, combined with the similar group of people that we will interview for our research, we predict that staff shortage will be identified as a problem by our interviewees as well. We feel that this article emphasises too much on a lack of (qualified) personnel as the main cause of non-performing TTOs. By focussing on the primary process and the way TTOs perform their tasks and activities, we feel that we do not put the emphasis on any expected bottleneck. The authors identify different groups of TTOs, (low and high performing); we will study the data derived from the annual reports to see whether we identify a similar separation between TTOs. However, as our population of 8 TTOs is very small, it is not likely we will be able to make a clear division between groups of TTOs.

## "The role of academic technology transfer organizations in improving industry science links"

*by K. Debackere and R. Veugelers (2005)*

The authors use the term Industry-Science Links (ISLs) to describe "the different types of interactions between the industry and the science sector that are aimed at the exchange of knowledge and technology". The formal forms of ISLs identified by the authors are:

- Start-up of technology-oriented enterprises by researchers from the science-base generated at the research institute;
- Collaborative research, i.e. defining and conducting R&D projects jointly by enterprises and science institutions, either on a bi-lateral basis or on a consortium basis;
- Contract research and know-how based consulting by science commissioned by industry;
- Development of Intellectual Property Rights (IPRs) by science
- Others, such as co-operation in graduate education, advanced training for enterprise staff, systematic exchange of research staff between companies and research institutes

The authors state that the success of ISLs is dependent on three factors: context, structure and process. All three are applicable to TTOs but we will focus on process and will not discuss the context and structure in-depth as we are studying the valorisation process and the activities involved.

Debackere & Veugelers identify six factors from other literature that seperate successful liaisons in ISLs from their peers. These are:

- Focus on combining basic and applied research
- The direct transfer between researchers and industry
- Proximity to the researchers themselves;
- Their emphasis on building the complementary assets needed for the research groups to be effective in
- The intensity of their ISLs (contract law, intellectual property management, spin-off development, access to venture capital, etc.);
- Design of sufficiently attractive individual remuneration packages that reward successful transfer activities.

The authors come to the conclusion that there are four crucial attributes to the success of a liaison unit (i.e. the TTO in our research). First is a well-balanced process to manage and to monitor contract research in the area of industrial innovation, supported by a central staff of professionals. An example of coordination processes are innovation meetings and training for researchers in the field of technology transfer

Second, the operational process must be based on an active knowledge management policy. Third, it is highly recommended by the authors that a seed fund is available to support entrepreneurial activities. This incorporates a monitoring of the process from invention to spin-off via a business plan etc. Fourth, the liaison unit should offer opportunities for entrepreneurs and academics to meet, enabling them to form networks.

The article outlines the success story of the liaison office at K.U. Leuven, called Leuven Research and Development (LRD). LRD is seen as a best practice on how universities should arrange their knowledge valorisation. The authors attribute the success of LRD to the professional degree of the staff, the broad palette of services offered and also to the long presence of LRD within the organisation, as the unit was founded in 1972.

**Relevance to our research**

The authors give very concrete advice on crucial attributes towards a successful TTO. These attributes are consistent with our knowledge valorisation process. The managing and monitoring is similar to our identification phase; the active knowledge policy is translated into our protection phase; entrepreneurial activities need to be supported so the inventions can evolve into more interesting products for commercial partners (marketing) and monitoring, up to the actual spin-off (commercialisation). The fourth attribute is linked to forming networks. Although facilitating network creation for scientists can be a TTO activity, networks belong a total different stream in research literature as described by Rothaermel, Agung & Jiang (2007) and therefore we will not discuss it in our thesis.

## "Technology transfer between university research centers and industry in Singapore"

*by J. Lee and H.N. Win (2004)*

This article is a review of the models used at three universities for technology transfer to industry in Singapore. Its goal is to identify factors that increase the success of technology transfer.

### Article outline

The article starts by introducing the three university centers that are the subjects of research. All three represent another part of the academic world, being information technology (Ken Ridge Digital Labs), automation and CAD/CAM (Gintic Institute of Manufacturing Technology) and construction management & technology (Center for Advanced Construction Studies).

None of these are focussed on the medical sector. We feel however that the results can be applied to the medical sector and other research areas as well as the research does not focus on one specific area. The authors give a general framework that applies to all three and, given the literature, is applicable to other areas as well such as the medical sector.

### Motivations for technology transfer

The article begins by explaining the benefits for parties to engage in technology transfer. We present a selection of these benefits.

University benefits

- The opportunity to access the needs of the economy and to develop its activities accordingly through income from the sales of technology
- Access to industry for both fundamental and applied research
- Access to the protected markets
- Improvement in new technology implementation
- New product development and spin-offs
- Patenting

Industry benefits

- Access to research, consulting and data collection of the university
- An improved public image in the society in which it operates, which means that more talented students will be attracted to the industrial sector
- Gained technical knowledge
- Gained technology services not available before
- Quality improvement
- Cost savings
- New markets
- Manufacturing and lead time reduction

The leading motives that we extract are that technology transfer provides universities with access to (new) branches and that it is a way of generating funding (e.g. by saving costs and creating spin-offs). The main motives for industry are gaining knowledge that otherwise would not be available and competitive advantage (e.g. new markets and quality improvement).

## Mechanisms of technology transfer

The authors continue the article by defining nine technology transfer mechanisms. The mechanisms are aimed at technology transfer and by assessing which of these mechanisms also have the purpose of creating economic value; we can identify the mechanisms that are applicable to knowledge valorisation. Given this additional goal of creating economic value, we identify the most important instruments and activities for knowledge valorisation:

1. Consultancy and technical services provision
2. Patenting & Licensing
3. Contract research
4. Science park, research park, technology park or incubators
5. Spin-offs

The article makes a distinction between one-way and two-way technology flow. Knowledge valorisation by UMCs is clearly an example of one-way technology flow, (from university to industry). Heide (2007) identifies that the same mechanisms are applicable to one-way technology transfer, with the addition of spin-offs. Therefore we add this mechanism to our framework as well.

The article concludes with a comparison of the technology transfer mechanisms used per research centre. The conclusion is that universities are and will stay an important partner for further innovation.

**Relevance to our research**

The article shows the benefits for both university and industry and although the research subjects are not directly comparable to Dutch UMCs, we assume that the benefits and mechanisms are universally applicable. We make this assumption based on the fact that the three institutions come from different branches of research. Furthermore, Singapore is a country who's governing is strongly based on economic models (Huff, 1995). Therefore it is interesting to see how Singapore acts in technology transfer and more important, knowledge valorisation. We therefore incorporate the mechanisms and activities mentioned by the authors in identifying similar activities at Dutch TTOs.

## 2.3. Phases and tasks in knowledge valorisation

The following paragraphs give a more in-depth description of knowledge valorisation activities. As we have found no framework in literature that incorporates tasks and activities into different phases of knowledge valorisation, we explain why we position the activities into one of the four phases of the knowledge valorisation process framework, presented in paragraph 2.1.

### 2.3.1. Identification

The identification of potential intellectual property can be quite hard as researchers do not always actively approach the TTO when they have a finding that may result in a patent. Some researchers deliberately bypass the TTO as they feel that the employee is owner of the intellectual property instead of the employer. Identifying can be a serious challenge for TTOs. Below we describe a number of activities that TTOs can perform to identify potential intellectual property.

**Scouting**

A TTO can scout within the UMC and inform the scientists about the services that the TTO offers. When a TTO gets known to the employees of the UMC, scientists will contact the TTO earlier and more often when they have issues or questions related to IP. When scouting within the organisation, the TTO employees do not only hear about findings that are about to be valorised but about developments that will become interesting in the future.

**Grant management**

By managing the grants of a UMC, the TTO provides itself with an early role in the R&D process. Grant management itself does not automatically result in technology transfer or knowledge valorisation but it does place the TTO in a position where the TTO is informed about the research that institution employees long before publication, disclosure or patenting is relevant.

Grant management automatically means that third parties (the sponsors, e.g. European Union, national and regional governments or charity organisations) are involved. All of these parties have different granting conditions. By being involved in the application process, the TTO is able to assess granting conditions for unacceptable clauses and the TTO may give a negative advice on applying for certain grants. Also, the TTO can advise the scientists about alternative granting opportunities that might be interesting to the scientist.

**Publication review**

The average scientist's motto is: "Publish or Perish" (Markman, Gianiodis, Phan, & Balkin, 2005; Ndonzuau, Pirnay, & Surlemont, 2002; Vohora, Wright, & Lockett, 2004). As publication deadlines can be very tight, a swift review of publications on IP issues is absolutely necessary. Scientists will likely experience this as a procedure that slows down the publication. TTOs therefore must be able to guarantee a very short review period. One way of reducing the disadvantages of publication review is to submit a draft to the TTO; a draft usually contains the main concept and it reduces the delay because of a review by the TTO. The delay may even be totally eliminated as the TTO is able to identify and protect any IP long before the findings are ready to be published.

## 2.3.2. Protection

When information about technology is publicly available, it can help innovation and further development because everyone can use the information. However, when a technology is part of the public domain, there is no advantage for a commercial party in using it because the information is available for competitors as well and there is no advantage; even the best idea is worthless without protection.

**Patenting**

The best known method for protecting IP, is patenting. A patent basically provides the exclusive right to exploit a new finding. This right is given to an inventor and guarantees him exclusivity for a limited period of time. The return favour is that the inventor has to disclose its invention and this information becomes publicly available.

The basic requirements for obtaining a patent are, that it has to be a new technology that is applicable and can be produced in a normal industrial environment. 'New' means that it has to be an original idea, 'applicable' means that the technology can be produced, can be used and does what it is supposed to do. The TTO will perform a commercial and technology assessment to see whether applying for a patent has a chance of success and whether there is a market for the new technology.

As it is very easy to identify quantitative variables for patenting activity, (active patents in portfolio, newly acquired patents, patents that are licensed out and expired patents), these variables are commonly used as indicators for the knowledge valorisation output of a TTO. However, the number of newly acquired patents does not tell much about the quality of the

patents; as one IP manager from the AMC said in an interview during the exploration phase of this research: "If you want to have 20 patents by next week, including a patent on the wheel, we can arrange that".

After a patent is granted, there are usually three options; licensing, creating a spin-off or shelving. The licensing and spin-off activities are discussed in the Valorisation paragraph. Shelving means that a patent deliberately is kept 'on the shelf'. This frustrates the knowledge valorisation process and laws and legislation are put in place to prevent research institutions from shelving their patents. We will therefore not elaborate on this option any further.

With time, a UMC and/or its TTO can build a patent portfolio that consists of multiple patents that separately are of little value, but can be combined into a valuable technology collection. Also a UMC becomes an interesting business partner when they have specialized fields of research and own some important patents.

**Secrecy**

Another option for protection is not telling anybody, anything. The best known example is off course the Coca-Cola company that has kept its recipe secret for over a century. UMCs can use secrecy to protect their non-patentable technologies like algorithms and software. The risk with secrecy is that it provides no protection against e.g. reverse engineering of the technology. It is preferable to patent a technology whenever possible.

**IP clauses**

Agreements between parties are a daily practice and are a good medium to make arrangements on potential IP that may be developed during the cooperation. This technology is not patentable yet, nor is it clear whether it will become profitable. There are numerous examples of agreements in which research institutions give away all rights on technology that will be developed under the agreement. To prevent this, adding IP clauses that are advantageous for the research institution is an important task for TTOs.

## 2.3.3. Marketing

Making IP interesting for a commercial party is an essential part of the knowledge valorisation process. It is a constant comparison of the benefits (e.g. effectiveness and efficacy) and disadvantages (e.g. high costs) against existing technology. Furthermore, a proof of concept usually is not enough to convince potential customers; they will want to have more certainty on the claims made by the inventor.

### Validation

Validation is the process in which claims are checked by performing additional research. It is an important step to create extra data on the efficacy of a technology and to double check the original findings. Validation is an important factor in determining whether a technology has market potential.

### Commercial/technology assessment

The technology needs to be assessed. The goal of a commercial assessment is to assess whether the technology can become a commercial success, generating profit for the stakeholders. For example: if a technology enters an existing market, it will have to compete with similar products. Generally speaking, a new technology must be cheaper, more effective or both to have a chance of success.

## 2.3.4. Commercialisation

Commercialising a technology is the final step in the knowledge valorisation process. During the commercialisation phase it becomes clear wheter a technology is really profitable and ready for the market.

### Licensing

Licensing means that a technology is interesting enough for a commercial party to pay for the right to use the technology. The benefit of a license can be illustrated by a spin-off. Whenever the ownership of a patent is transferred from the UMC to a spin-off, the UMC loses its patent when the spin-off goes bankrupt. If the UMC licenses a patent to the spin-off, the spin-off company can still make full use of the patent whilst the UMC keeps ownership.

**Spin-off**

The phenomenon of spin-offs is extensively studied and successful spin-off creation is generally seen as the ultimate outcome for knowledge valorisation. This explains the attention given by UMCs to spin-offs. The benefits are that the technology development stays under supervision of the UMC and that any profit does not have to be shared with other parties. The disadvantages are that spin-off creation means taking big (financial) risks and that a spin-off has a very small chance of succeeding in the wider world market. It is more likely the spin-off is bought by a big multinational that by doing so, acquires the ownership of the spin-off's intellectual property.

## 2.4. Position of the TTO

*"TTOs … are usually in charge of processes related to the valorisation of the knowledge and intellectual property derived from university research"* (Gras, Lapera, Solves, Jover, & Azuar, 2008). TTOs act as liaisons between the institution and commercial parties. Knowledge valorisation by TTOs consists of different tasks and roles depending on the phase of the knowledge valorisation process. The TTO is usually an integral part of the organisation it works for. As part of the organisation, it has shared interests that can have influence on the mission and tasks of the TTO.

Rothaermel, Agung & Jiang (2007) provide a model for the entrepreneurial research university (Figure 3). In this model, the TTO is present in two parts of the model, as an intermediary and as part of an incentive system. A TTO can indeed create incentives for scientists to deploy entrepreneurial activities. As this research is narrowed down and focuses only on the intermediary tasks and activities performed by TTOs, we only discuss that part, but we do keep in mind that the intermediary office is subject to other incentives.

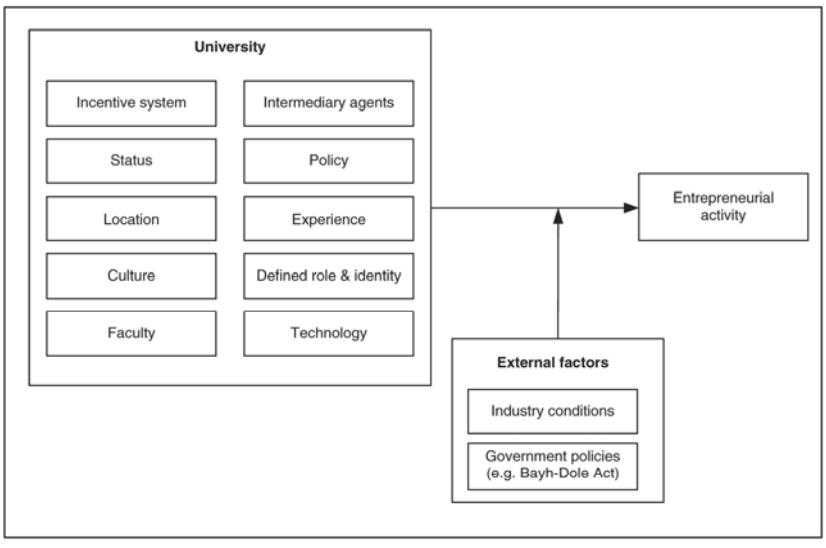



**Figure 3: Model of the entrepreneurial research university (Rothaermel, et al., 2007)**

Figure 3 presents a more detailed view of the entrepreneurial activity of an institution within the biomedical ecosystem. The 'intermediary agents' Rothaermel, et al. mention are TTOs and Incubators. We consider incubators not as an intermediary agent per se but as an instrument[4] available to an institution to valorise its knowledge. In this perspective, the TTO could be considered the only intermediary for knowledge valorisation from within a university to other parties.

As most articles and papers focus on the economic success of TTOs, there are non-financial benefits for universities as well. Stephan (2001) identifies the following benefits:

- Linking students with industry
- Providing industry and students a pre-employment look at each other
- Providing more job opportunities for students
- Increasing interaction of faculty and students with industry

**Relevance to our research**

This paper is focussed on the educational efforts of university-industry technology transfer and shows us that the concept of TTOs is not only interesting in matters of patenting, licensing and spin-offs. These educational efforts contribute to a broad palette of services provided by TTOs, improving the industry-science links.

[4] As the knowledge valorisation agent, the TTO can use the Incubator instrument and offer this as a service to scientists

## 2.5. Connecting the literature to our research

This paragraph explains the connection between the literature and our research. The paragraph starts with a short summary of the articles we have reviewed. After the summary, we explain the relevance of the literature to our research question, our framework and the design of our research (i.e. the desk research and interviewing TTO staff). At the end of this paragraph, we discuss some of the issues that are not covered by our literature review and how we handle these issues.

### Literature summary

Rothaermel, Agung & Jiang (2007) provide us with an overview of the literature, including a separation between different research streams. One of the research streams focuses on TTOs and therefore is relevant to our research. The authors describe a number of output indicators (patenting & licensing activities, equity positions), factors that can impact the performance of a TTO (the way a TTO is structured, (lack of) skilled staff) and solutions for the challenges that are identified (e.g. a transparent licensing policy, mixed-skill staff).

Sachwitz Apple (2008) evaluates TTOs and analyses whether TTOs have made the transition to a new economic model, called the entrepreneurial economy. Sachwitz Apple presents the traditional university technology development model, taken from Acs & Stough (2008). Our model for knowledge valorisation is based on the same model. The author defines three hypotheses to explore whether TTOs are adapted to the entrepreneurial economy. The conclusion is that TTOs have not yet made the transition. The author recommends TTOs to focus on small firm creation, create policy to stimulate entrepreneurship among researchers and transform the university organisation from a hierarchal organisation to a networked organisation.

Swamidass & Vulasa (2009) identify bottle necks in university technology transfer. One of the most important factors is that technologies that are developed at a university are very 'high-tech' and therefore difficult to market.

The authors introduce three models of technology flow, including the traditional model which is similar to the situation in the Netherlands. The authors define success factors for TTOs. These indicators (e.g. number of active patents, number of licenses) are derived from the number of disclosures by university staff. According to the authors, research shows that TTOs improve the knowledge valorisation as the growth in university patenting has grown faster than in other

sectors since the passing of the Bayh-Dole act. Swamidass and Vulasa note that the Bayh-Dole act has increased the quantity of TTOs, but has little influence on their quality.

The article continues with a presentation of a survey among a number of TTOs. This survey shows that lack of skilled staff and insufficient budgets are the main bottle necks identified by TTOs. Although we believe these results are biased by the fact that the authors have asked TTOs to identify these bottle necks themselves, we do agree with the authors that TTO staff is most accessible source of information.

Debackere & Veugelers (2005) study the role of academic technology transfer organisations in industry-science links (ISLs). The authors identify four crucial attributes to the success of a liaison organisation (in our research: the TTO). These are 1) competent management and staff, monitoring the process; 2) active knowledge management policy; 3) stimulate entrepreneurial activities; 4) formation of networks by creating opportunities for scientists and industry to meet.

