The Creation of Science-Based Entrepreneurial Firms as Institutionally Enacted Processes

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To Kurt, Lode and The New Life

“If a person does not become what he understands, he does not really understand it.”

Søren Kierkegaard, 1833 – 1855
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TABLE OF CONTENTS

ACKNOWLEDGEMENT ...............................................................................................................................3

TABLE OF CONTENTS .................................................................................................................................5

LIST OF TABLES ..........................................................................................................................................7

LIST OF FIGURES .........................................................................................................................................8

LIST OF ABBREVIATIONS ...........................................................................................................................9

SAMENVATTING .........................................................................................................................................10

SUMMARY ..................................................................................................................................................14

I. INTRODUCTION .........................................................................................................................................17

1. CONCEPTUALISATION OF RESEARCH-BASED SPIN-OFFS ................................................................18

2. OVERVIEW OF STUDIES .........................................................................................................................22

2.1. Study 1: A process study of entrepreneurial team formation: the case of a research-based spin-off .................................................................................................................................22

2.2. Study 2: Institutional change and resource endowments to science-based entrepreneurial firms: The case of IMEC ...........................................................................................................25

2.3. Study 3: Institutional linkage and resource endowments to science-based entrepreneurial firms: a European exploration ..................................................................................................29

REFERENCES ..............................................................................................................................................36

LIST OF PUBLICATIONS BASED ON DOCTORAL RESEARCH PRESENTED IN THIS THESIS .................39

II. A PROCESS STUDY OF ENTREPRENEURIAL TEAM FORMATION: THE CASE OF A RESEARCH-BASED SPIN-OFF ..............................................................................................................41

1. INTRODUCTION .......................................................................................................................................41

2. RESEARCH-BASED SPIN-OFFS AND TEAMS ....................................................................................43

3. RESEARCH SETTING ..............................................................................................................................46

4. METHOD ..................................................................................................................................................47

5. DATA SOURCES .......................................................................................................................................48

5.1. Participant observation ..........................................................................................................................48

5.2. Interviews ............................................................................................................................................49

6. DATA ANALYSIS .....................................................................................................................................49

6.1. THE PROJECT PHASE: a project team at university .............................................................................54

6.2. THE PRE START-UP PHASE: Championing the business idea into a new venture .........................54

6.3. THE START-UP PHASE: The champion as business manager and inducer of strategic inertia ..57

6.4. THE POST START-UP PHASE: Technological evolution as trigger for strategic focus and professionalising the organisation of the team ..............................................................................62

7. CONTRIBUTIONS TO THEORY .............................................................................................................63

7.1. Unfolding the paradox of the entrepreneurial champion: enabling experiential team learning ..................................................................................................................................................63

7.2. Toward a midrange theory: entrepreneurial team formation as a process of self-organised punctuated equilibria ..................................................................................................................66

8. CONCLUSIONS AND MANAGERIAL IMPLICATIONS .......................................................................67

REFERENCES ...............................................................................................................................................70
LIST OF TABLES

Table 1: Characteristics of UCL and CINE (2000) ................................................................. 47
Table 2: Sequence of venture development - first order issues ........................................... 50
Table 3: Team related second order issues ........................................................................... 52
Table 4: Founder and employee characteristics at time of start-up ..................................... 56
Table 5: Overview of Data Collection at IMEC ...................................................................... 85
Table 6: Characteristics of Research-Industry Technology Transfer in Flemish Public Research Organisations ................................................................. 87
Table 7: Science-based entrepreneurial firms from IMEC ...................................................... 96
Table 8: Resource endowments to IMEC ventures at time of founding compared to other science-based entrepreneurial firms and high tech start-ups in Flanders ........................................ 97
Table 9: Resource endowments of three generations of IMEC ventures at time of founding ... 100
Table 10: Performance indicators of three generations IMEC ventures ................................. 103
Table 11: Investment in R&D and output from de research sector ......................................... 130
Table 12: Descriptive data and non parametric tests for generic and specific PROs (hypothesis 1) ......................................................................................................................... 136
Table 13: Comparative output indicators for generic and specific PROs ................................ 137
Table 14: Means, standard deviations, ranges and correlations (of variables used to test hypothesis 2 and 3)................................................................................................................. 139
Table 15: MANOVA for founding resources: Start capital, Productisation of technology and number of employees ........................................................................................................ 142
Table 16: Post hoc tests for 2X2 factorial MANOVA (hypothesis 2) ...................................... 144
Table 17: Two-stage least-squares regression to test hypothesis 3 ......................................... 148
Table 18: Tests of assumptions for 2X2 factorial MANOVA: Homogeneity of variance-covariance matrix and Bartlett’s test of sphericity .................................................... 158
Table 19: Overview of data collection Vivactis ...................................................................... 174
Table 20: Overview of data collection Sirius Communications ............................................... 181
Table 21: Overview of data collection C-Cam Technologies .................................................. 186
LIST OF FIGURES

Figure 1: Development of the venture along the organisational life cycle ........................................53
Figure 2: Structure of the new venture team........................................................................................63
Figure 3: Patent Activity at IMEC ........................................................................................................83
Figure 4: The commercialisation process at IMEC by setting up science-based entrepreneurial firms...................................................................................................................................................88
Figure 5: Conceptual model: overview of hypotheses ........................................................................127
Figure 6: Plot of interaction effect in 2X2 factorial design MANOVA .................................................142
Figure 7: Coefficients of regression equations: relationships between formality of technology transfer, start capital and growth in employees / capital (hypothesis 3).................................................150
LIST OF ABBREVIATIONS

AUTM  Association of University Technology Managers
CEO   Chief Executive Officer
IPR   Intellectual Property Rights
PRO   Public Research Organisation
R&D   Research and Development
SBEF  Science-Based Entrepreneurial Firm
TTO   Technology Transfer Office
SAMENVATTING

Uit onderzoek blijkt dat Europese onderzoeksinstellingen, traditioneel sterk verbonden aan de overheid en ingebed in een historisch diep gewortelde academische cultuur, steeds meer actief zijn in het opstarten van ondernemingen vanuit de schoot van de instelling. Bovendien wordt gesteld dat bedrijven ontstaan vanuit onderzoeksresultaten een belangrijke rol spelen in economische ontwikkeling (OESO, 2003).

Een mogelijke verklaring voor dit fenomeen is dat universiteiten en onderzoeksinstellingen interne systemen ontwikkeld hebben voor de commercialisatie van hun technologie. Omdat heel wat producten en processen tegenwoordig op de markt, niet ontwikkeld waren zonder wetenschappelijk onderzoek (Mansfield, 1998), benadrukte de OESO het belang van onderzoeksinstellingen om structuren en formele beleidslijnen te ontwikkelen om de overgang van onderzoek naar het creëren van nieuwe bedrijven mogelijk te maken (OESO, 1998). Dit stemt overeen met de hedendaagse notie van (academisch) ondernemerschap, dat evolueerde van een individuele aangelegenheid naar een sociale en georganiseerde activiteit (Jacob et al., 2002). Bepaalde onderzoekers bestudeerden het effect van institutionele structuren en beleidslijnen op het nemen van patenten, het sluiten van licentie overeenkomsten (Bercovitz et al., 2000) en op het aantal academische spin-offs dat wordt opgericht vanuit onderzoeksinstellingen. De studie naar deze institutionele determinanten omvatte ondermeer karakteristieken van beloningsystemen, de ondernemings- en academische cultuur, het beleid rond intellectuele eigendom en de algemene organisatorische structuur van de onderzoeksinstelling. De interactie tussen academische starters en publieke onderzoeksinstellingen van waaruit deze ondernemingen ontstaan, is een onderwerp dat tot op heden slechts zeer weinig werd belicht.