The authors continue with an analysis of the TTO at the Catholic University Leuven, called Leuven Research and Development (LRD); LRD is considered to be a best practice in the field of knowledge valorisation. The authors identify the following success factors: a professional staff, a broad palette of services and the long presence of LRD within the organisation as it was founded in 1972.

The research by Lee and Win (2004) includes three universities in Singapore that are very different from each other and from UMCs. However, because the differentiation between the universities, we feel that the analysis and conclusions can be applied to other types of research institutions (i.e. UMCs) as well. The authors describe the benefits of technology transfer for both universities (e.g. new product development and patenting) and industry (e.g. cost savings and market advantage). The authors continue their article by presenting nine technology transfer mechanisms. From these mechanisms we have extracted five mechanisms that are applicable to knowledge valorisation. These mechanisms are: consultancy and technical services provision, patenting & licensing, contract research, science park, research park, technology park or incubators and spin-offs. A Masters thesis by Heide (2007) includes these mechanisms as well as one way technology transfer mechanisms. This confirms our assumption that they can be seen as knowledge valorisation mechanisms as well.

### Relevance to our research question and framework

Our research question (paragraph 1.4) is: 'what are the tasks and activities, challenges and vision of TTOs affiliated to university hospitals in the Netherlands?' The literature from chapter 2 provides us with a general overview of the tasks and activities that are associated with TTOs. Based on this literature, we have constructed the framework from paragraph 2.1. The four phases in our model are based on the important role TTOs play discussed by Lee & Win (2004) and the traditional university technology development model presented by Sachwitz Apple (2008). Constructing four phases helps us to structure the interviews and to cluster the tasks and activities. Although there are many authors describing tasks and activities associated with TTOs (including Debackere & Veugelers (2005) and a summary by Heide (2007)), we found no literature that clusters the tasks and activities into different phases within the knowledge valorisation process. The literature more or less provides a summary of tasks with for example no distinction between identification tasks and marketing tasks.

In paragraph 2.3, we discuss the most important tasks and activities from literature. After describing a task or activity, we explain why we assign it to one of the phases within the knowledge valorisation process. A model can never contain all possible tasks and activities and therefore we use the framework as a guideline during the interviews. Whenever an interviewee mentions another task or activity, we mention this in the results.

### Relevance to our research design

Our research focusses on two sources of information; a desk research on the quantitative knowledge valorisation statistics incorporated in the annual reports from the UMC and interviews with TTO staff.

Our desk research analyses the knowledge valorisation output indicators from UMCs. These indicators are generally accepted in literature (Heide, 2007; Rothaermel, et al., 2007) and give insight in the valorisation activities performed by TTOs.

TTOs are considered to be very important in the knowledge valorisation process (Debackere & Veugelers, 2005; Rothaermel, et al., 2007). We therefore believe that the best sources of information for our research are the TTOs themselves. This assumption is supported by the reviewed articles by Debackere & Veugelers (2005) and Swamidass & Vulasa (2009).

## Gaps, pitfalls and other issues

Concluding this paragraph, we look at some subjects that are not fully covered by the literature we have discussed. We present some issues shortly. In chapter three, we discuss into more detail how we avoid certain pitfalls.

Relevance of the literature to Dutch UMC TTOs

The literature we review is not focussed on the Netherlands nor is it explicitly discussing the knowledge valorisation within a healthcare environment. One may wonder whether the literature is relevant to our subject of research. We did not find any sources on knowledge valorisation by UMCs in the Netherlands. Therefore, we are forced to use international literature. The legislation and policies in the Netherlands seem to be based on the Bayh-Dole act, granting ownership to the institution. Furthermore, all TTOs are centralised and responsible for the knowledge valorisation as is the case in most other universities. We therefore feel that the literature we have reviewed applies to TTOs in the Netherlands as well.

Intellectual property developed at universities usually is very high-tech and needs a lot of additional effort before it is ready to be commercialised. Although the technology that is developed by a UMC will differ from that of a normal university, the process by which it is valorised is very much alike. The tasks and activities performed by a UMC TTO will therefore be similar to those of a TTO in any other research environment. The staff of a UMC TTO needs to have specific knowledge within the area of healthcare research and this makes it difficult to find skilled staff. This level of expertise applies to a TTO facilitating a mechanical or electrical engineering faculty as well.

Small sample size

Our sample size is quite small However, our sample group is representative for our subject of research as all subjects (Dutch UMCs) are included in the sample (n=8). An alternative would be to set up a broader survey across different stakeholders such as industry representatives and scientists. To set up such a large survey is very difficult within the boundaries of a Masters thesis. This has been confirmed by a number of interviewees and examples from literature (Lee & Win, 2004; Sachwitz Apple, 2008) show it is common to perform a research on a small number of institutions.

Assigning tasks and activities to separate phases of the knowledge valorisation framework

Our framework is heavily based on literature; we modelled the phases according to the traditional university technology development model and we derived the most important tasks and activities for TTOs from different sources. However, we found no theoretical model incorporating the TTO tasks and activities into different phases of knowledge valorisation and therefore we had to construct it.

Assigning a task or activity to one of the phases means we restrict the use of it. Our framework is, just as any other model, a simplified representation of reality. Paragraph 2.3 discusses the most tasks and activities and explains our choice for placing them in one of the four phases. It is up to the decision of the reader to (dis-)agree with the decisions we make.

Interview bias

The most important bottlenecks identified by Swamidass & Vulasa (2009) are lack of skilled TTO staff and insufficient budget for TTOs. As the authors have surveyed the TTOs, it is obvious that there might be some bias along the survey. As it is not possible to set up a survey among peer groups, we can only try to prevent bias as much as possible. We will elaborate on this subject in chapter three.

# 3. Methods & Materials

**This chapter describes the methods and materials we use to perform the research. The chapter starts with describing the data collection for the desk research and interviews. Afterwards, we explain how we analyse the data and the choices we make for presenting the data.**

## 3.1. Data collection

During the data collection phase consisted of desk research and semi-structured interviews. The desk research focussed on the annual reports of the UMCs. The interviews were performed on location with key staff members of the TTOs. The interview protocol can be found in Annex I-a. During the interviews, we used a model "from idea to IP" to target the questions towards different phases within the knowledge valorisation procees. The model "From Idea to IP" can be found in Annex I-b.

### 3.1.1. Desk research - Annual reports

Every UMC publishes an annual report on their activities in a certain year. These reports are publicly available. We used the reports to analyse facts and figures concerning their valorisation activities.

#### Collecting reports

We searched on the websites of all eight UMCs for the annual reports of the previous years. If no annual reports were found, we contacted the UMC asking where they could be found. In the end we were able to collect annual reports ranging from 2001 up to and including 2008. The availability differed greatly between the UMCs, with a complete coverage of all UMCs as of 2005. No extra effort was put into collect more annual reports as a preliminary analysis of the available report showed that information on valorisation and patents was absent in most of the reports from 2004 and earlier years. All the collected reports were available in Dutch and published in the portable document format (PDF).

## Indicators

Both in policy (NFU, 2008) and scientific literature (Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005; Colyvas, et al., 2002; Mowery, Nelson, Sampat, & Ziedonis, 2001; Saragossi & van Pottelsberghe de la Potterie, 2003; Siegel & Phan, 2004; Swamidass & Vulasa, 2009) we see that patents are important indicators for the valorisation output of a university. Universities have assigned the patenting task to their TTOs. This makes patenting a very good indicator for a TTO's effectiveness. Simply counting the number of patents is insufficient and gives no insight in the performance of a TTO. If TTOs would be judged by the number of newly filed patents, they could simply file a number of irrelevant patents only to achieve the set targets. We need more relevant indicators to judge the effectiveness of a TTO.

Both national and international policy (AUTM, 2005; NFU, 2008), instruct UMCs how to report on their patenting indicators. TTOs and UMCs should provide information on the number of filed patents, the number of active patents the TTO/UMC has in portfolio, the number licensed patents and the number expired patents. Information that can be derived from this data is the number of disclosures of potential IP by employees to the TTO (filed patents), the size of the patent portfolio that is managed (active patents), the degree of success in commercialising patents (licenses) and an insight on the degree of patent management and history of the portfolio (expired patents).

## Extracting data from the reports

The first step was testing whether it was possible to search the text within the PDF files. Saving to the PDF-format gives the option to prevent readers searching the document for specific text. Another option is that the pages are saved as images. If this was the case, optical character recognition (OCR) was used to convert images to text.

To check whether the previous steps succeeded, we searched each document for 'en' (a very common combination in Dutch language). If this query returned results, we used three different queries to locate relevant paragraphs. These queries were 'patent', 'octrooi'[5] and 'valor'. Valor was used because it would return multiple relevant results such as valorisation and knowledge valorisation[6]. We fully read the reports that returned no result whatsoever on the queries, to see whether there was any other information available on knowledge valorisation activities.

[5] 'Octrooi' is the Dutch word for patent. The term patent is also frequently used in Dutch, so we searched for patent as well.
[6] Knowledge valorisation, valorisation activities etc are written as one word in Dutch.

### 3.1.2. Interviews

We visited seven of the eight UMCs in the Netherlands between May and November 2009. Unfortunately it was not possible to arrange an interview with a member of staff at the UMC Utrecht TTO, but via e-mail the TTO has sent some documentation on their valorisation activities and policy.

#### Introduction and interview procedure

We sent an e-mail to each UMC TTO introducing the interviewer, explaining the goal of the interview and asking whether it was possible to arrange an interview with a key member of staff, preferably the CEO. We preferred talking to the CEO because the interview aims at a broad palette of subjects such as tasks, activities, responsibilities, challenges and policy. Whenever the CEO was too busy or otherwise unavailable, we asked the TTO whether it was possible tointerview a senior member of staff. To our great surprise, only at two UMCs it was not possible to talk with the CEO; in one case the CEO would leave the organisation shortly after the planned interview date and had other priorities; the senior employee replacing the CEO, was involved in the development of the TTO from the moment the TTO was established. In the other UMC, the CEO was not available and was replaced as well by a senior staff member. She was working at the TTO for a very long period and has extensive international experience in the field of life sciences.

For the interviews, we visited each site to make it as easy as possible for the interviewee to cooperate. The interviews were semi-structured. We recorded the interviews so the interviewer could focus on the interview structure and the interviewee instead of taking notes. As promised to a number of interviewees, the audio recordings are destroyed after completion of this thesis and the transcripts will be held confidential. On request of the interviewee, we sent a written summary for revision. If we did not receive a response within two weeks, we sent a reminder. If there was no reply on that either within two weeks, we assumed that our summary of the interview was approved by the interviewee.

#### Translating the theoretical framework to interview questions

The subject of the interview was knowledge valorisation at the specific UMC. The main goal of the interview was to get insight into the tasks and activities performed by the TTOs and whether some activities get more attention than others. We interviewed the staff member on this subject in two ways. First we asked whether the interviewee could describe the tasks and activities of the

TTO and what they consider to be the most important tasks. We would then ask what tasks consume most of the time of the TTO.

Second we presented the model "From Idea to IP" (Annex I-b) and asked whether the interviewee could explain in what way the TTO is engaged in the different phases of the knowledge valorisation process.

We asked the interviewees what challenges they and the TTO face in their daily work. Although there are some challenges identified in different articles (e.g. staffing problems), we did not suggest challenge they might face to prevent any influence on their answer on this question. We concluded by asking the interviewees their vision for the future; both for the TTO they are and for the knowledge valorisation in the Netherlands.

## 3.2. Data analysis and presentation

This paragraph describes the means of analysis. These differ for the annual reports and the interviews. We describe the way of presenting the results of the analysis as well.

### 3.2.1. Desk research – Annual reports

To process the data from the annual reports, we used SPSS. Given the incomplete annual reports, we were not able to create a reliable dataset on which we can perform reliable tests on statistical trend analysis. However, SPSS allows us to present the data in different formats in order to extract any valuable information from it.

Some annual reports presented not only the data for that particular year but a historical overview as well (e.g. presenting the data for 2006 accompanied by the same data for 2005 and 2004). We checked whether the historical data matches the data in the original report. If there was an inconsistency, we used the data from the youngest report as we believe this is the most reliable data. E.g. a patent is filed in December 2005, it might very well be acquired in June 2006, adding one patent to the 2005 score. During this process, the data for the 2005 report are gathered and the first opportunity for the UMC to report on this patent is in the 2006 report.

### 3.2.2. Interviews

We started by fully typing the interviews. We soon switched to extracting the relevant information on tasks, activities, challenges and vision for the future from the audio recordings. We analysed the recording twice to make sure we did not miss any important subjects or information. We combined these abstracts with the notes we made during the interview. We rewrote this raw data and clustered it into different subject categories. The outcome is presented in chapter 4, together with the data from the desk research.

# 4. Results

**Chapter 4 presents the results and it follows the structure of the interviews. During the interviews, we started with talking about the TTO in general, its position within the institution and the background of the interviewee. We discussed the current tasks and activities and the challenges the TTO faces. We concluded with the interviewees' vision for the future; for the institution and for the Netherlands in general. Obviously the interviews weren't always as rigid in their structure, but the result paragraphs are modelled to keep them consistent and to provide an oversight to the reader.**

We can draw two preliminary conclusions: reporting on valorisation statistics has no priority for UMCs and every TTO does facilitate the knowledge valorisation process. The TTOs focus on the traditional knowledge valorisation activities of patenting, licensing and spin-offs. They are focussed primarily on the internal customers and TTOs put a great amount of effort into internal marketing. TTOs try to create a good reputation within the UMC and they want to familiarize the employees with the services the TTO provides.

## 4.1. Desk research results

The desk research focussed on the annual reports that are publicly available via the websites of the UMCs. We compare UMCs based on the data from their reports but this information gives us a historical perspective on knowledge valorisation as well. Table 3 presents a summary of the data we collected per reporting year.

| Year | Annual reports available | Patents in portfolio | Patent applications | Expired patents | Licensed patents |
|---|---|---|---|---|---|
| 2001 | 3 | 0 | 0 | 0 | 0 |
| 2002 | 4 | 1 | 1 | 1 | 0 |
| 2003 | 4 | 1 | 1 | 1 | 0 |
| 2004 | 5 | 2 | 4 | 3 | 2 |
| 2005 | 7 | 4 | 6 | 2 | 0 |
| 2006 | 8 | 3 | 4 | 2 | 1 |
| 2007 | 8 | 6 | 6 | 2 | 2 |
| 2008 | 8 | 6 | 7 | 3 | 3 |

**Table 3: Summary of valorisation data UMC annual reports ($n_{UMC}$=8)**

Three UMCs provide annual reports since 2001. As we can see, none of the UMCs give any information on their 2001 patenting and/or licensing activities. For 2002 and 2003 there are four annual reports available and one UMC presents data on patenting. Licensing still is not a subject in the annual reports.

As of 2004 we see a growth in availability of annual reports and in the reporting on patents and licenses. However, in 2008, which is the most recent year available, we still see that two UMCs (the MUMC and the UMCG) do no report on their patent portfolio size. The MUMC has a separate company that functions as a TTO and therefore the MUMC does not report any statistics on the subject in their annual report. The UMCG only mentions in 2008, that four patents were acquired and two start-ups were realised.

As the dataset has a great number of missing values, it has little use to present the data only as absolute numbers. The increase would be enormous in one year only because two UMCs start to report their valorisation indicators. We therefore choose to present most of the data as average statistics per year. By doing this, we do not get a bias because of new cases; the numerator and the denominator both increase with the addition of a new dataset from a UMC. Because of the small sample size (eight UMCs) and the missing data, none of our data has statistically significance on a $p=0.05$ level.

Some of the annual reports combine the data for both the UMC and the University. This results in more data bias, but there was no possibility of filtering out the University data. However, the data still present the knowledge valorisation activities at the involved TTOs.

We present our results on the size of the active patents portfolio, the number of applications for new patents, the number of expired patents and the number of licensed patents in separate subparagraphs.

### 4.1.1. Portfolio of active patents

Figure 4 presents the average portfolio size of active patents per year. We would expect a steady increase as over the years but this is not the case. The decrease in portfolio size for the years 2003-2005 coincides with the increase in UMCs reporting on their patent portfolio.

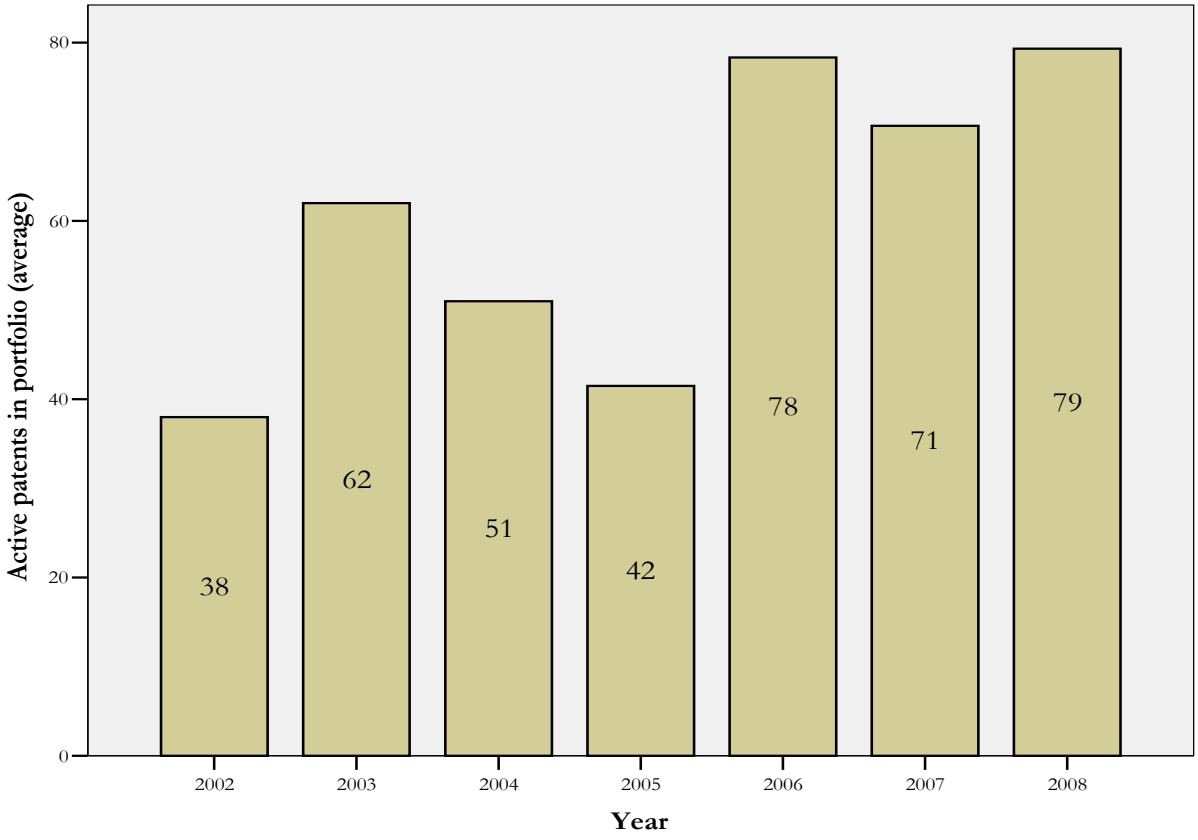



**Figure 4: Portfolio size of active patents per year**

We provide the total sum of active patents per year in Table 4 to illustrate the increasing attention that is given to knowledge valorisation. In 2001, none of the UMCs reports on the subject, in 2002 only one UMC reports a porfolio size of 38 patents and in 2008 six UMC together have 476 active patents in their portfolios.

| Year | Sum of ative patents |
|---|---|
| 2001 | 0 |
| 2002 | 38 |
| 2003 | 62 |
| 2004 | 102 |
| 2005 | 166 |
| 2006 | 235 |
| 2007 | 424 |
| 2008 | 476 |

**Table 4: Sum of active patents**

### 4.1.2. Patent applications

Figure 5 shows the average number of new patent applications. This figure shows a steady increase of the average number of patent applications. This indicates that TTOs become more and more active in protecting ideas and technologies developed by the employees of the UMC. We see a small decrease in the average number of applications in 2008, compared to the previous year. It is unknown why this is.

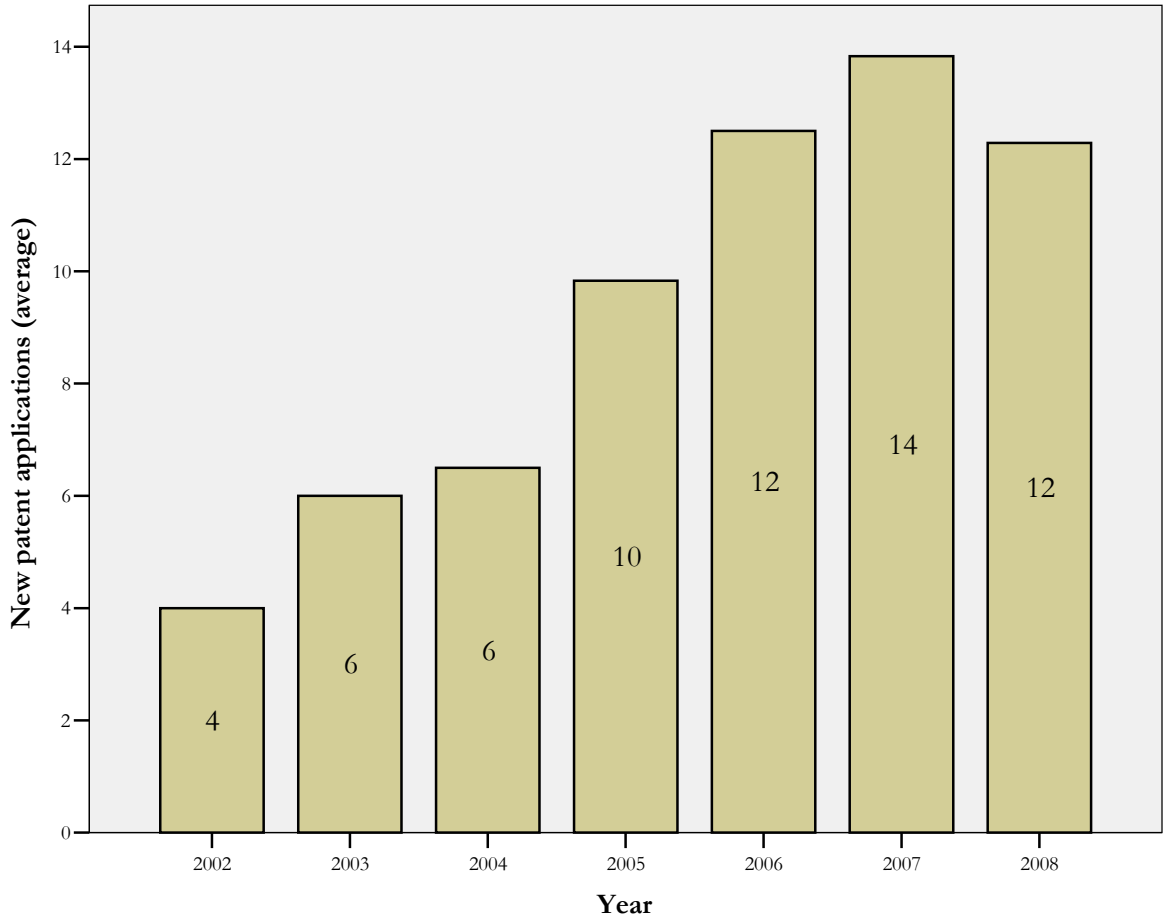



**Figure 5: Average number of new patent applications per year**

### 4.1.3. Expired patents

Figure 6 presents the average number of expired patents. This is an indicator of active portfolio management. Portfolio management does not only mean an increasing number of patents and licenses, but also incorporates terminating patents that are not profitable and probably will not become profitable in the future. Please note that a maximum of three UMCs report on this variable and therefore this graph is far from complete. We have doubts on whether the UMCs that report on this variable are representative for the other UMCs.

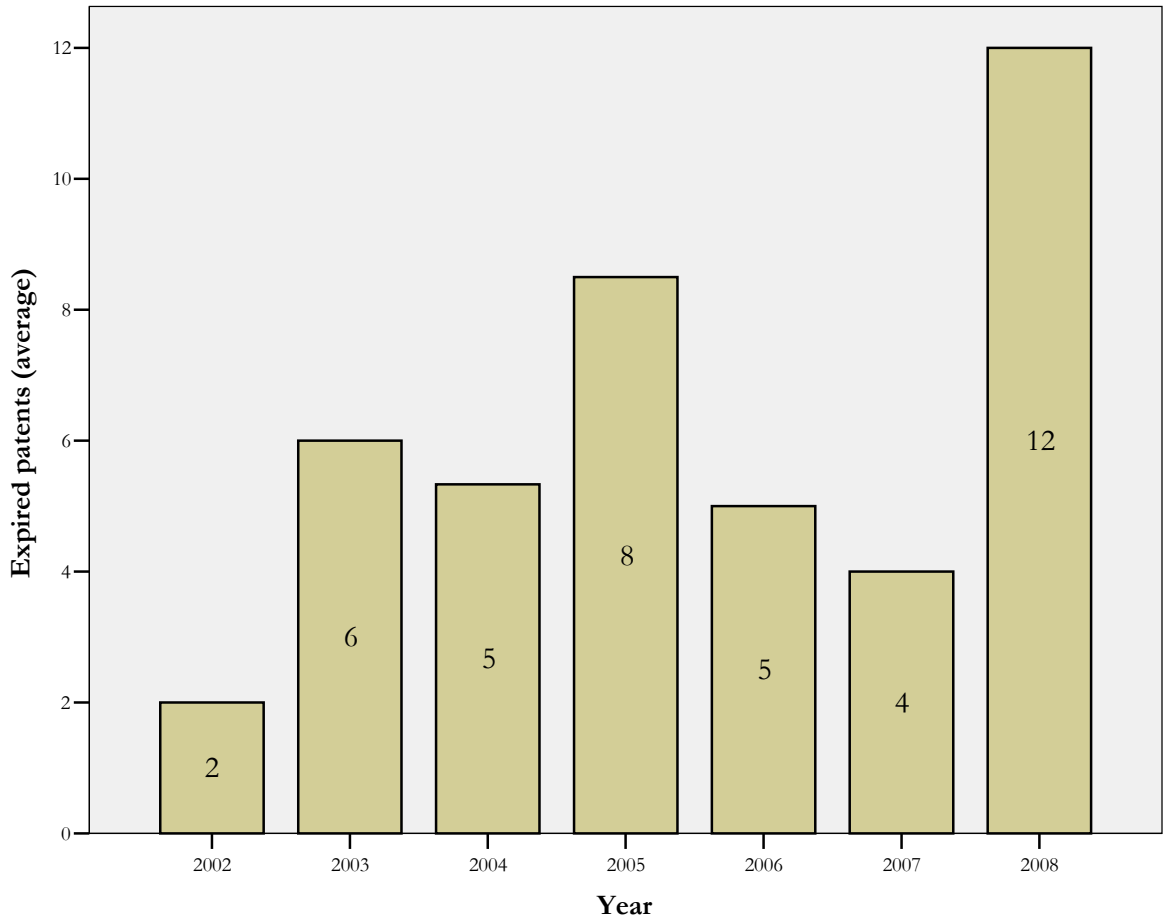



**Figure 6: Expired patents per year**

### 4.1.4. Licensed patents

Figure 7 presents the average number of licensed patents. Please note that none of the UMCs has reported any licensing activities for 2005. Starting from 2006, the number of UMCs reporting on licenses, increases every year (i.e. 2006 n=1; 2007 n=2 and 2008 n=3). The average number of licenses decreases only because of the data of the UMC that starts reporting on licenses. Table 5 shows this effect.

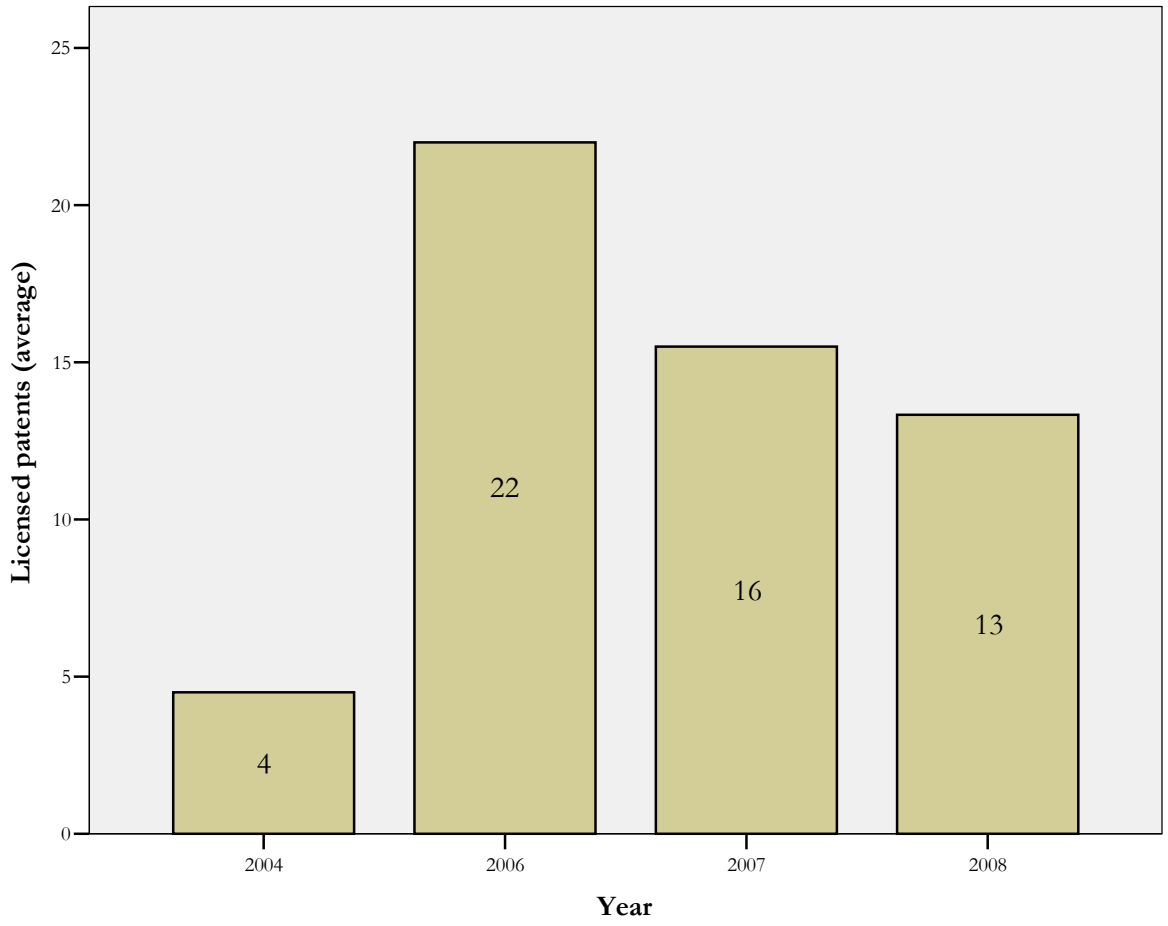



**Figure 7: Licensed patents**

As we can see in Table 5, every UMC that reports their licensing activities shows an increase in the number of licenses compared to the previous year, except the UMCU as there is only data available for the year 2008.

| Year | AMC | LUMC | UMCU |
|---|---|---|---|
| 2006 | 22 | N/A | N/A |
| 2007 | 25 | 6 | N/A |
| 2008 | 26 | 11 | 3 |

**Table 5: Licensed patents per UMC**

## 4.2. Interview results

We combine the results of the interviews into one paragraph. Discussing the results from each UMC in a separate paragraph would result in an unstructured chapter as subjects would not be clustered. For more detailed information, a summary per TTO is included in Annex IV. We start with presenting general information on the TTOs. After this, we will discuss the knowledge valorisation process, knowledge valorisation tasks and activities, challenges and vision for the future.

### General information on the TTOs

Every UMC in the Netherlands has a TTO that is responsible for the knowledge valorisation at the UMCs. Table 6 presents a summary of the TTOs and their position to the UMC.

| UMC | Name | Founded | Position of the TTO to the UMC |
|---|---|---|---|
| AMC | AMC TTO | 2003 | Directly under the board of directors of the UMC |
| EMC | EMC TTO | 2004 | Directly under the board of directors of the UMC |
| LUMC | Luris | 2005 | Directly under the board of directors of the UMC and university |
| MUMC | BioMedbooster | 2005 | Separate company owned by the university and other parties |
| UMCG | Business Generator Foundation Groningen | 2007 | Separate company owned by the university and other parties |
| UMCN | Directorate Valorisation | 2007 | Directly under the board of directors of the UMC |
| UMCU | UMC Utrecht Participations | 1996 | Separate company owned by the university |
| VUMC | VUMC TTO | 2005 | Directly under the board of directors of the university |

**Table 6: UMC, TTO name, foundation year and position of the TTO**

Except the UMC Utrecht, every UMC TTO is founded after 2003. That makes the TTO a very young concept for UMCs. During the interviews we asked what the situation was before the establishment of the TTO. Most interviewees described a situation with a small bureau (2 to 3 FTE) that did some patenting, but did not perform any active marketing or other types of knowledge valorisation activities. In the old situation, the UMC departments were responsible for any valorisation activities.

The position of the current TTOs within, or in relation to the UMC has two variations. The first and most common option is that the TTO is a department that is not directly connected to any other department within the UMC such as the financial or facilitary department. These TTOs are positioned directly under the board of directors. The only difference that exists is, whether the TTO falls under the responsibility of the board of directors of the UMC or is positioned under the board of directors of the university to which the UMC is affiliated. Whether the TTO provides its services only to UMC employees or to employees of the university as well, logically coincides with the positioning of the TTO. The two TTOs that fall under the universities' board

of directors, Luris and VUMC TTO, do provide their services to all the staff of both the university and the UMC. The position of the other TTOs falling under the board of directors means that they only support the employees of the UMC. At the AMC, the CEO of the AMC TTO is also the CEO of the TTO at the University of Amsterdam (UvA). He describes it as being a connecting link and he feels this situation is far more practical than one TTO for the UvA and the AMC as their physical locations are not close to each other.

Of the TTOs that form a separate company outside the UMC organisation, UMC Utrecht Participations and the Business Generator Foundation Groningen still have a very strong bond with their UMC. They only provide services to their mother-institution. BioMedbooster (Maastricht) differs significantly as it truly is a separate company that acts independently and is allowed to provide services to third parties as well, even including other universities. The business model of BioMedBooster is also aimed at total financial independence and therefore BioMedbooster works on a for-profit basis.

Almost every TTO is founded with support from the ministry of economic affairs via the Granting Regulation for Knowledge Exploitation (SKE). As these TTOs acknowledge this regulation as an incentive to professionalise knowledge valorisation through a TTO, we can conclude this regulation is a successful incentive.

| UMC | FTE |
|---|---|
| AMC TTO | 6 |
| EMC TTO | 7 |
| Luris | 20 |
| BioMedBooster | 6 |
| Business Generator Foundation Groningen | 20 |
| Directorate Valorisation | 23 |
| UMC Utrecht Participations | 6[7] |
| VUMC TTO | 9 |

**Table 7: Staff employed by the TTO**

The oldest TTOs are five to six years old. The most important issues they face are to build a good reputation within the institution and to broaden their palette of services. This is very hard because most TTOs have a relatively small staff size (Table 7). Paragraph 4.2.2 further elaborates on this problem. All the offices meet the definition of a TTO as they facilitate commercialisation of research by means of patenting and licensing.

[7] Estimation based on the staff listed on the website of Utrecht Holdings

Many interviewees mention cooperation with the other TTOs as an important future improvement. As there is no consensus about how this cooperation can be effectively realized, it is unrealistic to think that close cooperation between the TTOs will be established in the near future. The distance between the UMCs plays a role as well. Furthermore, the focus for the TTO in the near future will stay on internal marketing, an activity impeded when the TTO is not near to (or positioned within) the institution.

## 4.2.1. The knowledge valorisation process

This paragraph presents the interview data on the subject of the knowledge valorisation process. We discuss every phase separately and the tables provide information on the activities the TTOs perform in that phase.

### Identification

Table 8 presents the activities mentioned during the interviews concerning the identification phase.

| Identification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Activity** | **Mentioned by** | | | | | | | |
| Screening | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| Scouting | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | |
| IP Clauses | AMC | EMC | LUMC | MUMC | | UMCN | | |
| In-house courses | | | LUMC | | UMCG | | | VUMC |
| Grant support | | | LUMC | | | UMCN | | |

**Table 8: Activities during the Identification phase**

All the interviewees mention screening as an identification activity. This relates to the patenting activity in the protection phase of knowledge valorisation. A TTO can patent every idea or technology that an employee discloses, but this is not efficient. The screening usually consists of two assessments. The TTO looks whether the idea or technology is 'patentable' (e.g. software is not patentable in the EU) and whether there is a market for the idea or technology. It has no use to patent a technology that is more expensive and less effective than an existing technology. This last assessment is not very extensive during the identification phase because it is part of the marketing phase as well.

All TTO interviewees except the VUMC mention scouting as an important activity during the identification phase. The VUMC TTO does not scout as their philosophy is that, whenever an employee has a good idea, he will know where to find the TTO. The other TTOs do scout throughout the organisation, not only to identify potential intellectual property but as a form of internal marketing to their customers, the employees, as well.

Although only five interviewees mentioned reviewing or providing IP clauses for contracts between the UMC and third parties as one of their activities, we believe all TTOs perform this task. Three UMCs provide in-house courses for employees to make them more aware of the possibilities of knowledge valorisation. These in-house courses are seen as an internal marketing instrument as well because the TTO establishes important contacts with their internal customers.

## Protection

Table 9 presents the activities performed during the protection phase.

| Protection | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Activity** | **Mentioned by** | | | | | | | |
| Patenting | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| Portfolio management | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| IP Clauses for PPPs | AMC | | | MUMC | | UMCN | | VUMC |
| Secrecy | | | | MUMC | | | | |

**Table 9: Activities during the Protection phase**

All TTOs file patent applications, which many authors (e.g. Debackere & Veugelers, 2005; Mowery & Shane, 2002) and many of the interviewees consider to be a TTO's core business; without patenting there is no protection and consequently nothing to valorise. Together with patenting, all TTOs manage the patent portfolio of the UMC. Active portfolio management does not only mean keeping a database of all the active patents but also expanding the portfolio, stimulating the development of patented technologies and ending patents that are no longer of any interest to the organisation.

Four of the TTOs negotiate the IP-clauses for Public Private Partnerships (PPPs) as well. These partnerships are consortia with parties from academia and industry cooperating in research. The TTOs provide this service to prevent IP leakage.