Nochtans stellen onderzoekers binnen het neo-institutionalisme dat nieuwe bedrijven vaak interne consistentie opbouwen met de verwachtingen die leven binnen hun institutioneel, organisatorisch kader. Isomorfe krachten zouden zelfs veel sterker kunnen spelen in jonge, startende bedrijven die typisch een beperkte basis aan
middelen hebben. Vanuit dit perspectief is het denkbaar dat academische starters structurele elementen incorporeren om de benodigde legitimiteit te bekomen en om de nodige middelen te kunnen aantrekken. Bovendien is er een consensus dat gedrag beïnvloed wordt door sociale structuren die zowel beperkingen als opportuniteiten met zich mee brengen (Granovetter, 1985). Individuele ondernemers handelen in een sociale context, maar deze context is geen "dwangbuis" waarin ze slaafs bepaalde scenarios volgen: ‘agency’ en ‘structuur’ lijken dynamisch op elkaar in te spelen. Dit doctoraal onderzoek bestudeert de interactie tussen academische starters en de micro-institutionele context waarin deze bedrijven hun oorsprong kennen: eerst op het niveau van één spin-off (waarbij inzicht wordt verkregen in een spin-off proces); vervolgens op het niveau van één onderzoeksinstelling (waarbij de relatie belicht wordt tussen het micro-institutionele beleid met betrekking tot technologie transfer en de academische starters die hierin tot ontwikkeling kwamen) en, ten derde, in een steekproef van Europese publieke onderzoeksinstellingen en academische starters (waarbij de relatie tussen institutionele link, middelen en groei van academische starters wordt bestudeerd). Dit onderzoek bestaat dan ook uit drie empirische studies, die conceptueel, methodologisch en op vlak van niveau van analyse op elkaar verder bouwen.

Een eerste studie is een diepgaande analyse van een spin-off proces ingebed in een Belgische universiteit. Het basisargument van deze longitudinale, exploratieve studie is dat de ontwikkeling van de ‘project kampioen’ en van het ondernemersteam als geheel duidelijk verband houdt met de verschillende ontwikkelingsstadia in de levenscyclus van het bedrijf. Veranderingen in het team gaan hand in hand met strategische veranderingen in het bedrijf, waarbij telkens een nieuw evenwicht wordt tot stand gebracht. De start-up fase, zoals beschreven in traditionele levenscyclusmodellen wordt conceptueel uitgebreid en vanuit management oogpunt wordt gesteld dat er tijd over gaat vooraleer het oprichtende team de nood aan een ervaren CEO accepteert. De rol en het belang van de specifieke onderzoeksinstelling van waaruit deze onderneming ontstond wordt toegelicht. Immers, nieuwe bedrijven die gevormd worden om onderzoeksresultaten en/of intellectuele eigendom te exploiteren zijn sterk ingebed in de moederorganisatie, met een specifieke cultuur, regels en procedures.
De tweede studie bouwt hier dan ook op verder door de mate te bestuderen waarin het technologie transfer beleid van een Belgisch onderzoeksinstuut de financiële, technologische en menselijke middelen bepaalt waarmee academische starters oprichten. We maken gebruik van een duale case studie methodologie (Leonard-Barton, 1990) en volgen daarbij Eisenhardt’s (1989) en Yin’s (1991) richtlijnen voor case study onderzoek. We integreren historische analyse, prospectieve studie en gestandaardiseerde vragenlijsten om te onderzoeken of de middelen die naar academische starters gaan, verweven zijn met veranderingen in organisatorische en micro-institutionele technologie transfer gebruiken. In deze studie geven we een integraal beeld van de organisatie van het commercialisatieproces in een publiek onderzoekscentrum, dat wereldwijd erkend wordt als een ‘centre of excellence’ op het gebied van micro-electronica. Met kwalitatieve en kwantitatieve data tonen we aan hoe veranderingen in het transferbeleid van onderzoeksresultaten een impact hebben op de middelen die naar (potentiële) academische starters gaan. We onderscheiden drie generaties van academische starters, die telkens de micro-institutionele set-up rond technologie transfer reflecteren.

Een derde studie behandelt theoretische en empirische leemtes in de relatie tussen de institutionele link, de middelen en de groei van academische ondernemingen in een Europese steekproef. Institutionele link wordt geconceptualiseerd als een tweedimensioneel construct dat bestaat uit technologie transfer (formeel of niet formeel) en de specificiteit van de onderzoeksactiviteiten van een publieke onderzoeksinstelling (specifiek of generisch). De beide categorische variabelen worden gehypothetiseerd de middelen waarmee academische starters oprichten te beïnvloeden. Gezien de aandacht van academici en beleidsmakers voor academische starters gebaseerd op intellectuele eigendom – de zogenaamde pure ‘spin-offs’ - ligt het in de lijn van de verwachtingen dat deze bedrijven een hogere groei kennen dan academische starters die geen formele overdracht van technologie kregen bij opstart van hun activiteiten (de ‘start-ups’). In dit perspectief testen we een aantal hypothesen in een dataset van een 100 tal academische starters, die 24 publieke onderzoeksinstellingen vertegenwoordigen. Multivariate variantie analyse toont aan dat institutionele link de middelen van een bedrijf voorspellen. We vinden significante resultaten voor het startkapitaal en de mate waarin de technologie al dan niet een product benadert. Een ordinaal interactie effect toont echter dat bedrijven die
opgestart zijn met een formele technologie transfer ‘groter’ starten als ze afkomstig zijn van een publiek onderzoeksinstituut met een specifieke onderzoeksbasis. Tegen de verwachtingen in, toont een 2SLS regressie aan dat een formele transfer van technologie enkel een effect heeft op groei in werknemers gemedieerd door het startkapitaal waarme de onderneming opricht. Er is echter wel een gematigd direct effect – los van startkapitaal -- van een formele transfer van technologie op het aantrekken van additioneel kapitaal.
Studies report that European research labs, traditionally closely tied to government and enshrouded in the cocoon of academia, are increasingly involved in spinning off ventures. Moreover, these companies are argued to play an increasing role in economic development (OECD, 2003).

One explanation for this phenomenon is that universities and research institutes alike have increasingly developed internal systems for the commercialisation of their technology. Since a lot of products and processes currently on the market could not have been developed without scientific research (Mansfield, 1998), the OECD has stressed the importance for research organisations to develop structures and formal policies to facilitate the transition from research to the creation of new spin-offs (OECD, 1998). This is line with the contemporary notion of entrepreneurship, and science-based entrepreneurship in particular, which is shifting from serendipitous and individual to being perceived as social and organised (Jacob et al., 2002). Some researchers have looked at the effect of institutional structures and policies on the patenting and licensing behaviour (Bercovitz et al., 2000) and on the rate of establishing science-based entrepreneurial firms from universities and research organisations. These institutional determinants include, among others, characteristics relating to reward systems, entrepreneurial / academic culture, IP policies and the overall organisational structure of the research organisation. However, the nature of the interaction between science-based entrepreneurial firms and the institutional parent has largely remained an unexplored theme.