It is interesting to see that only one TTO mentions secrecy as an instrument to protect intellectual property. Software and algorithms are not patentable in the EU, so when a scientist for example develops software that uses an algorithm to calculate the chance that a patient develops breast cancer, he cannot patent this software. Secrecy then is a legitimate option. Another example is a technology that still is in a premature phase. Instead of patenting, the TTO advises scientists to further develop the technology and not to communicate about it.

## Marketing

Table 10 presents the activities that TTOs perform during the marketing phase.

| Marketing | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Activity** | **Mentioned by** | | | | | | | |
| Technology assessment | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| Internal marketing | AMC | EMC | LUMC | MUMC | | UMCN | | |
| Cooperation with other institutions | AMC | | | | UMCG | | | VUMC |
| Industry in-company days | AMC | EMC | | | | | | VUMC |
| Seed fund | | EMC | | MUMC | UMCG | | | |
| Alumni network | | | | | UMCG | | | |
| Granting opportunities for SMEs | | | | | | | UMCU | |

**Table 10: Activities during the Marketing phase**

Again there is one activity that all TTOs perform: technology assessments. We have seen this activity in the identification phase as well as a part of the screening activities. A technology assessment is also part of the marketing phase as TTOs investigate the market potential of a technology.

Five interviewees mention internal marketing. Some of the interviewees were triggered by the word 'marketing' as internal marketing does not have to be part of the marketing phase. As more employees know that there is a TTO available to support them in valorising their knowledge, the number of disclosures will increase. This enables the TTO to identify new technologies and ideas, but it is irrelevant to the marketing phase in which the TTO develops intellectual property for commercialisation. However, a few interviewees defined internal marketing as 'educating UMC staff', making sure that whenever there was a request for e.g. a consultancy agreement, the TTO would be involved. This internal marketing is more aimed at transforming the employees of the UMC from TTO customers to TTO account managers and that can be seen as marketing; it enables UMC staff to initiate the first contacts with industry and to negotiate with third parties up to a certain level. Within this process, the UMC staff then can rely on the expertise of the TTO.

Three institutions mention the cooperation with other institutions as an activity they perform during the marketing phase. An example of such cooperation is that the AMC and the VUMC, together with other institutions in the Amsterdam region, cooperate in the Life Sciences Centre Amsterdam (LSCA). The LSCA is a partnership in which the institutions jointly their portfolio of services to the industry, enabling them to offer a wide variety of high-quality services. The LSCA also organises in-house days for companies. One interviewee described in-house days as a "possibility to hear from the industry what they want from the UMC. In-house days enable us to

create some push marketing instead of pull; it creates a market not only for the patents but for the scientists' expertise as well".

Three TTOs manage a seed fund from which spin-offs or scientists can receive funding to further develop their products. The interviewees from the UMCG TTO mention maintaining contact with alumni as a marketing instrument. People who have studied in Groningen seem to keep a strong bond with the city. Whenever an alumnus has an invention, the TTO hopes he will approach the TTO for assistance. The UMCU TTO mentions the fact that they help SME's in receiving grants and additional government funding.

### Commercialisation

Commercialisation is the last phase in the valorisation process. Table 11 presents the activities that TTOs perform in this phase.

| Commercialisation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Activity** | **Mentioned by** | | | | | | | |
| Licensing | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| Spin-off | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| Commercialising expertise | AMC | EMC | LUMC | MUMC | UMCG | UMCN | UMCU | VUMC |
| Business & Science park / Incubator | | | LUMC | MUMC | UMCG | UMCN | UMCU | |
| Contract research | | | | | UMCG | | UMCU | |
| Private clinics/independent treatment center | | | | | | UMCN | UMCU | |
| Protocol development | | EMC | | | | | | |

**Table 11: Activities during the Commercialisation phase**

All UMC TTOs engage in licensing, spin-off activities and commercialising expertise (e.g. consultancy agreements for UMC staff). Licensing is the most important task in the commercialisation phase according to all TTOs as this is an effective way of creating economic value out of intellectual property. The license deals can be very sophisticated, including different varieties of royalty distributions between inventor, UMC and TTO and non-shelving clauses, preventing companies only to buy an exclusive license for a technology that is competitive to their own technology, making it impossible for the new technology to enter the market.

The support that TTOs offer to spin-off creation varies from informing UMC staff about the possibilities and referring them to the Chamber of Commerce, to writing a business plan, forming a professional board of directors and providing office space in the TTO's incubator.

The third commercialisation tool all interviewees mention is commercialising expertise. Consultancy agreements are the most common form of commercialising expertise and can be a useful addition to a department's research budget. Other forms of commercialising expertise are

for example providing laboratory or imaging services to third parties. Companies do not need to have all the equipment and expertise themselves and a UMC's department can generate extra income with the know-how and equipment already available.

Five TTOs mention a business and science park or business incubator as a commercialisation activity. The goal of a business and science park is to enhance the cooperation between companies and UMCs by physically placing the companies close to the institutions. Incubators are meant to stimulate spin-offs (and sometimes other start-ups such as engineering companies as well) in their development by providing business support and services. Many of the interviewees mention the LUMC as example of a UMC with a very successful business and science park. During the interview at the LUMC TTO, it became clear that the development of the business and science park was not stimulated at all by the LUMC or its TTO; it were the companies that made the business and science park into the success it is today. The interviewee believed that Leiden's location (in the middle of the Randstad area, close to Schiphol airport) and the history of the Leiden University (being the oldest university in the Netherlands, established in 1575) attribute to the popularity and success of the business and science park.

Some TTOs provide services in the field of contract research (mostly drug development). Contract research is usually managed by a separate agency, for example the Clinical Trial Center Maastricht (MUMC) or the AMC Medical Research B.V. (AMC). Two interviewees mention the formation of independent treatment centres as a commercialisation activity. Independent treatment centres enable physicians to perform standard procedures efficiently but there is no real new research or creation of new knowledge involved.

Although not creating significant economic value, the EMC TTO mentioned the development of protocols. By doing this, they share their knowledge and the healthcare improves based on evidence based practice. Via protocols, methods of treatment are standardised between hospitals. The Daniel den Hoed clinic is a very good example as it is specialised in oncology and can share its knowledge on treatments by protocols.

*Note: after completing the interviews, the Eye Hospital Rotterdam announced that it will set up a franchise in which other hospitals get the opportunity to open a 'department' of the Eye Hospital (Baltesen, 2010).*

*This as well is a method of knowledge valorisation, but this knowledge is in the field of management and business administration. Therefore, it falls out of the scope of this research.*

### 4.2.2. Challenges

The Dutch TTOs face various challenges. During the interviews, staff size and the difficulty to find skilled staff was a recurring topic. Another challenge is the delay customers experience when involving the TTO. This causes difficulties in cooperation between the TTO and scientists but also in the cooperation with third parties. Non-cooperating scientists do not disclose their inventions so internal marketing is very important. Also, whenever a scientist does not wish to cooperate during the valorisation process, the TTO cannot work effectively. The last great challenge is the discrepancy between funding possibilities for spin-offs which makes it difficult to meet all the conditions that come with the funding.

#### TTO staff size

Given the size of the average TTO, it is hard to give enough attention to the employees and their demands. It makes it even harder to be proactive towards the researchers. The TTO wants to be the liaison between the researcher and the industry. Almost all TTOs indicate that they need extra staff to enable this change from reactive to proactive.

#### Eliminating delay caused by the TTO

The TTO is focussed on protecting intellectual property and secrecy whilst scientists pursue publications and maximising the related citation and impact scores. Whenever a TTO demands to review an article before it is published to scan it for potential intellectual property, this may cause a delay in the opinion of a scientist. Although both the scientist and the TTO work for the same organisation, cooperation may be difficult on this subject. According to the interviewees, the key to solving this problem is that scientists contact the TTO in an early stage. The TTO does not necessarily need the final version of an article in order to review it. A near-final draft usually gives enough information, the TTO has enough time to protect any potential intellectual property and the scientist does not experience any delay in publication of his article.

Agreements with third parties are another example. A significant amount of the TTO efforts go into contracts with third parties (e.g. material transfer agreements, confidentiality agreements and consultancy agreements). These contracts have a great danger of IP leakage. In these contracts, the parties arrange the subject and scope of the cooperation. If the scope is too broad, the other party may gain access to knowledge owned by the UMC without paying for it. One of the TTOs mentioned that the UMC is implementing a change in their internal policy so that IP-leakage is

stopped. The policy implies that all agreements are subject to an obligatory review by the TTO before signing a contract. The problem with implementing this policy according to the interviewee is that professors in Europe are free in the research they perform without internal review mechanisms, so the policy is expected to generate quite some resistance from scientists.

### Non-cooperating scientists

According to an interviewee, scientists usually overrate their ideas and findings. A TTO sees that without a transformation of the finding, it has little to no value. For successful valorisation, it is of utmost importance that the researcher is involved in the valorisation process. If for example a researcher does not wish to cooperate by validating its preliminary results with a larger number of subjects, validation becomes impossible.

### Financing possibilities

To start a new company, there is a great number of financing possibilities, but all of these options have their own conditions that sometimes cannot be met at the same time. Some are only granted to an individual inventor; others are focussed on a company or have restrictions regarding other funders.

### 4.2.3. Vision for the future

The Dutch knowledge valorisation policy is heavily based on the 'old' idea that intellectual property must be protected by a patent that can be commercialised through a license or a spin-off. These are therefore defined as the core tasks of all TTOs; their valorisation performances are also evaluated based on the patent portfolio, licensing and spin-off creation.

There are four changes the interviewees often mentioned that can improve the quality of knowledge valorisation in the Netherlands. These are:

1. Closer cooperation between Dutch TTOs through networks
2. External marketing focus
3. Structural funding for TTOs
4. Focus on SMEs as the main source for innovation

**Closer cooperation between Dutch TTOs through networks**

The interviewees are ambivalent on the subject of how cooperation between Dutch TTOs can be improved. Every interviewee emphasises the importance of being close to the scientists and the mother-institution. However, a number of interviewees think that there is room for improvement in the way Dutch TTOs work together. The views on this subject vary from 'cooperation is very useful, but not necessarily on a national level', via 'regional cooperation is the most efficient option' to 'one central TTO for all the universities in the Netherlands would be the best option'. Together with these different views, the interviewees disagree about location. Some interviewees feel that a central TTO can combine all the valorisation activities. This gives companies one point of contact for all their research activities in the Netherlands. One interviewee mentions the London area and Singapore as successful examples of such cooperation.

Only a few interviewees mentioned the option of one TTO for the whole of the Netherlands, but this option has many practical problems. (Not close to the scientist, not the same involvement as someone within the same organisation) The main disadvantage of one central TTO is that the TTOs are not close to their internal customers so it is impossible to approach the scientists individually. An alternative is that TTOs cooperate on a regional level. This is a legitimate option for the UMCs situated in the Randstad-area but less practical for e.g. the Maastricht UMC or the UMC Groningen. It is interesting to notice that these 'isolated' UMCs do not see their physical distance from other UMCs as a problem. International cooperation between scientists via the

Internet and e-mail are very common nowadays. The physical distance is no issue anymore. These TTOs feel that they should be able to cooperate in the same way as scientists do.

### External marketing focus

Most TTOs are still in the process of informing and convincing their internal customers about the quantity and quality of services they provide. By being well known to their internal customers, the TTOs hope to achieve more disclosures, more patent applications and more success. However, as the focus in their early phase of existence is very much on the internal marketing, the result is that TTOs spend less time on their external customers.

Creating push instead of pull is the wish of a number of UMC TTOs. They want to be more proactive towards the industry, creating a market not only for the patent portfolio but for the scientists' expertise as well. This is very hard when most effort goes into the relation with the internal customer.

### Structural funding for TTOs

TTOs are judged on their valorisation activities. This means that a TTO is considered to be more successful when it creates a significant amount of spin-offs. Their funding is also based on the success of their valorisation activities. At an American university that is considered to have a very successful TTO, the TTO creates one spin-off for every $ 90 million spent on research. With the research budget of Dutch UMCs, this would mean that a TTO does not even have to establish one spin-off per year on average to be as successful. E.g. the AMC had a research budget of € 52 million in 2008; for the LUMC this was € 55 million (AMC, 2009; LUMC, 2009).

Furthermore, the TTO output is usually seen as a formula of the research budget. The expectation is that this formula is exponential, i.e. whenever a UMC is successful in acquiring more funding for their research, the TTO should deliver an even greater result in valorisation. The interviewees describe the correlation between research budget and valorisation output as 'linear at best', but certainly not exponential. TTOs should focus on entrepreneurship, put the customer in first place and provide all possible services. The only factors the UMCs often consider are the number of patents and licenses. The impact on society is not taken into account, nor do people look at the amount of IP that is protected by the TTO that otherwise would have been published or leaked.

The interviewees feel that the the performance indicators do not match with the goals that UMCs define for TTOs. The interviewees believe that the main solution for this problem lies in the way TTOs are funded. As with healthcare and education, for which a UMC receives structural funding, a small part of the structural research budget and acquired grants should be earmarked for valorisation activities. This guarantees the continuity of the TTOs and enables TTOs to focus on the goals and services set out for them in policies.

**Focus on SMEs as main source for innovation**

Examples of popular stimuli in research cooperation between academia and industry are public-private partnerships such as CTMM and BMM, and the 7th framework programme of the European Union. These stimulation programmes focus mostly on cooperation with large enterprises such as Philips and Schering-Plough. The interviewees have the opinion that, although these programmes certainly stimulate the research flow, the most important source of innovation and research flow are small and medium enterprises (SMEs). The European framework programmes are usually favourable towards the academic institutions but some interviewees describe the public-private partnerships as a disaster for the UMCs. The IP usually ends up with the large industrial partners. The government invests a significant amount of money to stimulate companies to innovate, but gives little attention to the output and whether it is valuable in more than an economic way (i.e. job creation). This kind of output will be higher when UMCs and SMEs cooperate and the government focuses its stimulation programs towards cooperation between academia and SMEs.

## 4.3. Peers - MIT and KU Leuven

Whenever the interviewees referred to a TTO they consider as a best practice, two TTOs were mentioned, the TTO of the Massachusetts Institute of Technology TTO in Boston, USA (MIT TTO) and the Catholic University of Leuven TTO (KU Leuven TTO) in Leuven, Belgium.

According to the interviewees who worked in the US, the MIT TTO does not support any spin-off activity as it is not necessary for the TTO. The MIT creates enough 'critical mass' to be interesting enough for third parties. Whenever companies are interested, they will buy a license and start their own company. The philosophy of MIT is that their technology does not need to be placed in a spin-off.

The goal of a spin-off usually is to further develop the technology, making it ready to be commercialised. It did not become clear during the interviews how it is possible that the technology at MIT does not need this kind of development. As individual TTOs in the Netherlands do no have this kind of 'critical mass' to attract the industry, spin-offs are a necessary instrument for knowledge valorisation in the Netherlands.

The European counterpart of the MIT TTO is the KU Leuven TTO. A number of interviewees mentioned the KU Leuven TTO as a good example of a TTO that has a holistic way of working. The KU Leuven TTO does not only offer the core valorisation services but also provides other related services that not necessarily have any direct economical results. The KU Leuven supports scientists by providing grants management and contract research. Also, the KU Leuven TTO provides data management and statistic services etc. Annex V presents a summary of the services the KU Leuven TTO provides. In short, for the researchers at KU Leuven, there is one desk where they will find full support for all of their research. This way, the KU Leuven TTO stays close to their customers, is visible to them and can offer visible added value to the research.

All these factors are mentioned by the interviewees as challenges. The policy also describes a desired level of service from TTOs that resembles the service level of KU Leuven TTO. We suspect that due to the location of the KU Leuven, the environment in which its TTO acts strongly resembles the environment of Dutch TTOs. We think that of these two good practices mentioned during the interviews, KU Leuven TTO is a best practise example for Dutch TTOs.

# 5. Conclusions

**This research has not explored a transition of the Dutch economy from a managed to an entrepreneurial economy but the interviews do indicate such a shift. This follows mostly from the recommendations given by the interviewees on how to improve the quality of valorisation in the Netherlands. Acs & Stough (2008) identify three major changes that show a transformation into an entrepreneurial economy. These are: Small Firm Innovation, Individual Manages Own Career and Networked Structure. The fact that multiple interviewees mentioned SMEs as the most important source of innovation instead of large international firms and that they feel that cooperation between TTOs through networks is very important to improve the quality, indicate that the Dutch economy at least has some entrepreneurial characteristics.**

Given that most TTOs are modelled in the traditional way, positioned centrally within the organisation, mostly focussed and judged on patenting and licensing, it is possible that there is a discrepancy between the policy and management regarding TTOs and the demand from the external market and internal customers.

## 5.1. Desk research

The desk research consists of a scan of the relevant policy and an analysis of the annual reports published by the UMCs. The policy documents show that the quality of Dutch research is excellent but the economic value arising from that research lags behind. Policy on knowledge valorisation is aimed at eliminating this discrepancy. The policy documents describe the desired situation in which a centralized TTO offers many services to internal and external customers and helps to improve the knowledge valorisation process.

The UMCs commit themselves to publishing data on knowledge valorisation in their annual reports. The desk research has proven that this data is incomplete and not presented in a transparent way. The data shows an increase in the importance of knowledge valorisation and the urge for UMCs to report on their achievements.

### 5.1.1. Policy

Every document concerning the research and valorisation climate concludes that the standard of Dutch research is excellent (Interdepartementale Programmadirectie Kennis en Innovatie, 2009; NFU, 2009). For the healthcare in particular, the NFU (2008) even reports that the impact and citation scores of the Dutch UMCs are above average in every research area.

The problem is that these indicators are focussed on the scientific quality of the research and do not give any insight on economic value or practical use of the published findings. The performance indicators defined for TTOs are based on the old model of the managed economy in which the TTO protects knowledge with patents and commercialises it by licenses and patents. There are no other performance indicators defined for TTOs although parties agree on a number of other very important tasks for TTOs such as stimulating entrepreneurship and establishing research relationships between the institution and the market (Interdepartementale Programmadirectie Kennis en Innovatie, 2009).

### 5.1.2. Annual reports

The annual reports show a trend in presenting information on knowledge valorisation. In 2002 the first UMC started reporting on patents and in 2008 all UMCs except one reported on valorisation indicators. The MUMC has placed its patents in a separate company and therefore these valorisation indicators are not a part of the MUMC's annual report. Although the quantity of reported valorisation indicators has increased steadily, the reporting quality is insufficient, not transparent and incomplete.

In 2003, Arundel, Bordoy and Van der Steen recommended creating a more transparent policy concerning knowledge valorisation in public institutions (Centraal Bureau voor de Statistiek). The NFU has anticipated on the growing demand of transparency by formulating guidelines on knowledge valorisation and how to report on the indicators (2008). The annual reports however show a very mediocre quality in reporting valorisation indicators concerning patents, licenses and spin-offs. Although almost all UMCs report on patenting activities, only three reported the number of expired patents and the number of licensed patents in 2008. Given the attention that goes to knowledge valorisation, we would expect the UMCs to transparently report on the results of these efforts.