Institutional theorists argue that emerging firms build internal consistencies that are in alignment with their institutional context. Isomorphic forces might even be especially true in new ventures, which typically have a limited resource base: science-based entrepreneurial firms incorporate legitimating structural elements in order to gain the legitimacy needed and to attract the necessary resources. Additionally, there is a consensus that behaviours are influenced by social structures, which represent both a set of constraints and of opportunities (Granovetter, 1985). Individuals act within a social context, but this context is not an “iron cage” in which they follow scripts.
slavishly: agency and structure seem to dynamically interact. This doctoral research looks in depth at these issues: first at the level of one spin-off (providing knowledge about the spin-off process), then at the level of one research institute (providing insight in the interrelation between spin-off generation and micro institutional policies regarding technology transfer) and in a sample of European public research organisations and science-based entrepreneurial firms they generated. Thus, my PhD consists of three studies each following up on the previous study’s findings, both methodologically and conceptually.

Taking a contextualised, qualitative approach, the first study in this thesis provides an in depth analysis of a spin-off process from a Belgian university. The basic argument of this prospective study is that the development of the champion role and the entrepreneurial team as a whole clearly interrelates with life cycle stages of the venture – extending the “start-up phase” described in traditional life cycle models -- and that it takes time before a founding team finds its role and accepts the need for an experienced CEO. Changes in the team go hand in hand with shocks in the emerging business, pointing to a self-organising process of punctuated equilibriums. The role and the importance of the institutional parent in which this start-up trajectory takes place is highlighted. Clearly, new firms founded to exploit intellectual property emerging from science are typically embedded in a parent organisation, bringing about its own culture, rules and procedures.

The second study explores empirically whether and how a Belgian research institute – and the technology transfer policies in particular -- shapes the founding resources of ventures that are set up to commercialise its research results. Using a dual case study methodology (Leonard-Barton, 1990) and following Eisenhardt’s (1989) and Yin’s (1991) guidelines for case study research, we methodologically integrate historical analysis, prospective study and a standardised questionnaire, to examine whether and how the resources going to science-based entrepreneurial firms are intertwined with changes in the organisational, micro institutional technology transfer practices. In this study, we offer an integrative perspective on how the commercialisation process is organised in a public research organisation, which is recognised as being a worldwide centre of excellence in the field of microelectronics. We show how changes in the nature of knowledge transfer have an impact on the resource endowments going to
science-based entrepreneurial firms. In this perspective, we distinguish between three generations of science-based entrepreneurial firms, reflecting the micro-institutional set-up regarding the commercialisation of research through setting up companies.

The third paper addresses theoretical and empirical gaps in the relationships between the nature of institutional linkage, firm resources and growth in the context of spinning off ventures from public research organisations (PROs). Institutional linkage is considered a two dimensional construct consisting of the formality of technology transfer (formal or informal) and the research specificity of a PRO (generic or specific). In this perspective, both categorical variables are hypothesised to predict the resource endowments of science-based entrepreneurial firms. Additionally, given the widespread attention from academics and policy makers to IP based science-based entrepreneurial ventures, the formality of technology transfer is expected to be associated with growth of these firms. Empirical tests of hypotheses derived from this view are based on data from about 100 science-based entrepreneurial firms, representing 24 public research organisations. The research sought to identify how the variables interrelate at the multivariate level. Multivariate analysis of variance shows that institutional linkage predicts firm resources in general, showing significance levels for start capital and the degree of productisation of the technology. An ordinal interaction effect shows that companies established with a formal transfer of technology start with higher resource levels when started from a PRO with a specific research base. Contrary to expectations, two-stage least squares regression analysis indicates that the formality of technology transfer has no single direct effect on growth in employees, although it is mediated by start capital. A formal transfer of technology however does affect the propensity to attract additional capital, independent of the start capital of the firm.
I. INTRODUCTION

Since the mid-nineties, there is increasing attention for spinning off ventures as a venue for commercialising research. Since only few empirical research has been devoted to the spin-off phenomenon in Europe and to the processes underlying the emergence of research-based spin-offs in particular, this study started in an explorative way: if one is to gain insight and understanding about spin-offs from public research organisations, we argued the first step was to investigate real time the way a spin-off gets established. The first article in this thesis is the result of this explorative phase. The first draft of this article was presented on a conference organised by Journal Business Venturing and National University of Singapore and published in the Conference proceedings (Moray and Clarysse, 2001). A revised and elaborated version of this article was published in January 2004 in Journal of Business Venturing (Clarysse and Moray, 2004). This process study provides an in depth analysis of a spin-off trajectory from a Belgian university. More specifically, an evolutionary perspective on the role of the entrepreneurial champion, his surrounding entrepreneurial team and the co-evolution with shocks in the business is provided. Next to this, the study highlights the role and the importance of the institutional parent. Clearly, new firms founded to exploit intellectual property emerging from science are typically embedded in a parent organisation, bringing about its own culture, rules and procedures. Therefore, the second study in this PhD thesis explores empirically whether and how changes in a Belgian research institute’s spin-off trajectory shapes the founding conditions of the ventures that are set up to commercialise research results. Using a dual case study methodology (Leonard-Barton, 1991) we integrate historical and prospective case analysis. A third study analyses a theoretically sampled selection of European PROs and firms that has been established from their research base. The research addresses theoretical and empirical gaps in the relationships among the nature of institutional linkage, firm resources and growth and sought to statistically analyse these issues at the multivariate level.

The studies in this thesis subsequently build on the previous study’s findings and dynamically integrate a variety of data collection techniques: participant observation, face to face structured and semi-structured interviews, archival searches and
standardised surveys at the institutional as well as at the company level. The first two studies are process studies, providing detailed knowledge about the specifics of a spin-off trajectory, how such a process evolved over time and whether it shapes the resource conditions of emerging research-based spin-offs. Whereas process researchers provide explanations in terms of the sequence of events leading to certain outcomes (Langley, 1999), ‘variance’ researchers provide explanations for phenomena in terms of relationships between dependent and independent variables. Thus, the first two papers are particularly concerned with ‘events’; ‘variables’ are important in that they represent the operationalisation of concepts and constructs but these are not used in a classical hypothesis testing or statistical sense. The third paper in turn, provides some evidence that variability in terms of resource endowments at time of founding can be partly explained by institutional linkage.

We start the discussion shedding some light on the definitional complexity that has characterised (studies on) spin-offs from public research organisations. We explain how our research has evolved in the use of terminology: from research-based spin-offs to science-based entrepreneurial firms. We also provide a summary of the studies in this thesis.

1. CONCEPTUALISATION OF RESEARCH-BASED SPIN-OFFS

Both academics and policy makers have been developing a variety of definitions for research-based spin-offs. A common two-dimensional definition of a research-based spin-off is a new company that is formed (1) by a faculty member, staff member or doctoral student who left university to found the company or started the company while still affiliated with the university, and/or (2) a core technology (or idea) that is transferred from the parent organisation (e.g. Smilor et al., 1990; Steffenson et al., 1999). The OECD posits that a spin-off is a company that meets at least one of the following criteria: (1) one of the founders is an employee of the public research organisation (PRO), (2) the company licenses a technology from the PRO, (3) a PRO has equity in the company or (4) the PRO directly established the company (Callan, 2002). The latter criterion opens up the distinction between spin-offs that are set up with the support of the parent organisation – push or passive spin-offs – and ventures that are established without participation or support from the parent organisation, the
so-called ‘pull or active spin-offs’ (e.g. Matkin, 2001). Another inclusive, broad definition has been proposed by UNISPIN, a project of the 4th Framework Programme of the European Commission: a spin-off is a new firm that is largely dependent on knowledge / research from a public research organisation for its establishment (Callan, 2002). The Association of University Technology Managers (AUTM hereafter)\(^1\) suggested making a distinction between companies established with and without formal transfer of technology at time of founding. They refer to the companies as “spin-offs” and “start-ups” respectively. Spin-offs denote all the companies or traders as persons engaged in businesses that were dependent upon licensing or assignment of the institution’s technology for initiation. Conversely, start-ups are those companies that were not dependent upon licensing or assignment of the institution’s technology for initiation. However, the business was established based on the research / knowledge base of the PRO. Although there is no formalised technology transfer, it is possible that the PRO holds equity in these companies. Upstill and Symington (1999) made a similar distinction, referring to direct research spin-offs and indirect spin-offs, representing companies built on codified knowledge (intellectual property) and tacit knowledge, which is embedded in people.