We also noticed a significant amount of corrections in annual reports concerning previous years and even some discrepancies in historic overviews. It is possible that at the time of creating the annual report, there are still a number of patent applications being processed and it is acceptable

to correct this number in the following year. This is no excuse for discrepancies in tables presenting data from previous years. We are not sure whether these discrepancies are caused by changes of definitions or to change the perspective on the presented data. Because of this limited data set it is difficult to draw reliable conclusions on the subject. Therefore, the conclusion in the sections below may be seen as indecisive.

### Active patents

As the average number of patent applications fluctuates heavily over the years, we can only conclude by mentioning the growth of the absolute sum of reported active patents. The reported sum has grown significantly over the last years. The reported sum increased with 52 patents in 2008 compared to 2007. These are the only years that six UMCs have reported on this indicator. This increase means an average growth of 8.67 patents per UMC. Again, we can not say whether this growth is caused by TTOs applying for more patent or by the growing attention given to the subject.

### Patent applications

The average number of patent applications has grown consistently over the years. Although we can not eliminate bias caused by improved reporting on the subject, we suspect that this growth is caused by the TTOs.

### Expired patents

Only three UMCs have reported the number of expired patents in 2008. The number of expired patents is an important indicator for the patent portfolio management as it represents the refreshment rate of the portfolio. We would advise UMCs to structurally report on this indicator in their annual reports.

### Licensed patents

Again only three UMCs report on this indicator for 2008. Although the average number of licensed patents decreases from 2006 to 2008, we do see an increase per UMC in number of licensed patents. The data is too incomplete to enable us predicting a trend, but it seems that TTOs start to take the commercialisation of patents seriously.

## 5.2. Interviews

The interviews were a very valuable source for new insights and gave an overall view on the knowledge valorisation activities the TTOs perform. It is positive to see that all UMCs acknowledge the importance of knowledge valorisation and therefore have established a TTO. Although a decentralised TTO is considered to be more successful (Debackere & Veugelers, 2005), all UMCs have a centralised TTO. BioMedbooster, the TTO of the MUMC is the only TTO that is deliberately positioned as a for-profit organisation outside of the UMC structure.

It is interesting to see that in literature it is acknowledged that a skilled TTO staff increases its efficiency but that it is hard to find good staff. During the interviews, almost all interviewees mentioned this as a challenge. The following paragraphs discuss the interview results.

### 5.2.1. Knowledge valorisation process

Every UMC has a central UMC that coordinates the knowledge valorisation process and all TTOs perform activities in the phases of the knowledge valorisation process. What we see is that internal cooperation has impact on all phases. The TTOs focus on internal marketing and still not all scientists disclose their inventions to the TTO (identification & protection). As a result of their focus on internal customers, TTOs have less time to improve their external contacts (marketing) and commercialisation can be frustrated by non-cooperating scientists. This blocks TTOs in their task to function as a link between industry and science as described by Debackere & Veugelers (2005).

It is worth noticing that all TTOs perform one or two standard tasks per phase. The other activities differ greatly.

#### Identification

All TTOs perform screening activities but there is no standard procedure that all TTOs use. Furthermore, all TTOs stress the importance of entrepreneurial scientists, but only three interviewees mention some sort of in-house course, informing the employees about the do's and don'ts of knowledge valorisation. Debackere & Veugelers (2005) recommend implementing an active knowledge management policy. It seems only a few TTOs have done this.

Another factor of importance is the early involvement of a TTO. As most of the knowledge arises from government and charity funded research, one would expect TTOs to be involved in, or at least provide services aimed at, grant support. Only two interviewees mentioned this as a TTO activity. Three interviewees explicitly claimed that providing grant support was not a task of

the TTO and that they were glad the TTOs did not have to bother with that kind of work. It is plausible that the involvement of TTOs would increase when a small part of government funding would be earmarked as funds for the TTO, aimed at knowledge valorisation as is suggested by Swamidass & Vulasa (2009).

### Protection

Protection is the most important phase in the knowledge valorisation process because unprotected knowledge has little to no economic value. All the UMCs have put the TTO in control of their patent portfolio, regardless of its legal entity or position within the organisation. All TTOs provide patenting services to the employees. Four interviewees explicitly mention revising IP-clauses for public-private partnerships (PPPs). According to the interviewees, PPPs stimulate cooperation between industry and academia, but at the same time this cooperation has a great danger for IP leakage.

### Marketing

Again, there is one activity that all interviewees mention for the marketing phase, the technology assessment. The goal of such an assessment is to investigate the market potential of a technology and is crucial in determining the economic value.

One of the most interesting marketing activities is the cooperation within the Life Sciences Centre Amsterdam. This is a virtual partnership in which the AMC and VUMC cooperate together with other research institutions from the Amsterdam area.

We recommend that TTOs do not only invest in staff that has experience in patenting and legal affairs. As Swamidass & Vulusa (2009) mention, the lack of trust in TTOs among researchers comes partially from the fact that TTOs are not capable of marketing a new technology from scratch. TTO staff with expertise in this field could improve the results and image of a TTO.

### Commercialisation

Although all TTOs engage in licensing, spin-off creation and commercialising expertise, the most important of these three tasks for all TTOs is licensing. The interviewees describe it as an efficient mechanism to transform intellectual property into economic value. Another benefit is that it requires a relatively small investment from the UMC and the financial risk is very low as well.

Support for spin-off and commercialising expertise differs greatly among the TTOs; some TTOs actively scout a board of directors while others only advise scientists on funding opportunities and business plans. Commercialising expertise requires little effort from the TTO and the return is relatively small compared to a license or spin-off.

When we discussed the concept of a business and science park, all interviewees mentioned the LUMC and its business and science park as a best practice. However, during the interview at the LUMC, it became clear that neither the LUMC nor the TTO had put much effort in creating the business and science park. It was the companies that came to the LUMC, probably because of its good name and central location in the Netherlands. Obviously, these factors are difficult to duplicate for the other TTOs.

As Sachwitz Apple (2008) mentions, it is important that TTOs focus on small firm innovation (cooperating with SMEs and creating spin-offs) rather than large firm innovation (e.g. commercialising expertise and contract research). We feel that TTOs should emphasise on this cooperation. TTOs can have a leading role in this process.

### 5.2.2. Challenges

As most TTOs had a relatively small staff, a majority of the interviewees mention it as a challenge and the TTOs with a relatively large staff complain about the difficulty to find capable staff employees in the Netherlands. There is a significant number of researches that acknowledge this is a problem (Debackere & Veugelers, 2005; Swamidass & Vulasa, 2009).

TTOs function as a liaison for valorisation activities. Some parties experience this as an obstruction within the knowledge flow because they have to involve the TTO. Some UMCs implement policies to prevent scientists from bypassing the TTO. Although this is a good decision (Debackere & Veugelers, 2005) it is hard to form such policy as national legislation does not allow a UMC to impose such restrictions on its employees.

### 5.2.3. Vision for the future

The interviewees mentioned four important changes for the future, improving the knowledge valorisation process and the entrepreneurial climate in the Netherlands. These are:

1. Closer cooperation between Dutch TTOs through networks
2. External marketing focus
3. Structural funding for TTOs
4. Focus on SMEs as main source for innovation

**Closer cooperation between Dutch TTOs through networks**

All interviewees agree that the cooperation between TTOs has to be improved. As the formation of one TTO for all UMCs and universities in the Netherlands probably is not possible, the preferable option is that TTOs form regional networks. By cooperation, TTOs can standardise their services, make these more efficient and thus improving the Dutch valorisation structure towards a more entrepreneurial economy (Sachwitz Apple, 2008).

**External marketing focus**

Because TTOs are a fairly new concept in the Netherlands, their focus is more on internal marketing then on their external partners. As globalisation causes more competition in the life sciences, good contacts between UMCs and companies are essential for successful valorisation.

**Structural funding for TTOs**

Most TTOs receive funding from the UMC, but the general philosophy is that TTOs must become self providing within a few years. Almost every interviewee mentions this as a great risk. The idea behind this funding is that TTOs only need support in their start-up phase but afterwards can fund themselves with the income that comes from the deals they make. Most interviewees think that this is not the case and that TTOs need structural funding. This opinion is supported by literature (Swamidass & Vulasa, 2009). If a TTO must become profitable, chances are that TTOs will only focus on the profitable activities and will stop providing services that do not give a profitable return on the time they invest. Examples of non-profitable activities are consultancy agreements and revising IP clauses for public-private partnerships.

**Focus on SMEs as main source for innovation**

Most stimulation programs are aimed at improving cooperation between academia and international companies such as Pfizer or Philips. These incentives improve the flow of knowledge from academia to industry, but according to the interviewees real innovation power can be found with small and medium enterprises. The research by Sachwitz Apple (2008) confirms this opinion.

**Lessons to be learned from MIT and KU Leuven**

Can Dutch TTOs draw any conclusions from the examples of MIT and KU Leuven? It is hard to say as one offers a very broad palette of services (KU Leuven TTO) and the other only focuses on licensing (MIT TTO).

What concept would fit the Dutch situation best? The main wish for the future of most TTOs is to provide excellent services to the scientists. The emphasis will be on internal marketing and with that in mind; the Dutch TTOs could take an example from KU Leuven as it is very much focussed on the internal market whilst being very successful in knowledge valorisation.

## 5.3. Recommendations and critique

The first and most important recommendation is on providing information. The UMCs should start with standardising their annual reports. A correction of the number of patents in a previous year is acceptable, but the fact that the number of promotions fluctuates as well, is an indicator that the administration is below standards.

The TTOs mention close cooperation as a strong wish but it is always 'the other one' that does not want to cooperate. All interviewees acknowledge that their quality of services would improve if they would cooperate. The interviewees all feel that the TTO must have a leading role in cooperation between UMCs in the field of knowledge valorisation. There seems to be some reluctance among the TTOs for cooperation. The Amsterdam-region shows some level of cooperation and can be described as a 'reasonably good practise'. The TTOs can learn from each other about organisational change and internal customer relations, create standards for their activities and define performance indicators. Most important, TTOs can act as one party towards the industry, creating a national research network and creating critical mass needed to stay ahead of upcoming Eastern-European countries.

All TTOs provide the same basic services (screening, patenting and licensing). The other number and quality of other services differ greatly between TTOs. Standardisation does not only provides

a minimum level of quality towards internal customers but also helps in gaining confidence from external parties who rely heavily on standards such as ISO certification or Good Clinical Practise. Lastly, standardisation saves time. Whenever a contract is negotiated and there is one standard draft agreement that complies with all laws and regulations, this standard agreement only needs to be modified in detail for different parties. A good start would be if the TTOs standardise the IP paragraphs for different kinds of agreements.

As for differentiation in services, TTOs should look at the different services their colleagues provide. The atmosphere during the interviews was very informal and the interviewees were very proud on the specific services provided at their TTO. This knowledge can and must be shared and we believe the TTO staff is willing to do so if this sharing of information is reciprocal.

Another recommendation is that TTOs are very much focussed on keeping the internal customers satisfied. This usually means that TTOs try to take over as many tasks as possible from the scientist. This is very noble but does not stimulate scientist entrepreneurship and goes against the very nature of scientists who want to be in control. As good as TTOs can be, the best representative for any institution is an entrepreneurial scientist who will ask for help from the TTO whenever it is necessary. Furthermore, scientists who have a basic understanding of knowledge valorisation can prevent a serious amount of corrections by the TTO.

## 5.4. Reflection

Although we have learned a lot from this research, it is strongly biased. The literature is not focussed on the Dutch situation in particular nor does it covers only the life sciences. The interviewees are all staff members of the TTO and that too can give a strong bias. Because of organisational difficulties, we did not perform an additional survey among other stakeholders to verify the claims and opinions of the TTO interviewees.

The conclusions and challenges we discuss are reliable to a certain extent. Obviously the 'smaller' TTOs mention staff size as a problem but every TTO, even those with a large staff agree on the fact that it is very hard to find skilled personnel with relevant working experience in the Netherlands.

Another comment was the discrepancy between policies regarding knowledge valorisation and the indicators to measure the success of TTOs in their work. We would recommend policy makers discuss the policy with the stakeholders to create consensus on the expectations.

## 5.5. Recommendations for further research

As the creation of one TTO for all the Dutch UMCs (or even for all Dutch universities) is improbable, it is best to focus on a consistent policy which all TTOs implement. TTOs should learn from each other and do not need to reinvent everything themselves. This eases cooperation and improves the services that TTOs provide because the TTOs can focus more on their core business. In this light, we would recommend performing policy-oriented research with a multidisciplinary discussion to test to what extent other stakeholders share the problems of TTOs and whether it is possible to connect the policy and management in Dutch knowledge valorisation to the desired output.

We have based our research framework on international literature and this may be a good starting point for a more regional approach. As the KU Leuven TTO is mentioned several times as a successful TTO, the KU Leuven TTO might be a good example of a best practise. A research that tests this hypothesis and performs a more in-depth comparison of Dutch TTOs with the KU Leuven TTO can explain why the KU Leuven TTO is more successful that its Dutch counterparts.

Another point of interest is the claim that true innovation can be found at SMEs instead at large multinationals. Is this a statement aimed at creating support for spin-offs from the UMCs themselves or is this true for the whole group of SMEs? A good starting point would be the considerations that underpin the programs aimed at stimulating cooperation between academia and industry; do these programs give an advantage to large enterprises over SMEs or is that just an opinion of the interviewees.

# Annexes

# Annex I-a: Interview Protocol

**Interviewprotocol**

Bedoeld als ondersteuning van de semi-gestructureerde interviews die afgenomen gaan worden met sleutelfiguren binnen de Technology Transfer Offices (TTOs) verbonden aan de acht Universitair Medische Centra (UMCs) in Nederland

Interviews duren 60 à 90 minuten en tijdens deze interviews worden onderstaande punten ter sprake gebracht. De structuur van een semi-gestructureerd interview geeft interviewer en geïnterviewde de mogelijkheid om dieper op bepaalde zaken in te gaan.

Onderstreepte vragen worden gesteld; bullets geven aan welke zaken aan de orde dienen te komen bij die vraag, **dikgedrukte punten** geven belangrijke thema's aan;

Meenemen naar ieder interview: **memorecorder**, **reservebatterijen**, **notitieblok+pen**, **interviewprotocol**, **adresgegevens** voor geïnterviewde, schema "**van Idee naar IP**", **afspraakbevestiging**.

Opzet interview:

**Vooraf & introductie**
UMC en TTO; introductie
**Taken / Verantwoordelijkheden TTO**
**Werkwijze Valorisatie**
**Voorbeelden uit de praktijk**
**Onderscheidend vermogen TTO**
**Toekomstvisie**
**Afronding**

Versie 2.0
Juni 2009

**Vooraf & introductie:**

- Bedanken voor tijd, akkoord met opnemen gesprek?
- Algemeen doel: meer te weten komen over werkzaamheden TTO en kennisvalorisatie binnen het UMC
- Verloop gesprek *(wederzijdse introductie, UMC algemeen, TTO binnen UMC, werkzaamheden TTO, Valorisatie en wvttk)*

Gesprekspartner hiermee akkoord?

Introductie interviewer:

- Student UT, werkzaam bij AMC
- Masterscriptie valorisatie vanwege interesse & nieuwsgierigheid naar verschillen UMC's. Geen/weinig literatuur over NL gevonden.
- Besloten daarom scriptie hierover te schrijven.
- Interviews met key personnel en zou graag een enquête willen verspreiden onder klanten en medewerkers *(komt later nog ter sprake)*
- Uitnodigen gesprekspartner om zich te introduceren

Introductie gesprekspartner (Functie binnen TTO, Aantal jaren werkzaam)

UMC en TTO; introductie
Wilt u iets vertellen over de historie van het UMC en het TTO?
*(afwachten in hoeverre de gesprekspartner ook ingaat op de geschiedenis van het UMC; niet van groot belang voor onderzoek, toch zeker interessant)*

- TTO, wanneer opgericht?
- Hoe geregeld voor die tijd?
- Veranderingen die persoonlijk zijn opgevallen?

Hoe is de situatie tegenwoordig? (TTO nu)

- Positie binnen organisatie? (Centraal/decentraal)
- Wat zijn de missie en doelstelling van TTO?
- Samenstelling personeelsbestand *(juristen, business managers e.d.)*

**Taken / Verantwoordelijkheden TTO**

Waar bestaan de werkzaamheden van het TTO uit?
*Welke van de 9 TT mechanismen (Lee, 2004) worden genoemd? Degenen die niet worden genoemd, ter sprake brengen, doorgaan op de 3 à 4 meest belangrijke (volgens gesprekspartner)*

9 TT Mechanismen

- □ Collegial interchange, conference, publication
- □ **Consultancy and technical services** provision
- □ Exchange program
- □ Joint venture of R&D
- □ **Cooperative R&D agreement**
- □ **Licensing**
- □ **Contract research**
- □ **Science park, research park, technology park or incubators**
- □ Training

Hoe geeft het TTO invulling aan het identificeren, beschermen, vermarkten en commercialiseren van intellectueel eigendom?
*Gesprekspartner vragen per onderwerp hoe daar invulling aan gegeven wordt.*

TTOs play an active role in commercialising university research by (Djokovic, 2008)
- identifying,
- protecting,
- marketing and
- commercialising intellectual property developed by faculty

**Werkwijze Valorisatie** (eigen schema)
*Checken of gesprekspartner zich kan vinden in schema, geef hem/haar een eigen versie, het kan zijn dat hij/zij er aantekeningen op maakt die nuttig kunnen zijn*

Kunt u aan de hand van het schema aangeven hoe hier invulling aan wordt gegeven?

Screening
- Op zoek naar kansen?
- Wachten op onderzoekers?

(Medical) Technology Assessment
- Gestructureerd?
- Terri Young? (Profit/efficacy)

Protection
- Geheimhouding
- Octrooi

Commercialisation
- Licensing
- Spin-Off
- Other…?

**Voorbeelden uit de praktijk**

Kunt u één (of twee) succesverhalen omschrijven?
- Succesfactoren
- Betrokken partijen
- Waarom is het een succes? (financieel, maatschappelijk relevant, speerpunt)

Kunt u een minder geslaagd project omschrijven?
- Factoren van invloed
- Betrokken partijen
- Welke lessen zijn er te leren?