All these definitions show that the relationship between a spin-off and the parent company can take on a variety of forms. Carayannis et al. (1998), for example, suggested to include the transfer of services to the company (e.g. capital, management advice, physical infrastructure, …) or to restrict the spin-off concept to a specific form of transfer, so that we can refer to “technology spin-offs”, “founder spin-offs”, “venture capital spin-offs”, etc. Franklin et al. (2001) suggested to differentiate between spin-offs where the researcher leaves the research organisation and the case where the researcher remains active as an academic, suggesting that the first group tends to be more successful.

Some academics particularly pointed to internal characteristics of spin-offs, associated to the business model of the company. Bullock (1983) already identified two categories: “soft companies”, the technical consultants solving customised problems, and “hard companies” that sell standardised products to a general market. In parallel,

\(^1\) http://www.autm.net
Stankiewicz (1994) classifies spin-offs according to the way they operate. He identifies three different operation modes: consultant and R&D boutique mode, product-oriented mode, and technological-asset mode.

Researchers in different countries have used a lot of the aforementioned definitions according to their own context and research needs and different terms have been used to refer to the same phenomenon. Terms used include (academic) spin-outs, university based starts-ups, (academic) spin-offs, firms created by researchers, research-based spin-offs, … Indeed, most of the aforementioned definitions leave room for inclusion of a variety of firms. The heterogeneity in the interpretation of concepts may partly reflect the fact that researchers have observed that research-based spin-offs are not a homogeneous group of companies (Mustar, 1997; Druihle and Garsney, 2004).

Given the definitional complexity and the heterogeneity of classifications / typologies, it is not surprising that there is no uniform interpretation of what exactly constitutes a spin-off company. Initially, we posited that the formal transfer of technology from a research organisation is a conditio sine qua non for defining a company as a research-based spin-off (Moray and Clarysse, 2001; Clarysse and Moray, 2004). However, in Belgium as well as in a variety of other European countries we observe that in fact a lot of research-based spin-offs did not receive a formal transfer of technology, but in fact are still identified as a spin-off company. In Flanders, for example, we have identified the total population of research-based spin-offs based on the listings from the technology transfer offices (Moray, 2004). From the 93 firms that were set up from 1991 to 2002, 40 are companies that started activities without a formal transfer of technology. Although we have no exact figures for other European countries, researchers in Italy, France and Portugal make similar observations (PRIME Network of Excellence, 2004). Different explanations can be given for this observation. First, the formal transfer of intellectual property through setting up companies has only gained more policy attention since the mid nineties. It is likely that most PROs only started to give the establishment of these firms more attention since that era, as compared to companies that are set up without the formal transfer of technology. Additionally, it is likely that formal transfer of technology into newly established companies is a largely evolutionary phenomenon, given the recent upsurge. That is to say, firms that used to be set up without formal transfer of technology during the early
nineties would today probably be more likely to be established with a formal transfer, all else being equal. Secondly, there is a large tendency in promoting the ‘entrepreneurial university’, stimulating research institutions to set up ‘as many spin-offs as possible’. As a result, research organisations in general and universities in particular will be inclined to ‘list’ the firms that are established from their research base in an inclusive way. As a result, in Europe, spin-offs often comprise all the ventures that are “listed” or “identified” by researchers and / or technology transfer officers as having emerged from the research base of Public Research Organisations (Moray and Clarysse, 2004a).

In line with the variety of definitions and classifications found in the literature, it is not surprising that this PhD research also evolved in the use of definitions. We started off our research using the broad definition of ‘research-based spin-off’ (Moray and Clarysse, 2001). However, building on this broad definition and focusing on the micro-institutional context we found the distinction as conceptualised by AUTM crucial to better understand the heterogeneity among these firms. AUTM succeeded in fine-tuning the plethora of definitions that exist regarding spin-offs, by taking into account whether or not formal technology transfer took place at time of founding. Therefore, we use the term “science-based entrepreneurial firms” in the next two articles that comprise this thesis, to denote both the start-ups and the spin-offs that emerge from public research organisations. The basic argument for using this inclusive definition is that it will prove to be crucial to gain more understanding in the similarities and differences that characterise European (samples on) spin-offs. More specifically, we posit that it is important to take into account the nature of institutional linkage of the company with the PRO at time of founding, in order to arrive at a non-evolutionary and mutually exclusive categorisation of science-based entrepreneurial firms.

The remainder of this chapter summarises each of the articles in this PhD thesis, both in terms of methodological perspective and main findings.

2 The managerial and potential policy implications of the respective studies are not included in these summaries.
2. OVERVIEW OF STUDIES

2.1. Study 1: A process study of entrepreneurial team formation: the case of a research-based spin-off

Performing a qualitative process study is an overwhelming task for a junior PhD researcher. Doing participant observation and exploratory interviews about a topic and in a context that had largely remained unexplored from a process perspective was a challenge in itself. How were we to analyse the data? What would be the appropriate theoretical framework? When during the process, which was the level of analysis, were we to make the decision to hone in on a specific unit of analysis that both displays theoretical and practical relevance? The main goal of this study was to learn to understand how a science-based entrepreneurial firm comes into existence. This analysis formed the basis to develop other research questions and hypotheses, of which some are addressed in the remainder of the thesis. As such, the first paper in this thesis describes how a team of entrepreneurs is formed in a research-based spin-off, how the team copes with crisis situations during the start-up phase, and how both the team as a whole and the team members individually learn from these crises. The progress of a university spin-off has been followed up from the idea phase onwards. Adopting a prospective, qualitative approach, the basic argument of this paper is that shocks in the founding team and the position of its champion co-evolve with shocks in the development of the business. We summarise the paper’s methodological perspective and main findings.

2.1.1. Method and data collection

The aim of this research was to inductively describe and explain the emergence of a research-based spin-off. Since processes are involved we adopted a longitudinal approach. To track and analyse changes over time, some researchers have adopted well-accepted business history approaches (see e.g. Cusumano and Selby, 1995). Studying the early phases of a research-based spin-off we could not adopt this given the clear absence of track records and archives that document on these particular companies’ very early stages. Also, identifying all stakeholders involved during the spin-off process post facto is not easy and recall-bias might be introduced when using retrospective analysis. For an exploratory study, that formed the basis of further study,
we deliberately choose to adopt a prospective qualitative approach (see e.g. Perlow, 1999), in order to discover more about “how” and “why” a spin-off process in general and the entrepreneurial team in particular evolves as it does. We collected real time longitudinal, qualitative data and attempted to extract theory from the ground up (Eisenhardt, 1989; Yin, 1994; Langley, 1999). The total duration of prospectively following up this venture amounted to a period of 20 months (2000 - 2001).

Participant observation and semi-structured interviews were used as main data collection procedures. During the idea phase and the time during which capital was attracted, the process of new venture creation was followed up by having different contacts with the researchers of university. We visited the researchers several times at university, until formal legislation of the company. The researchers got to know us and we agreed that we would come over “on site” of the venture to engage in participant observation. The actual time of participant observation ranged from August 2000 to June 2001, about 3 days per week, observing the engineers at work, during meetings and informal conversations. Further, we interviewed each of the team members, the CEO and the research assistant that helped writing the business plan. Some broad questions guided us throughout the interviews ensuring that we would get comparative data. Each interview took about two hours. Following the guidelines of Miles and Huberman (1984) and Glaser and Strauss (1969) we performed data analysis throughout data collection. In order to arrive at a processual view and empirically grounded themes, the data were analysed sequentially. Field notes were typed out consequently and after a period of participant observation, all issues and reflections were condensed in an interim site summary. Analysing the field notes and interviews notes, we dotted down the most important issues as perceived by the different team members. At the conclusion of the fieldwork, we integrated the analysis of the interview transcripts, field notes and the interim site summary in order to address the following question: How does the entrepreneurial team get formed and evolve in a research-based spin-off?

2.1.2. Main findings

The basic argument of the paper is that shocks in the founding team and the position of its champion coexist with shocks in the development of the business, along the life
cycle of the new venture. Our analysis shows four distinct phases of development of the venture and its entrepreneurial team. A first phase is related to the idea phase. Herein, the project team consists of three technical researchers, with one clearly delineated project leader. The latter is in charge of planning, follow up and proposal writing. The pre-start-up phase is introduced by the actual decision to spin-off from university. The project leader proved to be the “champion”, driving the idea, looking for business plan coaching and putting a team together: “managing the idea all the way through completion”. After formal legislation, introducing the start-up phase, our observations and interviews supported the well-accepted view that champions often do not make good managers. This paradox can be explained by the fact that the team needed time to accept that the initial champion is actually not the appropriate person for being the business manager. Triggered by speedy technological evolutions, the post-start-up phase is characterised by gaining strategic focus and professionalizing the organisation of the team.

Hence, we empirically elaborated the “start-up” phase discussed in the traditional life cycle models. Although consistent with the models found elsewhere in the literature, our model differs in that it explicitly describes stages as linked to the spin-off process. Encompassing four phases, our model adds value by pointing to the process character of “founding” a research-based spin-off. Moreover, our case data suggest that shocks in the environment precipitate the shift from one stage to another.

Next to the development of the entrepreneurial champion along the evolution of the business, this study also provides an initial intuition about the potential role of the parent organisation in shaping the events that make up the spin-off trajectory. In this perspective, three models were distinguished conceptually: a free market model, a Keynesian model and a protective model. Building on these intuitive ideas another research project honed in on different incubation strategies employed in public research organisations. Empirical evidence was found for these models and the authors found that the boundaries of these models are not always clear-cut, especially when a particular institution actually wants to be active in a certain model but lacks the resources and/or competences to do so (Clarysse et al., 2004). The process study described in this paper, together with the results from the research project on European incubators, opened up the question whether empirical evidence could be
found for structural similarity among firms that emerge from a similar institutional environment. The next articles in this thesis build on these intuitions. First, at the level of a public research organisation, including all the firms that emerged from its science base. Second, at the level of a European sample of PROs and science-based entrepreneurial firms.

2.2. Study 2: Institutional change and resource endowments to science-based entrepreneurial firms: The case of IMEC

This study takes an institutional perspective on spinning off ventures as a venue for commercialising research. The central question dealt with is the following: are the resource endowments of science-based entrepreneurial firms at time of founding influenced by the way in which technology transfer is organised at the parent organisation? We have selected a research institute known for its international research excellence and with a track record in spinning off ventures: IMEC (Leuven, Belgium). We questioned all senior managers involved in technology transfer and the founders of all science-based entrepreneurial ventures set up between 1987 and 2002. The basic argument of the research is that changes in the internal institutional environment -- and the technology transfer policy in particular – goes together with a changing overall tendency in the resources endowed to the science-based entrepreneurial firms. More specifically, we identify three generations of IMEC ventures. We discuss the paper’s methodological perspective and main findings.

2.2.1. Method and data collection

Investigating how institutional changes influence the resource endowments of science-based entrepreneurial firms implies a process approach and a variety of informants. Since the value chain of technology transfer by spinning off science-based entrepreneurial firms encompasses different parties -- scientists, technology transfer personnel, senior administrators and the founders of the companies -- we employ a dual case study methodology (Leonard-Barton, 1990), combining historical and prospective case analysis.

First, we collected data on the rate of establishment of science-based entrepreneurial firms from other PROs in the region (Flanders). We found this was crucial since this
study is in its pure form “one case”. Although in “single” case studies analytical generalisation is of primary importance – instead of statistical generalisation – these regional data allow contextualising the findings and discernment about the scope of analytical generalisation. We position IMEC to other PROs in Flanders in terms of technology transfer indicators, its relative importance in setting up companies from its research base and the extent to which start-ups versus spin-offs are generated. Second, we have interviewed all senior managers involved in the spin-off policy at IMEC. The persons interviewed have significant experience in the organisation in general and in business development and technology transfer activities in particular (>10-15 years). Third, we interviewed one or more representatives (founders and/or CEO) of the 20 science-based entrepreneurial firms that emerged from the institute since 1991. Face to face interviews at the premises of the venture helped us to understand the organisational context. During these 1.5 hour interviews, attention was given to the start up history of the firm in terms of technology transfer from IMEC, the inventors involved, how capital was attracted and how the company evolved since then. Fifth, we performed more detailed process studies of 3 spin-offs, to better understand the dynamics of venture formation and development as it is embedded in this particular research organisation. One venture was prospectively studied, by interviewing the 3 founders over a 15-month period. Two ventures (both set up in 1996) were studied retrospectively by interviewing the persons involved in the start-up process (see appendix 2 for write ups of these cases). We deliberately decided to select one successfully exited and one failed company that were established in the same year, to control for broader environmental / economic conditions. Finally, in order to understand the resource conditions of science-based entrepreneurial firms at time of founding and how this evolved over time, we surveyed the ventures using a structured, standardised instrument. In sum, data consisted of 40 face-to-face interviews, 20 standardised questionnaires, archival searches and a database with evolutionary financial data about the companies, resulting in a combination of quantitative and qualitative data allowing triangulation (Jick, 1979).
2.2.2. Main findings

IMEC was established in 1984 and is one of the largest Flemish research organisations in terms of research expenditure, the size of the technology transfer office and the science-based entrepreneurial firms generated from their knowledge base. The research institute accounts for almost one fourth of the companies set up from PROs in Flanders from 1991 to 2002 (Moray, 2004). Studying the technology transfer practices in IMEC as they evolved over time, following the different activities of proactive spin-off process as conceptualised by Degroof (2002) and Clarysse et al. (2004), we found that IMEC increasingly professionalised and structured its venturing process. More specifically, IMEC increasingly evolved towards a centrally led technology push model when commercialising research results through setting up ventures.