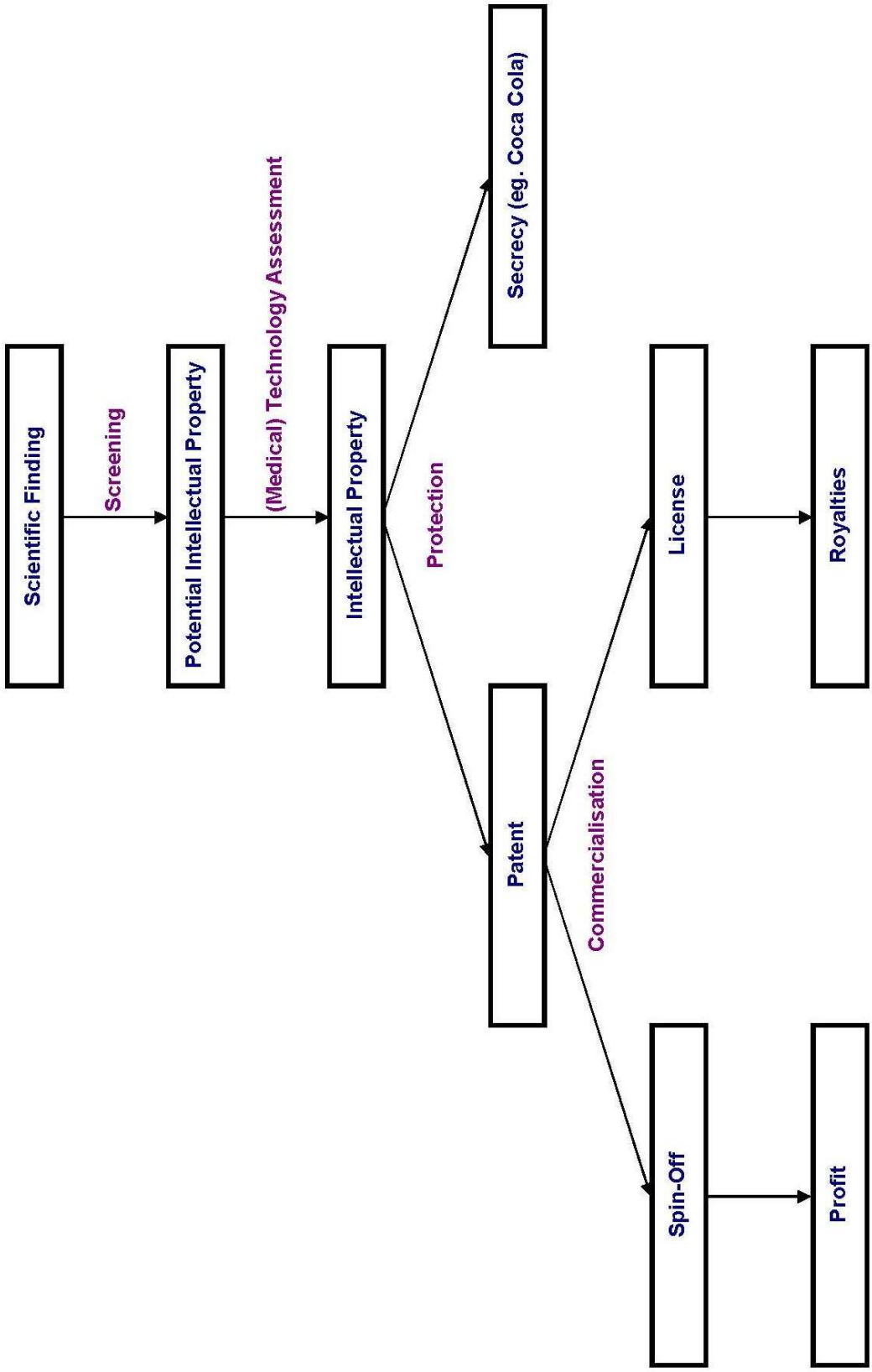
**Wat onderscheidt dit TTO van de andere TTOs?**

**Toekomstbeeld?**
- Voor het TTO in diensten en als organisatie
- Voor het valorisatiebeleid in NL

**Afronding (indien nodig/niet aan bod gekomen)**

Is het mogelijk dat ik relevante documentatie ontvang m.b.t. productiecijfers e.d.?
- FTE, budget, omzet, jaardocument

## Annex I-b: From Idea to IP



# Annex II: Literature reviews

## "Evaluating University Technology Transfer Offices"

*by K. Sachwitz Apple (2008)*

This research forms a chapter of the book "Public Policy in an Entrepreneurial Economy". The paper starts with introducing TTOs as departments within institutions with the mission of supporting staff in developing and commercialising their inventions. The usual form of a TTO was a centralized office to which the inventions were disclosed, the TTO would then patent it and license it out to large companies or the TTO would form a spin-off company. The goal of the research is to evaluate whether this 'classic' model of a TTO is ready for the shift to an entrepreneurial economy.

The rise in the number of established TTOs in the US started after the passing of the Bayh-Dole act in 1980. The increase in TTOs was gradual as it took some universities years to establish a TTO because of budgets and complex organisational changes that were necessary.

The general model implemented by most of the universities is the Traditional University Technology Development Model. This model is depicted in Figure 2 (Acs & Stough, 2008).

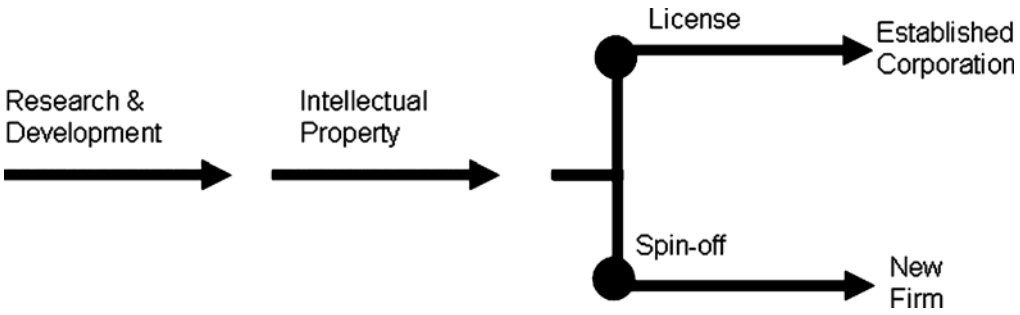



**Figure 8: Traditional University Technology Development Model**

The first step is research and development, performed by the institution's employees. This R&D can lead to intellectual property that, when promising, can be patented. Most universities have delegated the task of patenting to a TTO and this means that the institution's employee has to disclose his invention or finding to the TTO. Other models include a dean or head of department that with external legal counselling is responsible for the patenting process.

After the patent is granted to the institution, their intellectual property is protected. The institution is now in a position to try to turn this patent into economic value. The two traditional ways of doing so are to license the patent to an established company, allowing that company to develop the innovation; the second possibility is to create a spin-off company to exploit and possibly further develop the invention.

The transformation from a managed to an entrepreneurial economy includes a number of shifts. Three important shifts that are identified in the research are presented in Table 2.

| Managed Economy | Entrepreneurial Economy |
|---|---|
| Large Firm Innovation | Small Firm Innovation |
| Corporation Lifetime Jobs | Individuals Manage Own Career |
| Hierarchy Structure | Networked Structure |

**Table 12: Three shifts in the Entrepreneurial Economy**

The paper evaluates whether universities have adapted to the entrepreneurial economy. The researcher does this by posing three hypotheses based on the three aforementioned shifts. These hypotheses are:

H1: The university TTO is focused on small firm formation
H2: The university TTO policies support individual career management
H3: The university TTO is a networked organisation

H1 is tested by looking at the focus of TTOs; is it on licensing out patents to large companies or do TTOs stimulate the creation of spin-offs? The conclusion based on the case studies is that TTOs are not specifically focussed on spin-off creation and that even for an employee that wants to start a spin-off, the cooperation with his colleagues from the TTO can be a long-term struggle.

H2 implies that the TTO forms policies on how employees of the institution as a whole are stimulated and facilitated to take time off to explore entrepreneurial activities, related to their field of expertise. This policy can be compared with the well established policy for sabbaticals at universities in the US. However, in her research, the author already states that it is not the TTO but the university itself that puts such policy in place. The hypothesis that TTO policies support individual career management is found to be true but minimal.

H3 states that university TTOs that adapt to the entrepreneurial economy are networked organisations. The elaboration of this definition shows that traditional TTOs do not meet this definition as they are central departments within the organisation, funnelling all knowledge valorisation activities; they are in no way spread out through the hospital or the external environment, lacking contact with their customers. Hence, H3 is found to be false as well.

Based on the analysis and results, the author makes three recommendations. These are that TTOs should focus more on small firm creation as an important source of qualitative and fast knowledge valorisation. Second, universities should improve their policies so it becomes more attractive for employees to develop entrepreneurial activities that do not directly contribute to their research activities. Third, the total structure of universities should be changed from a hierarchal organisation to a networked organisation. Research shows that this type of organisation works better in an entrepreneurial organisation. In the hierarchal organisation, the TTO works like a funnel, which at times can become clogged.

The author acknowledges the fact that her research is based on a few case studies and in the recommendations for further research she suggests to broaden the research by a quantitative

research, performing interviews with both TTO staff and university employees, also exploring their opinions on the suggestions for improvement the author has made.

### Critique on the research

The hypotheses that are formulated reflect shifts from the managed economy to the entrepreneurial economy. However, the hypothesis that 'the university TTO is focussed on small firm formation' implies a contra-hypothesis that TTOs focus on the formation of large firms in the 'old' managed economy. As a department of a mostly publicly funded institution, a TTO does not have the means to focus on the formation of big, multinational companies. In the analysis of the case studies it becomes clear the author sees a focus on the formation of small spin-off companies opposed to licensing out patents to large international firms. This is not an indicator for the focus on the formation of small companies but an indicator for the degree to which a TTO is externally focussed towards cooperation.

Hypothesis 2 states that, in the entrepreneurial economy, TTO policies should support individual career management. The question with this hypothesis is to what degree TTOs have any influence on this policy. The career management the author refers to is that of the employees of the university and therefore the TTO might have no influence on the universities' policies on career management. It is therefore a hypothesis that is not applicable only to the TTOs but to the university as a whole. The author concludes with the remark that university policy should include the option for individuals to take time off to explore entrepreneurial activities.

Despite the weak link between indicators and hypotheses and the small number of cases studied, the conclusions and recommendations can be very valuable as they show us that traditional TTOs are not capable of responding adequately to the changing demands of their customers and the environment.

## "Why university inventions rarely produce income? - Bottlenecks in university technology transfer"

*By P.M. Swamidass & Venubabu Velasa (2009)*

This research paper focuses on the United States, home to the Bayh-Dole act and it investigates the bottlenecks in university technology transfer. The article starts with a quote from dr. Das, CEO of Transwitch. He states that "high-technology is … one of the most difficult things to market" According to the authors, a second reason is that it takes time to successfully license or market the inventions and patents from a university because they do not create immediate business value such as cash flow. The third reason a university inventor does not have any ties to parties that may be interested in the technology. This means the marketing of the invention or patent needs to be done from scratch after disclosure to the TTO8.

### Introduction

A reason for not having a strong stream of revenue according to Trune & Goslin (1998) may be that most university technology transfer programs exist for less than 10 years, and are not yet self-supporting. This is a serious threat to the existence of TTOs as these kinds of departments are the first to find themselves on a reduced budget when the university faces a budget deficit. The authors describe three models of technology flow: the current, traditional flow under the Bayh-Dole regime where the university is owner of the patents on inventions done by its employees and the TTO is responsible for the commercialisation. The second model is different as the inventor (being the employee) becomes owner of the patent and may further commercialise it through the TTO. The university however does not get any revenue from this model. The third model, based on 'open science', implies that neither universities nor their employees patent their inventions. In this model, there is no valorisation and therefore no TTO involved. The research does explore the TTO effectiveness under the current regime in which the university becomes owner of the inventions and patents. The legislation and policy in the Netherlands is based on the same regime.

### Rationale of the research

There are many indicators for the success of university technology commercialisation. Examples are the number of disclosures to the TTO, patent applications filed, number of patents issued, number of licenses granted, license income, number of spin-offs etc. All these indicators follow from the total number of disclosures. These disclosures in turn are the result of university

[8] The article uses the abbreviation UOTT for the University Office of Technology Transfer. For consistency reasons, we will use the TTO abbreviation which has the same meaning.

policies, the IP environment and the perception of the fairness and simplicity of the process by the staff 'inventors'.

Research of the data coming from the annual survey performed by the Association of University Technology Managers (AUTM) shows that the income from licenses as a percent of the research expenditure has grown from 1.7% in 1994 to 2.9% in 2004. This means an annual growth of 6% per year. However, the license income still is a small percentage of the total expenditure on research. The growth of staffing at TTOs has grown 11% per year in the same period. So the increase in staff is twice the increase in license income. The reasons for this may be that TTOs appoint staff without marketing skills or TTO personnel do not work effectively. The research investigates whether a staffing shortage is a performance-limiting constraint as identified by several other studies.

On the subject of spin-offs9 the authors refer to research showing that spin-offs can be more successful vehicles for knowledge valorisation then licensing or publications in scientific journals. However, the AUTM data show an average annual growth in number of spin-offs per university of 0.14 per year. The authors state that spin-offs are the vehicle mostly used to further develop technology that is not yet ready for the market, meaning that there is no interest from a commercial party in the technology without further developing it first.

**Background literature**

The literature that the authors discuss consists of two subjects: The opportunity and the challenge and inadequate capacity to market inventions

In the opportunity and the challenge, the authors discuss the result of the passing of the Bayh-Dole act and that research shows that TTOs are more successful in knowledge valorisation since this legislation has been in place; the relative number of patent applications from universities has grown much faster than that from the private sector. The difference between patents from university and that of industry is that companies mainly apply for patents relevant to their business that can be used by the company itself. Universities will have to search for a third party that is interested in the patents in their patent portfolio. The authors conclude this part of literature review with the fact that literature is divided on whether TTOs should be self supportive and therefore work for-profit or should receive structural funding from the university. As mentioned before, chances are that TTOs are among the first departments to be impacted by budget cuts.

[9] Called 'new startups' by the authors

In regard to "inadequate capacity to market inventions" the authors discuss the emerging consensus among researchers on the point of TTOs lacking the competencies and resources to be efficient and effective in their work. Although many universities recognize the importance of founding TTOs, these TTOs were usually not adequately equipped to perform their tasks. The Bayh-Dole act was therefore effective concerning the quantity of TTOs established but not so much in their quality.

The emphasis when looking for TTO personnel is rarely on marketing skills but mostly on patent law and technical expertise. This lack of marketing skills is less important when there are already contacts between the researcher/inventor and a third party. However, if these contacts do not exist, the marketing of a technology from scratch can be a serious challenge for TTOs.

**Under-funding of TTOs**

Technology commercialisation is a long-term process and it takes 7 to 12 years on average to successfully complete a commercialisation process of an invention. This long time between start and results is similar for TTOs. First success can only be expected after at least 7 years. This is a long time in which the TTO is vulnerable for budget cuts. The risk for budget cuts is even higher when TTOs do not generate income yet.

Resources within universities are allocated to processes based on the added value they bring to the core tasks of a university. Chances are that if a TTO is only judged on their net cost or profit, the non-financial benefits (e.g. providing job and graduation opportunities for students) universities are forgotten.

**Methodology**

The article describes the study as a research on the innovation processing capacity in TTOs. The researchers sent a survey questionnaire to 99 universities. 26 returned surveys were used for the research. The collected data includes:

- The percentage of inventions that was not processed due to the lack of personnel
- The number of FTEs required to process inventions
- The kind of training given to commercialization personnel
- The time to hire commercialization staff
- Formal methods or tools that TTOs use for technical evaluation of inventions
- The budget allocated for invention commercialisation

## Results

The survey shows that the TTOs have an average staff size of 4.3 FTE and about 75% reports that they currently have a staff shortage. 57% expects the need of one to four FTE in the next three years; 12% expects they need more that ten FTE in the next three years. 46% has no legal staff.

The technology transfer performance shows a division between TTOs with little provisional patent applications (0-25 annually; 61% of TTOs) and TTOs with many provisional applications (150-300; 13%). The average was 62.7 provisions but with such a spread, this statistic is not very useful. Together with the licensing statistics, the researchers suspect significant internal infrastructural differences between high-end and low-end performing TTOs. The authors suggest further research on the subject in the future, possibly enabling low-end performing TTOs to improve their commercialisation performance.

Regression models show only a few significant results for the relation between performance and staff capacity, one of which a positive association between patents applied for and number of legal employees.

The budget allocated by universities is found to be adequate by 25% of the respondents; all other respondents feel they need more budget.

## Conclusions and recommendations

The research paper concludes without a judgement on whether TTOs have any added value in the knowledge valorisation process at universities. The paper does recognize the under-funding of TTOs as a serious threat to the knowledge valorisation and calls the effect of low budgets on marketing of inventions 'disproportional'. Another conclusion is that there is no ready market for the inventions from universities and these inventions need extra attention to be made ready for the market. This process consumes significant amounts of time and budget. The results suggest that most TTOs do not actively transfer technology to external parties but are waiting for external parties to knock on the door for a license, making the Patent Licensing Offices.

The authors suggest that federal granting agencies earmark a small portion of the funding for the commercialisation of inventions, not necessarily through TTOs but for example through external agencies or by training staff in the subject of commercialisation. Another example of a strong incentive for technology transfer appears to be the pre-invention ties between inventors and

companies. It shortens the commercialisation process as the supply and demand side are more connected.

The authors recommend further research on the subject of the split between high- and low-end performing TTOs. What can be learned by the low-end from the high-end performers? Other recommendations include studies on improving the performance of TTOs and exploring other way of technology transfer then through the TTO.

**Critique on the research**

The authors refer to an article that states that "among the studies focussing on the tangible outputs of technology transfer, several focussed on spin-off companies". The authors do not give their opinion on the value of this quote for their research and all it actually does is state that they are not the first to investigate the subject. It would be more interesting if the authors would give results of these studies and would anticipate on these results in their study.

Furthermore, the researchers anticipate beforehand on the conclusion that TTOs perform badly due to a lack of qualified personnel. The survey questionnaires leave very little room for the respondents to identify other factors that influence their performance. The chances are that the respondents will fill in the survey in a way that leads to there seeming to be a shortage of qualified personnel. The article, together with its conclusion then becomes an instrument for TTOs to 'prove' to the university that they do not have sufficient budgets.

The conclusions are based on the results of 26 respondents. This is a very bad response ratio of only 26.27%. Perhaps the TTOs that did not respond represent a group of TTOs that do not experience the same problems as the respondents to the survey.

Note: TTO staff is probably the best source of data on TTO performance and problem identification but this research has more emphasis on identifying lack of qualified personnel as the main cause for TTOs not performing.

## "The role of academic technology transfer organizations in improving industry science links"

*by K. Debackere and R. Veugelers (2005)*

The authors use the term Industry-Science Links (ISLs) to describe "the different types of interactions between the industry and the science sector that are aimed at the exchange of knowledge and technology". The formal forms of ISLs identified by the authors are:

- start-up of technology-oriented enterprises by researchers from the science-base generated at the research institute;
- collaborative research, i.e. defining and conducting R&D projects jointly by enterprises and science institutions, either on a bi-lateral basis or on a consortium basis;
- contract research and know-how based consulting by science commissioned by industry;
- development of Intellectual Property Rights (IPRs) by science
- others, such as co-operation in graduate education, advanced training for enterprise staff, systematic exchange of research staff between companies and research institutes

The authors state that the success of ISLs is dependent on three factors: context, structure and process. All three are applicable to TTOs but we will focus on process and will not discuss the context and structure in-depth as we are studying the valorisation process.

Debackere & Veugelers identify six factors from other literature that distinguish successful liaisons in ISLs from their peers. These are:

- Focus on combining basic and applied research
- The direct transfer between researchers and industry
- Proximity to the researchers themselves;
- Their emphasis on building the complementary assets needed for the research groups to be effective in
- The intensity of their ISLs (contract law, intellectual property management, spin-off development, access to venture capital, etc.);
- Design of sufficiently attractive individual remuneration packages that reward successful transfer activities.

The authors come to the conclusion that there are four crucial attributes to the success of a liaison unit (the TTO in our research). First is a well-balanced process to manage and to monitor contract research in the area of industrial innovation, supported by a central staff of

professionals. An example of coordination processes are innovation meetings and training for researchers in the field of technology transfer

Second, the operational process must be based on an active knowledge management policy. Third, it is highly recommended by the authors that a seed fund is available to support entrepreneurial activities. This incorporates a monitoring of the process from invention to spin-off via a business plan etc. Fourth, the liaison unit should offer opportunities for entrepreneurs and academics to meet, enabling them to form networks.