Following the evolution within IMEC regarding the transfer of IP and the investment policy, we distinguish “three generations” of science-based entrepreneurial firms at IMEC. These “generations” are conceptualised based on their level and source of capital at time of founding, the mode in which technology was transferred (start-up vs. spin-off), the maturity of the technology at time of founding and some characteristics of the human resources. The first generation of starters runs up to 1995. For all the companies established up to 1995, IMEC only brought in (a limited amount of) cash. The main source of external capital, were incumbent firms. Most of the companies set up during this era were based on a clear need from a corporate firm. As a result, most of these firms had a working alpha prototype ready at the time they started their business activities. Only few IMEC researchers joined the start-up (on average 1,5 full time equivalents). The 7 companies established up to 1995 were all “start-ups” at time of founding. During the early nineties, IMEC went through some major changes in the organisation of its business development activities. There was a significant professionalisation trend in industrial liaisons and it clearly affected the way IMEC set up ventures: IMEC grows increasingly attentive for bringing in IP in the firms from 1996 onwards. However, IMEC does not engage in this effort in a systematic way: of the 8 firms established from 1996 to 1998, 3 are spin-offs and received some start capital from IMEC. The other 5 companies are start-ups in which IMEC brought in some cash. From 1999 onwards, a third generation of IMEC science-based
entrepreneurial firms emerges. These firms are characterised by the fact that all but one are spin-offs and they are established with a less mature technology at time of founding.

Overall, we can conclude that the decisions taken at IMEC to change its venturing policies have an effect on the type of companies created: the starting resources of science-based entrepreneurial firms have changed. Companies have become larger, start up with more employees and a technology further away from an alpha prototype. As a result, they need more coaching and incubation support before they can start up and the screening mechanism has become more selective. Although we could potentially infer from this that a smaller amount of projects will be started, it seems that IMEC wants to upscale its technology push strategy: IMEC wants to realise 3-4 spin-offs per year. The underlying rationale of IMEC is that in fact the opportunities are there but that an increasing pro-active role needs to be played in recognising these technological and market opportunities in the labs.

Finally, we asked the question what the socio-economic role is of the companies set up from IMEC. We calculated the multiple (and related IRR) realised by the first generation science-based entrepreneurial firms and compared it to the multiples found in the venture capital literature. The IRR of 11.8% is double the IRR of 5.2% (Murray and Mariott, 1998) which was found to be an average for seed investments in high technology sectors. Still, this financial performance seems to be considerably below the expectations, which VCs had in the mid- and late nineties when they wanted to invest in high technology. In Belgium, these expectations were between 30 and 35% for seed investments. This means that only few projects seemed attractive enough to invest in (Manigart et al., 2002). Moreover, in other European countries, expectations were even higher. The conclusion is thus that the IMEC approach seems to work and renders more gross profit than an average approach, but the organisational cost to realise this is very high and the average IRR is still much lower than the one that is expected by VCs. As a result, IMEC seems to have substantial difficulties to convince institutional investors to invest in its own fund.

Further, we observe that from a socio-economic perspective the science-based entrepreneurial firms from IMEC create a total employment of about 450 full time equivalents (1/1/2004). This is significant, but the total employment of a much less
time consuming initiative such as the TOP programme at the university of Twente (The Netherlands) to stimulate science-based entrepreneurial firms was about 1200 people in 2001 (Van der Sijde et al., 2002).

The next article in this thesis builds on the empirical results of this paper in that it explicitly analyses the predictive capacity of institutional linkage between a SBEF and a PRO at time of founding on the resources endowed to these firms. The final paper however approaches this issue, in larger sample of European PRO and SBEF that emerged from their research base.


This paper addresses theoretical and empirical gaps in the relationships between the nature of institutional linkage, firm resources and growth in the context of spinning off ventures from public research organisations (PROs). Institutional linkage is considered a two dimensional construct consisting of the formality of technology transfer (formal or informal) and the research specificity of a PRO (generic or specific). In this perspective, both categorical variables are hypothesised to predict the resource endowments of science-based entrepreneurial firms. Additionally, given the widespread attention from academics and policy makers to IP based science based entrepreneurial ventures, the formality of technology transfer is expected to be associated with growth. Empirical tests of hypotheses derived from this view are based on data from 96 science-based entrepreneurial firms, representing 24 public research organisations. The research sought to identify how the variables interrelate at the multivariate level. Multivariate analysis of variance shows that institutional linkage predicts firm resources in general, showing significance levels for start capital and the degree in which the technology is embodied in a product. An ordinal interaction effect shows that companies established with a formal transfer of technology start with higher resource levels when started from a PRO with a specific research base. Contrary to expectations, two-stage least squares regression analysis indicates that the formality of technology transfer has no single direct effect on growth in employees, although it is mediated by start capital. A formal transfer of
technology however does affect the propensity to attract additional capital, independent of the start capital of the firm. We briefly elaborate on the methods employed and the main findings of the study.

2.3.1. Method and data collection

This research is performed in the context of a European collaborative effort between researchers from 7 European countries: Belgium (Flanders), France, the United Kingdom, Germany, Sweden, Italy and Hungary. By theoretically sampling a number of PROs, we arrive at a research design ensuring maximum variety regarding the organisation of R&D in PROs. A three-step approach was utilised for sampling and data collection at the PROs and the science-based entrepreneurial firms in the respective countries. First, for each country an analysis was performed looking at the broader context of the public R&D systems. How is research organised and financed? What is the R&D expenditure and patent activity? Since we analyse institutional linkage and its potential impact on resource endowments, a variety of contextual constellations improves external validity of the findings, i.e. improves the probability that the hypotheses at the level of the public research organisation and the firms hold true across national contexts. Next, we discussed with the national experts / researchers what would be the best way to sample public research organisations and the science-based entrepreneurial firms that emerged from their knowledge base ensuring ‘real life’ but ‘controlled’ diversity so as to maximise comparison and external validity (King et al. 1994). There was a general consensus that the common denominator for public research activities across Europe, is that the majority is organised in universities or research institutes. In relatively small samples – as compared to the total population – this controlled diversity is key in making scientifically sound inferences. Thus, the second step involved the selection of a small number of PROs in each country that is representative for the way research is organised. Moreover, the technology transfer office needed to be at least three years old and the PRO needed to have a significant track record in setting up science-based entrepreneurial ventures since the mid nineties. Data on each PRO was collected through personal interviews with technology transfer managers. Each public research organisation in the sample (N = 24) was interviewed using the UNICO-NUBS questionnaire specifically designed for collecting quantitative indicators from
Technology Transfer Offices of Public Research Organisations (UNICO-NUBS, 2003). Sampling the PROs first was crucial since we are typically interested in micro institutional linkage with the research base at time of founding the science-based entrepreneurial firm. Third, for each PRO about 4-5 science-based entrepreneurial firms were sampled. Companies established since 1991 were included. In some cases the national experts / researchers were able to identify the full population of science-based entrepreneurial ventures and sampled the firms as such that they can be seen as representative examples of companies set up from the research base of the particular parent. In most cases, populations were unknown and firms were included based on the ‘known’ science-based entrepreneurial firms and the willingness to participate in the study. Given our research questions, which want to explore the impact of institutional linkage on resource endowments and growth, this is appropriate, as we do not expect the willingness of founders/CEOs to cooperate or the (lack of) knowledge of the population of firms to influence both independent variables representing institutional linkage. We developed a standardised survey instrument that was used as a road map during face-to-face interviews with the founders and/or CEO’s of the companies. During these 1 - 1,5 hour interviews, we questioned the respondents about the start-up history of the firm in terms of technology transfer from the PRO, the inventors involved, how (much) resources were attracted at time of founding and how the company evolved since then. Special attention was given to the resource endowments: the human, financial and technology resources. Our final sample consists of 24 PROs and 96 science-based entrepreneurial firms that emerged from these institutions.

We developed three main hypotheses, of which the first is formulated and tested at the level of the public research organisation, so as to validate the conceptualised distinction between PROs with a generic and a specific research base. The main unit of analysis of this paper is the science-based entrepreneurial firm, i.e. institutional linkage of the firm with its parent PRO and the potential effect on the starting resources and growth of the created companies. Multivariate analysis techniques are employed to address the questions of interest.
2.3.2. Main findings

Different analysis techniques were used to test the three principal hypotheses. In order to test the distinction between the two conceptualised types of public research organisations in technology transfer related indicators, univariate Mann Whitney U tests were used. Although TTOs have in common that they facilitate technological diffusion through the licensing to industry of inventions or intellectual property resulting from university research, the research organisations seem to differ significantly in the magnitude of these activities. Non-parametric analyses supported the hypotheses for most indicators: specific PROs score significantly higher on IP protection expenditure, invention disclosures, patent applications, active license agreements and license income. Additionally, the technology transfer offices seem to be somewhat older and they employ significantly more personnel managing the start-up process of science-based entrepreneurial firms. Looking at the relative productivity by comparing some input indicators to output measures, it was apparent that the PROs with a specific research base file significantly more US and EU patents relative to the disclosed inventions as compared to the generic PROs. Overall, we find that specific PROs show clear indicators of a more professionalized TTO staff. Interestingly however, they seem to generate about the same amount of science-based entrepreneurial firms as the generic PROs. Moreover, if a specific PRO engages in the establishment of a SBEF, the data suggest that they put more effort in incubation and or coaching of the project.

Hypothesis 2 is tested using a 2X2 factorial design for MANOVA in order to assess the predictive power of institutional linkage on the resource endowments of the science-based entrepreneurial firms at time of founding. We found that spin-offs clearly display higher capital levels and a more productised technology than the start-ups in the sample. The fact that the spin-offs are established with higher capital levels reflects that PROs want to value their technology by converting it into equity shares. In turn, this leads to a higher valuation of the venture at time of founding and, by definition, to higher capital levels. In this respect it is interesting to find that the spin-offs from specific PROs start up at an even larger scale than the spin-offs from the generic PROs. Conversely, the start-ups from the PROs with a specific research base show the lowest resource levels. This might indicate two interrelated issues. Firstly,
setting up start-ups seems to be of less strategic importance for PROs that specialise in one or a number of technological domains. Secondly, in a parallel study we found that the average starting capital of the science-based entrepreneurial firms from a specific PRO has more than quadrupled over the last ten years (Moray and Clarysse, 2004). This increase in capital went together with the professionalisation of the technology transfer office and an increasing focus on transfer of intellectual property into new companies. Thus, if PROs want to commercialise their technology using spin-offs as a vehicle, this usually means that they need to set up an equity relation with the new firm. However, doing so, this boosts the value of the company at time of founding and makes external capital a necessity to balance the shareholder structure.

In order to attract capital, the business plan needs to be more ambitious, more oriented on quick return and growth and more focused on exit related valuation. All this implies however, that even more capital is needed while only a few of all invention disclosures have the intrinsic potential to establish such a growth path. This seems to be what professionalized TTOs at specific PROs are learning: if one wants to create spin-offs with the potential to become high growth ventures, scrutinised selection of ideas needs to be done, much support will be needed to incubate them and they will have to be established at sufficiently large scale. Ideas that not match these criteria are much less likely to receive a formal transfer of technology in terms of equity participation, but start up as a small SME. This is much less true for generic PROs where also start-ups -- receiving informal know how -- tend to be guided towards the public / private equity funds and start at a larger scale. A lot of these generic PROs are universities that want to meet today’s expectations of being an “entrepreneurial university”. Following a second academic revolution (after research had complemented their teaching mission), they also want to envision themselves as hotbeds of entrepreneurial activity. In this perspective, it is likely that they equally want to emphasise spin-offs and start-ups, resulting in a supportive structure for both types of firms. This interconnectedness of different objectives may partly explain the fact that start-ups and spin-offs from generic PROs do not differ as much in their starting resources as spin-offs and start-ups in general.

Finally, without having the ambition of performing an in depth growth analysis, we looked at whether spin-offs display higher growth as compared to start-ups. This analysis is informed by the fact that European public research organisations have been
strongly stimulated by policy makers to focus on the commercialisation of intellectual property, because of the greater awareness that results of scientific research, in the form of IP that can be protected through patents and copyright, contributes to technological innovation and economic growth (OECD, 2003, p21). Our hypotheses – that spin-offs grow more in terms of employees and capital – receive mixed support. The regression results indicate that the formality of technology transfer does not have an isolated effect on employee growth; start capital seems to operate as a mediator. In practice this means that having a sufficient amount of start capital is a powerful predictor of employment growth in the subsequent years, irrespective of whether or not the company received a formal transfer of technology. Being a spin-off as opposed to a start-up however, has a single direct effect on the propensity to attract additional capital. In other words, receiving a formal transfer of technology does not only impact the start capital but also the capital that can be attracted in the years to come. This reinforces our finding that these ventures are under scrutinised selection procedures since most ideas have not the intrinsic potential to justify a large capital basis and subsequent capital injections. Further, these companies need be incubated or embedded in a supportive entrepreneurial / business development network, to raise their chance on success.

These results open the perspective for policy makers to be cautious for focusing their measures solely to (IP based) spin-off companies, which are argued to have most potential to become high growth ventures, given the breadth of their technology platform, the possibility of mass production of a revolutionary product / new material and / or the scope of their market. Technology transfer offices have often been established or re-structured exactly to serve this type of science-based entrepreneurial firms. Start-ups however, embody tacit know how and often do not require a full-fledged organisational structure to support the start-up process. However, in some cases we observe that companies that could potentially start without formal transfer of technology from the PRO, are expected to do so given the upsurge of the phenomenon since the mid nineties, resulting in high valuations and necessary capitalisations. From a purely economic development perspective, stimulating start-ups could be argued to be equally important, especially given the lower costs involved in setting up these ventures.
In sum, the research has shown that institutional linkage matters and therefore needs to be taken into account by technology transfer managers as well as potential, (academic) entrepreneurs when commercialising research results through setting up new ventures. Traditionally, researchers have looked at broader environmental circumstances in understanding the resource constraints and opportunities for new ventures. For example, the availability of venture capital or public capital in a region and a network of entrepreneurs / experienced managers have traditionally been argued to be important for the successful establishment of the resource base of a firm (Roberts, 1991). This study substantially adds to these research endeavours by taking another lens: the parent organisation in general and the nature of the knowledge base, including varying emphases on respective transfer modalities seem to be equally important to take into account when assessing the founding resources and growth of science-based entrepreneurial firms.
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Moray, N. and B. Clarysse. 2001. Is there life for the champion after company start-up? The case of a research-based spin-off. Conference on Technological Entrepreneurship, National University of Singapore (June 28 - June 30, 2001)

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PAPER 1:

A PROCESS STUDY OF ENTREPRENEURIAL TEAM FORMATION:
THE CASE OF A RESEARCH-BASED SPIN-OFF

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II. A PROCESS STUDY OF ENTREPRENEURIAL TEAM FORMATION: THE CASE OF A RESEARCH-BASED SPIN-OFF

Abstract

This paper describes how a team of entrepreneurs is formed in a research-based spin-off, how the team copes with crisis situations during the start-up phase, and how both the team as a whole and the team members individually learn from these crises. The progress of a university spin-off has been followed up from the idea phase onwards. Adopting a prospective, qualitative approach, the basic argument of this paper is that shocks in the founding team and the position of its champion co-evolve with shocks in the development of the business.