The article outlines the success story of the liaison office at K.U. Leuven, called Leuven Research and Development (LRD). LRD is seen as a best practice on how universities should arrange their knowledge valorisation. The authors attribute the success of LRD to the professional degree of the staff, the broad palette of services offered and also to the long presence of LRD within the organisation, as the unit was founded in 1972.

## "Technology transfer between university research centers and industry in Singapore"

*by J. Lee and H.N. Win (2004)*

This article is a review of the models used at three universities for technology transfer to industry in Singapore. Its goal is to identify factors that increase the success of technology transfer.

*Article outline*

The article starts by introducing the three university centers that are used as research subjects. All three represent another part of the academic world, being information technology (Ken Ridge Digital Labs), automation and CAD/CAM (Gintic Institute of Manufacturing Technology) and construction management & technology (Center for Advanced Construction Studies).

None of these universities are focussed on the medical sector. However, we feel that the results can also be applied to the medical sector as the research does not focus on one specific area. The authors give a general framework that applies to all three and, given the literature sources used, is applicable to other areas as well such as the medical sector.

*Motivations for technology transfer*

The article begins by explaining the benefits for parties to engage in technology transfer. For universities the most important motivations according to the authors are:

- the opportunity to access the needs of the economy and to develop its activities accordingly through income from the sales of technology
- the opportunity to place students in industry so that classroom learning can be related to practical experience
- access to industry for both fundamental and applied research
- access to the protected markets
- business stature enhancement
- improvement in new technology implementation
- creation of goodwill
- new product development and spin-offs
- cost savings
- patenting

For industry Lee & Win give the following motivations to engage in technology transfer:

- a supply of better qualified graduates having more relevant training because industry's needs have been identified
- access to a variety of post-experience training facilities it has helped to design
- access to the university's physical facilities and the expertise of its staff
- access to research, consulting and data collection of the university
- an improved public image in the society in which it operates, which means that more talented students will be attracted to the industrial sector
- gained technical knowledge
- gained technology services not available before
- quality improvement
- cost savings
- new markets
- manufacturing and lead time reduction

The leading motives we can extract are that it provides universities with access to (new) branches and that it is a way of generating funding (e.g. by saving costs and spin-offs). The main motives for industry are gaining knowledge that otherwise would not be available and competitive advantage (e.g. new markets and quality improvement).

### Mechanisms of technology transfer

The authors continue the article by defining nine technology transfer mechanisms:

1. Collegial interchange, conference, publication
2. Consultancy and technical services provision
3. Exchange program
4. Joint venture of R&D
5. Cooperative R&D agreement
6. Licensing
7. Contract research
8. Science park, research park, technology park or incubators
9. Training

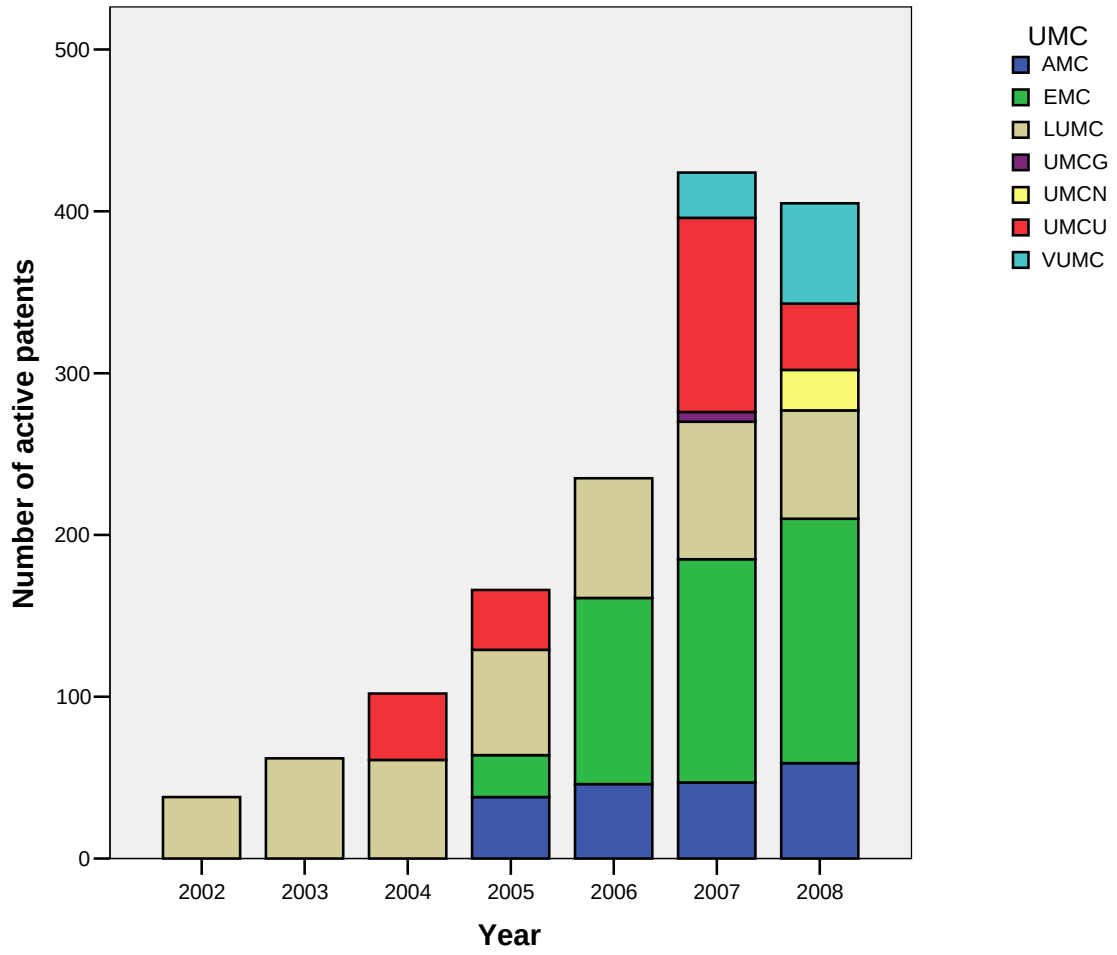
The mechanisms are aimed at technology transfer and by assessing which of these mechanisms create economic value, we can identify the mechanisms that are applicable to knowledge valorisation. Given this additional goal of creating economic value, we identify the most important instruments for knowledge valorisation:

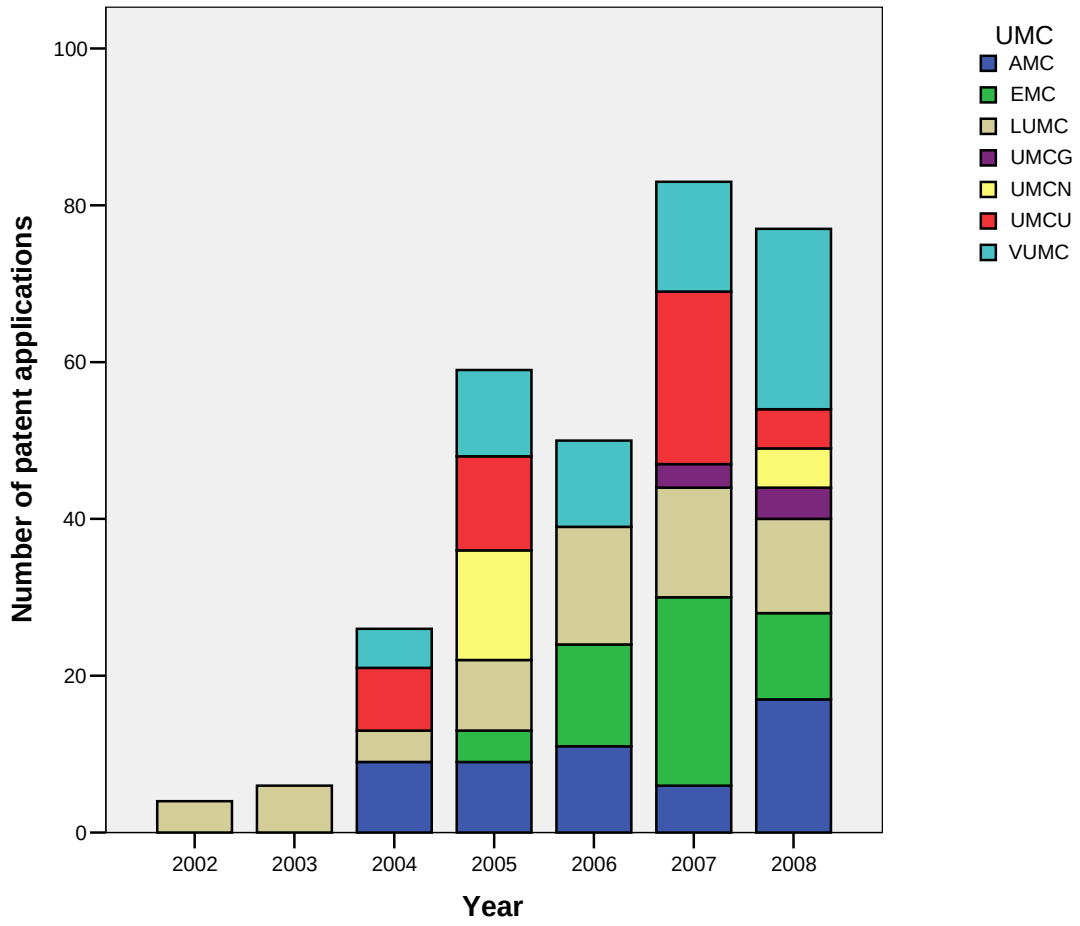
6. Consultancy and technical services provision
7. Patenting & Licensing
8. Contract research
9. Science park, research park, technology park or incubators
10. Spin-offs

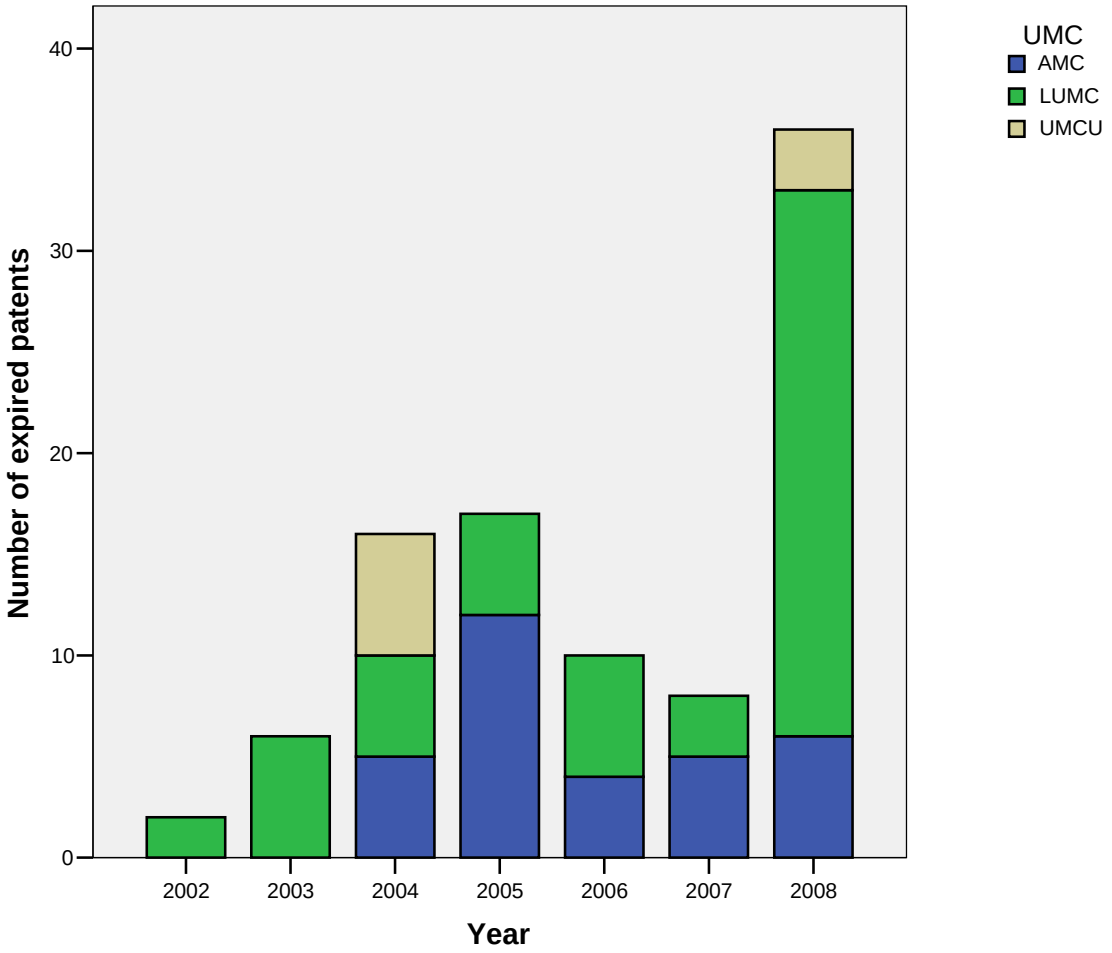
The authors continue by making a distinction between one-way and two-way technology flow. Knowledge valorisation by UMCs is clearly an example of one-way technology flow, (from university to industry). Heide (2007) identifies that the same mechanisms are applicable to one-way technology transfer, with the addition of spin-offs. Therefore we add this mechanism to our framework as well.

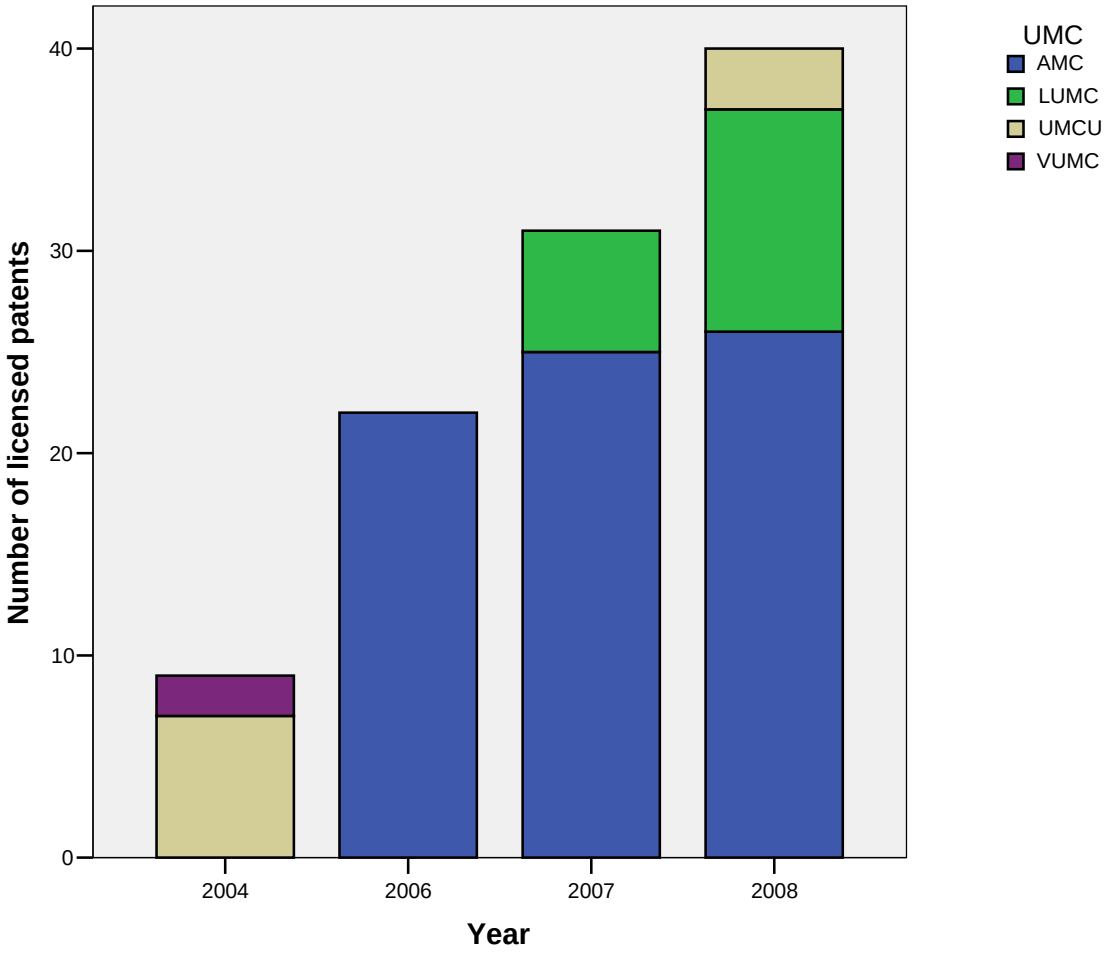
The article concludes with a comparison of the technology transfer mechanisms used per research center. The conclusion is that universities are and will stay an important partner for further innovation.

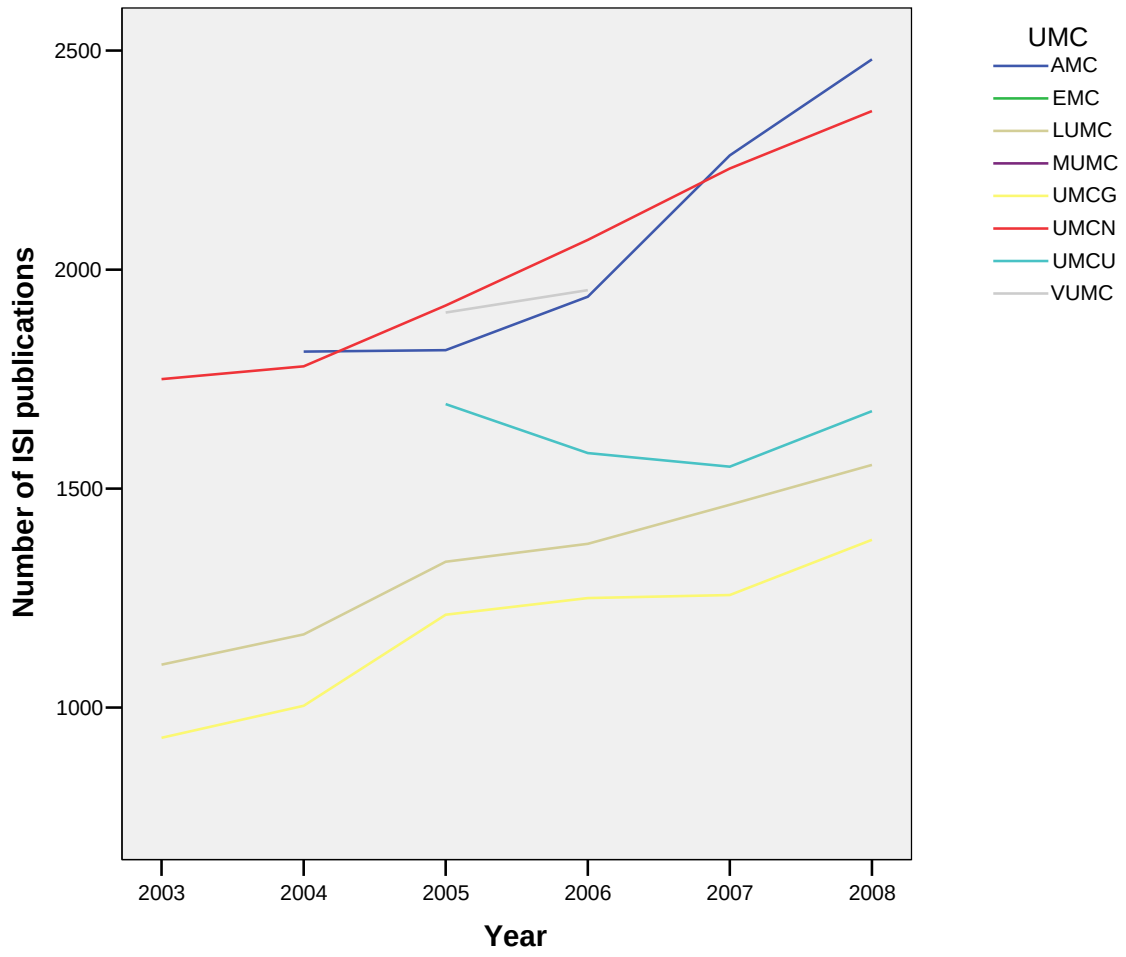
# Annex III: Valorisation statistics derived from the annual reports

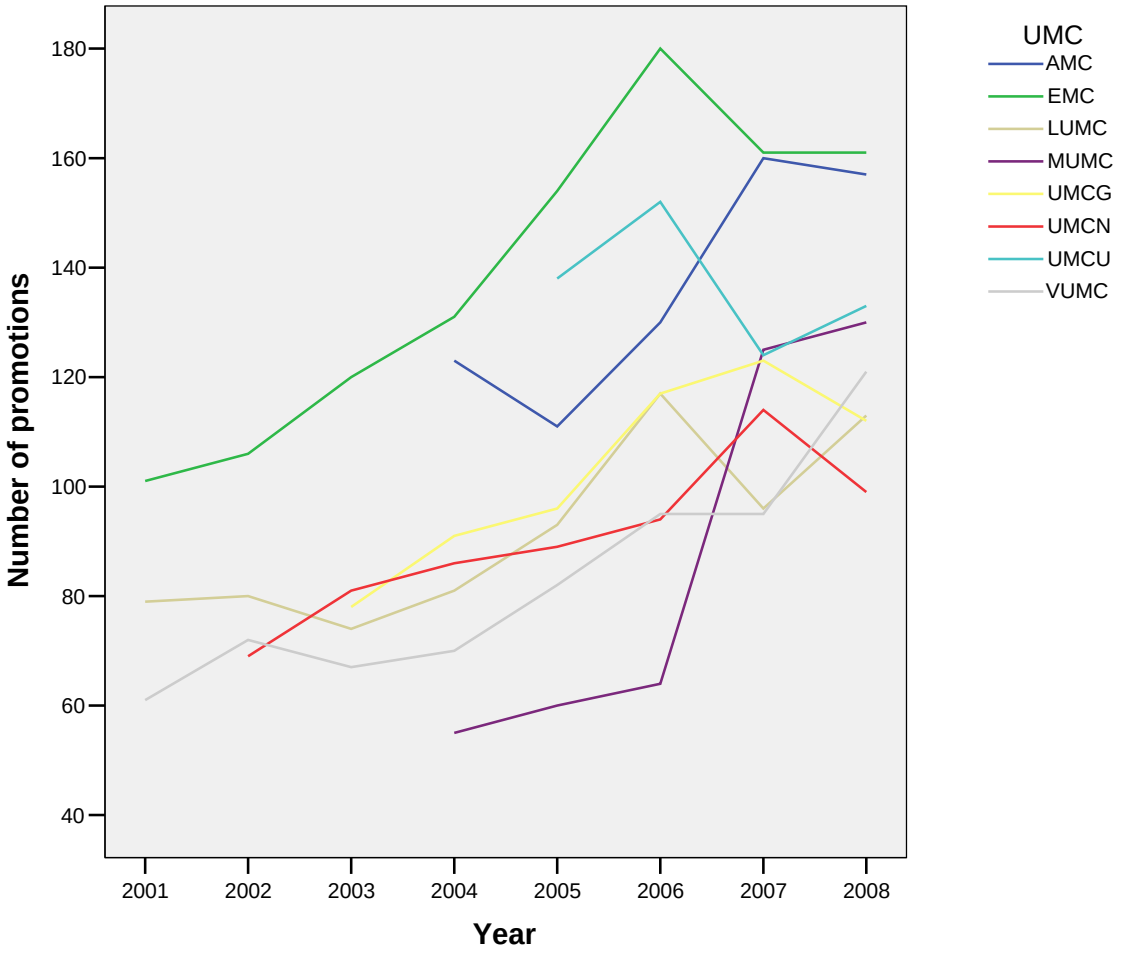


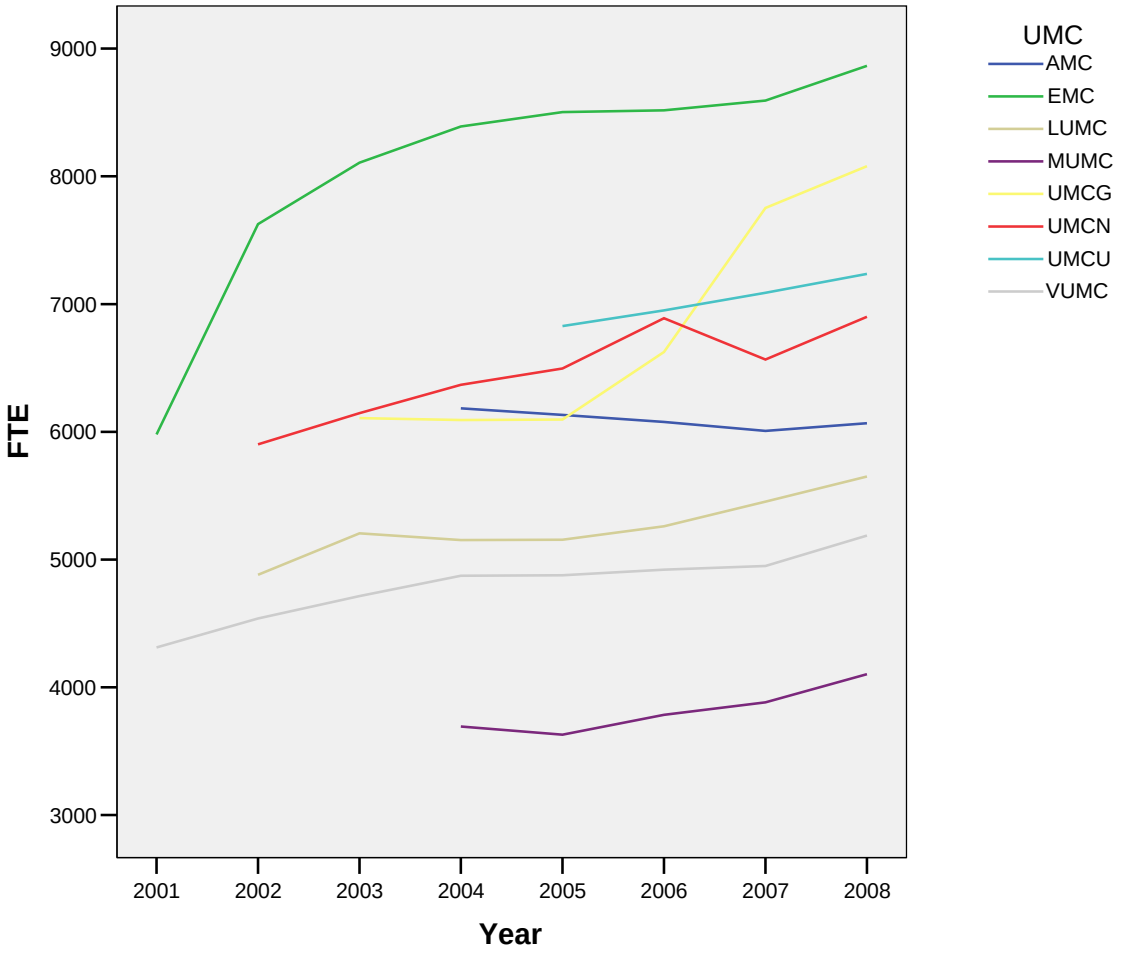

Number of patent applications
100
80
60
40
20
0
2002
2003
2004
2005
2006
2007
2008
Year
UMC
AMC
EMC
LUMC
UMCG
UMCN
UMCU
VUMC


UMC
AMC
LUMC
UMCU
Number of expired patents
0
10
20
30
40
2002
2003
2004
2005
2006
2007
2008
Year


Number of licensed patents
40
30
20
10
0
2004
2006
2007
2008
Year
UMC
AMC
LUMC
UMCU
VUMC


Number of ISI publications
2500
2000
1500
1000
2003
2004
2005
2006
2007
2008
Year
UMC
AMC
EMC
LUMC
MUMC
UMCG
UMCN
UMCU
VUMC


Number of promotions
180
160
140
120
100
80
60
40
2001
2002
2003
2004
2005
2006
2007
2008
Year
UMC
AMC
EMC
LUMC
MUMC
UMCG
UMCN
UMCU
VUMC


FTE
9000
8000
7000
6000
5000
4000
3000
2001
2002
2003
2004
2005
2006
2007
2008
Year
UMC
AMC
EMC
LUMC
MUMC
UMCG
UMCN
UMCU
VUMC

# Annex IV: Interview results (CONFIDENTIAL)

**The following annexes are confidential and therefore not accessible in the public version of this thesis:**

Annex IV-a (AMC)
Annex IV-b (EMC)
Annex IV-c (LUMC)
Annex IV-d (MUMC)
Annex IV-e (UMCG)
Annex IV-f (UMCN)
Annex IV-g (UMCU)
Annex IV-h (VUMC)

# Annex V: KU Leuven TTO description of services

**The following description of services was retrieved from the Leuven R&D website on January 26th, 2010. (http://lrd.kuleuven.be/en/researcher/int_property/index.htm)**

K.U.Leuven Research & Development offers active support with respect to all aspects related to intellectual property and the protection and commercialisation thereof. Support is offered with respect to the following activities:

- Awareness creation & knowledge transfer
- Providing information on Intellectual Property Rights (IPR)
- Providing access to the patent literature
- Assessing the feasibility, patentability and market potential of an invention
- Determining a protection strategy
- Drafting and filing a patent application
- Follow-up of patent procedures & costs
- Negotiating and drafting Non-Disclosure Agreements (NDA) and Material Transfer Agreements (MTA)
- Negotiating and drafting of license agreements
- Finding industrial partners

**Awareness creation & knowledge transfer**

The acquaintance with IPR-related issues varies strongly among the university staff. The IPR team tries to stimulate the IPR-awareness and knowledge in an informal way during its daily contacts with the university researchers as well as by organizing IPR-related seminars at the level of the research groups.

**Providing information on Intellectual Property Rights (IPR)**

The IPR-team of K.U.Leuven R&D can be contacted to obtain information regarding all forms of intellectual property rights, including copyright, patents, plant variety protection, trademarks, etc.

**Providing access to the patent literature**

The information available in the patent literature is often overlooked. Nevertheless, a growing volume of scientific and technical information is published in the patent literature, and may not be available by any other means. K.U.Leuven R&D assists researchers in finding the relevant patent literature within their field. Upon request an alert service, where researchers are informed as soon as a new patent (application) within their field of interest is published, can be provided.

**Assessing the feasibility, patentability and market potential of an invention**

On a regular basis, exciting research findings are disclosed to K.U.Leuven R&D. Following a disclosure, K.U.Leuven R&D interacts with the inventors in order to evaluate whether it is appropriate to seek patent protection for the disclosed results and concepts. Such an evaluation comprises an investigation with regard to patentability of the invention (novelty, inventive step) as well as a rough estimation of the commercial potential of the invention.

**Determining a protection strategy**

During the application, prosecution and maintenance of a patent, a variety of decisions have to be taken which affect the costs and duration of the application procedure, but also the broadness of the eventual protection. K.U.Leuven R&D manages this decision making process in interaction with the inventors and external patent attorneys.

**Drafting and filing a patent application**

When the decision to file a patent is made, K.U.Leuven R&D assists in the process of drafting and filing the patent application. This is done in close interaction between the IPR-officers of K.U.Leuven R&D and experienced external patent attorneys.

**Follow-up of patent procedures & costs**

K.U.Leuven R&D manages all financial administration related to the patent procedure.

## Negotiating and drafting Non-Disclosure Agreements (NDA) and Material Transfer Agreements (MTA)

Scientific advance partly depends on the exchange of information and research materials. However, the academic tradition of free exchange is not always compatible with the long-term

goal of commercialization of research. Using non-disclosure agreements (NDA) and material transfer agreements (MTA) when exchanging information and materials largely solves this ambiguity. K.U.Leuven R&D provides NDAs and MTAs to research groups that want to transfer information or material to third parties on a conditional basis. In addition, K.U.Leuven R&D also evaluates and negotiates incoming NDAs and MTAs.

### Negotiating and drafting of license agreements

Once an industrial partner has expressed its interest to commercialize intellectual property of K.U.Leuven, K.U.Leuven R&D represents the university in the negotiations concerning the terms and conditions of the license agreement, and is actively involved in the drafting of the agreement.

### Finding industrial partners

Most researchers have a broad contact network within their field of expertise. So, in many cases, the first contacts with industrial partners that are interested in commercialising university intellectual property are made by the researchers/inventors themselves. However, where necessary, K.U.Leuven R&D will actively search and contact potentially interested industrial partners.

# References

Acs, Z. J. e., & Stough, R. R. e. (2008). Public Policy in an Entrepreneurial Economy - Creating the Conditions for Business Growth, *International studies in entrepreneurship ; 17* (Vol. 17). New York, NY: Springer Science+Business Media, LLC.

AMC. (2009). *AMC-jaarverslag 2008 - betreffende het ACADEMISCH ZIEKENHUIS en de FACULTEIT der GENEESKUNDE van de UNIVERSITEIT van AMSTERDAM*. Amsterdam: Academisch Medisch Centrum.

AUTM. (2005). *AUTM U.S. Licensing Survey, FY 2004 Survey Summary*. Northbrook, IL: Association of University Technology Managers.

Baltesen, F. (2010). Oogziekenhuis opent twintig filialen. Retrieved April 25th, 2010, from http://www.nrc.nl/binnenland/article2526268.ece/Oogziekenhuis_opent_twintig_filialen

Centraal Bureau voor de Statistiek. (2003). *Kennis en economie 2002 - Onderzoek en innovatie in Nederland*. Voorburg: Centraal Bureau voor de Statistiek.

Clarysse, B., Wright, M., Lockett, A., Van de Velde, E., & Vohora, A. (2005). Spinning out new ventures: a typology of incubation strategies from European research institutions. *Journal of Business Venturing, 20*(2), 183-216.

Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R. R., Rosenberg, N., et al. (2002). How Do University Inventions Get into Practice? *Management Science, 48*(1), 61-72.

Debackere, K., & Veugelers, R. (2005). The role of academic technology transfer organizations in improving industry science links. *Research Policy, 34*(3), 321-342.

Goorden, J. G. V. L., R.; Wubben, E.F.M.; Omta, S. W. F. (2008). *Towards a Classification of Instruments for Valorisation of Academic & Industrial Knowledge. An exploratory analysis of eight European incubators in the life sciences*. Enschede: NIKOS.

Grant, R. M. (1996). Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration. *Organization Science, 7*(4), 375-387.

Gras, J. G., Lapera, D. G., Solves, I. M., Jover, A. V., & Azuar, J. S. (2008). An empirical approach to the organisational determinants of spin-off creation in European universities. *The International Entrepreneurship and Management Journal, 4*(2), 187-198.

Heide, S. v. d. (2007). *Bridging Ivory Towers - Think Local, Act Global?* , University of Twente, Enschede.

Huff, W. G. (1995). The developmental state, government, and Singapore's economic development since 1960. [doi: DOI: 10.1016/0305-750X(95)00043-C]. *World Development, 23*(8), 1421-1438.

Interdepartementale Programmadirectie Kennis en Innovatie. (2009). *Van voornemens naar voorsprong: Kennis moet circuleren - Voorstel voor een Nederlandse valorisatieagenda*. The Hague: IPKE.

Lee, J., & Win, H. N. (2004). Technology transfer between university research centers and industry in Singapore. *Technovation, 24*(5), 433-442.

LUMC. (2009). *Leids Universitair Medisch Centrum - Jaarverslag 2008*. Leiden: LUMC.

Markman, G. D., Gianiodis, P. T., Phan, P. H., & Balkin, D. B. (2005). Innovation speed: Transferring university technology to market. *Research Policy, 34*(7), 1058-1075.

Ministry of Economic Affairs. (2003). *Life Sciences: A pillar of the Dutch knowledge economy - Facts and figures, an analysis of the innovation system*. The Hague: Ministry of Economic Affairs.

Mowery, D. C., Nelson, R. R., Sampat, B. N., & Ziedonis, A. A. (2001). The growth of patenting and licensing by U.S. universities: an assessment of the effects of the Bayh-Dole act of 1980. *Research Policy, 30*(1), 99-119.

Mowery, D. C., & Shane, S. (2002). Introduction to the Special Issue on University Entrepreneurship and Technology Transfer. *Management Science, 48*(1), v-ix.

MUMC. (2009). *Academisch Ziekenhuis Maastricht - Jaarverslag en kengetallen*. Maastricht.

Ndonzuau, F. N., Pirnay, F., & Surlemont, B. (2002). A stage model of academic spin-off creation. *Technovation, 22*(5), 281-289.

NFU. (2008). *Wetenschap gewaardeerd*. Houten: Badoux BV.

NFU. (2009). *At a glance - Facts and figures for the Netherlands' University Medical Centres 2009*. Utrecht.

Rasmussen, E. (2008). Government instruments to support the commercialization of university research: Lessons from Canada. *Technovation, 28*(8), 506-517.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: a taxonomy of the literature. *Ind Corp Change, 16*(4), 691-791.

Sachwitz Apple, K. (2008). Evaluating University Technology Transfer Offices (pp. 139-157).

Samson, K. J. a. G., M.A. (1993). University scientists as entrepreneurs: a special case of technology transfer and high-tech venturing. *technovation, 12*(2), 63-71.

Saragossi, S., & van Pottelsberghe de la Potterie, B. (2003). What Patent Data Reveal about Universities: The Case of Belgium. [10.1023/A:1021678719567]. *The Journal of Technology Transfer, 28*(1), 47-51.

Siegel, D. S., & Phan, P. H. (2004). *Analyzing the Effectiveness of University Technology Transfer: Implications for Entrepreneurship Education*: Rensselaer Polytechnic Institute, Department of Economics.

Stephan, P. E. (2001). Educational Implications of University–Industry Technology Transfer. [10.1023/A:1011164806068]. *The Journal of Technology Transfer, 26*(3), 199-205.

Swamidass, P., & Vulasa, V. (2009). Why university inventions rarely produce income? Bottlenecks in university technology transfer. [10.1007/s10961-008-9097-8]. *The Journal of Technology Transfer, 34*(4), 343-363.

Trune, D. R., & Goslin, L. N. (1998). University Technology Transfer Programs: A Profit/Loss Analysis. [doi: DOI: 10.1016/S0040-1625(97)00165-0]. *Technological Forecasting and Social Change, 57*(3), 197-204.

Vohora, A., Wright, M., & Lockett, A. (2004). Critical junctures in the development of university high-tech spinout companies. *Research Policy, 33*(1), 147-175.