1. INTRODUCTION

The process of spinning of a venture from a parent organisation, and from a university in particular, has received increasing attention during the past few years both in the academic literature (Roberts and Malone, 1996; Mustar, 1997; Carayannis et al., 1998; Smilor et al., 1998; Steffenson et al., 1999) and in practice (Clarysse et al, 2001). Governments and universities do increasingly consider the creation of spin-offs as a way of commercialising their internal research results. In addition, the financial investors’ community, licking its wounds after the dot-com debacle, has shown a renewed interest in academic spin-offs as investment opportunity (International Herald Tribune, 2001). However, research-based spin-offs show some peculiarities, which make them distinct from other high tech start-ups. Usually, most of the founding team members know each other from university work and often there is a lead entrepreneur who was the technical project manager before start-up. Moreover, the founding members have little contacts with non-technical people when they start up the venture and show limited industry experience (Cooper en Daily, 1996). As a response, investors were traditionally very sceptic about these start-ups and only participated when they could recruit a functionally balanced professional team that almost replaced the original founding team at the managerial level (e.g. Roure and Keeley, 1990; Cyr et al., 2000).

3 We wish to thank the founders of the company for their participation in this research. Thanks also to the CEO for allowing a follow up interview two years after we finished the actual research that led to this article.
Till recently, this was a possible strategy since competition for good spin-off deals was nearly non-existent among investors, nor were universities themselves interested to invest. Equally, there was little interest among the researchers to get actively involved in the spin-off. Thus, if spin-offs were created, the lead technical entrepreneur before start-up either played a role as member of the board or as a Chief Technical Officer, at most. Today, an intense competition has developed among universities to maximise the number of growth-oriented spin-offs. Investors jump on the bandwagon to provide start capital through university funds, university related business angel networks or semi public seed capital funds. This change in environmental conditions has resulted in the fact that growth oriented spin-offs are increasingly started with the technical intrapreneurs in charge of the start-up. They receive managerial support from the financial investors, specialised service providers, incubators or venture accelerators with whom they collaborate or by whom they are nurtured (Smilor et al., 1990, p. 65; Feeser and Willard, 1998).

Despite the fact that the venture capital literature consistently points to the entrepreneurial team as one of the most important factors which makes professional investors decide to enter a company (e.g. Cyr et al., 2000), very little insights exist about how entrepreneurial teams are formed in these research environments, how these teams evolve in the pre-start or incubation phase and how they eventually gain, both through influx of new members and through learning by experience, enough maturity to attract a professional financial investor. To tackle these issues, we followed up a research-based spin-off from its idea phase through the start-up up to its first planned capital increase using participant observation as a main data collection procedure. The total period of observation lasted over a period of 20 months. In this period both authors followed closely the intrapreneur and the founding team, and took part in different founding team activities.

This paper unfolds along the following lines. First, we point to the relevance of studying the start-up process of research-based spin-offs, taking the perspective of entrepreneurial team formation and development. Second, we explain the research method that guided our data collection and analysis, in order to gain insight into the as yet incomplete documented phenomenon. Third, we provide a discussion of the main findings and how these contribute to theory building in the field of new venture
creation in general, and more specifically, in the area of championing and entrepreneurial team development. We conclude with some managerial implications and suggestions for further research.

2. RESEARCH-BASED SPIN-OFFS AND TEAMS

‘High tech start-ups’ or ‘new technology based firms’ play a prominent role in the current economy (e.g. Mandel, 1998; Hendry, 1999; Storey and Tether, 1998 for a review of the literature). They are a very heterogeneous category of firms including different types ranging from technology developers to technology adopters (Hellman and Puri, 2000). Technology adopters use new technologies to enter new markets or to launch new ways of doing business, but do not develop technologies themselves. The entrepreneurs launching technology-adopting companies normally tend to fulfill or serve a short-term market opportunity. The so-called dot-com companies are a recent example of this kind of firms. At the other end of the continuum, we find the technology developers, which act as R&D boutiques (Pisano, 1990). Expected product revenues seem to be much further away in these companies, where the technical people play a leading role. The literature on high tech start-ups is rather inconclusive about the way these ventures get established, their internal dynamics and growth. Much of the confusion seems to be related to the heterogeneity of the population of high tech firms. To tackle this heterogeneity problem, we follow previous research focusing on a particular sub-population of high tech start-ups: research-based spin-offs (Mustar, 1995 & 1997; Smilor et al., 1990; Steffenson et al., 1999).

Research based spin-offs have become increasingly popular as a way of commercialising the research results of a public / private laboratory or a university (Chiese and Piccaluga, 2000; Mustar, 1997; Clarysse et al, 2001). A common two-dimensional definition of a research-based spin-off (RBSO hereafter) is: a new company that is formed (1) by a faculty member, staff member or student who left university to found the company or started the company while still affiliated with the university, and/or (2) a core technology (or idea) that is transferred from the parent organisation (e.g. Roberts and Malone, 1996; Smilor et al., 1990; Steffenson et al., 1999). According to this definition, a spin-off can be seen as a technology transfer mechanism for the commercialisation of a technology developed at an R&D
institution or university. However, the actual relationship between the spin-off and the parent company seems to be much more complex than this definition assumes. Carayannis et al. (1998), for example, suggested to extend this definition to include the transfer of other services of the company (e.g. capital, management advice, premises, …) or to restrict the spin-off concept to specific transfer, so that we can refer to “technology spin-offs”, “founder spin-offs”, “venture capital spin-offs”, … Given the unique circumstances in which spin-offs can be set up, it is not surprising that there is no uniform definition of the phenomenon. In our research, we posit a transfer of technology from a research organisation as a \textit{conditio sine qua non} for defining a company as a research-based spin-off.

It is important to note that research-based spin-offs may have very different organisations as parent institutes. Universities, publicly or privately funded research institutes (excluding corporate R&D departments) and technical schools are examples of parents. A common feature of these organisations is that they have commercialisable ideas in their research portfolio but they differ significantly in the extent to which they actively search for these business opportunities as well as in the extent to which the trajectory of business development is guided and supported. Ideally, the endpoint of that trajectory consists of a defined market opportunity around which a well-balanced start-up team is composed. Depending upon the intensity of the management of the potential spin-off’s trajectory, three different modes seem to emerge: a protected mode, a free market mode and a “keynesian” mode. In the protected mode, the engineers / researchers that are interested and found eligible to get together in the potential spin-off are protected from the external environment until formal venture capital can be invested. This type of starter typically gets a small amount of finance to overcome a certain incubation period and remain on the premises of the research institute. During that time, venture capital is negotiated and a professional start-up team is built. In the free market mode, the researchers start with no money or at most a small amount of financing (usually a subsidy) without real due diligence. Hence, not being embedded in the parent organisation during the early stages, the venture has to find its own way in the market. Finally, the keynesian mode is in fact a variation on the free market mode in which the research team receives some start capital (often from the university seed capital fund), spins off and gets coaching from the network during its first phase.
There is a general consensus that high tech start-ups are more often created by a team than by a single entrepreneur (Roberts, 1991). Moreover, team started businesses account for a disproportionately greater number of high-growth firms (Kamm et al. 1990). It is not surprising then that investors often emphasize the quality of the management team more than any other single factor as they make investment decisions (e.g. Kamm et al. 1990; Cyr et al., 2000). Having identified the initial venture opportunity, they make up the intangible assets of the firm (Cooper and Daily, 1996). Although mainstream entrepreneurship journals have not handled extensively the impact of teams on company growth, very elaborated bodies of research in such fields as organizational behavior, strategic management and social psychology have examined team issues in some detail (Birley and Stockley, 2001). We would basically distinguish between two main currents. The social psychology stream has focused primarily on processes and outcomes within the boundaries of the group, for example, consensus, conflict, problem solving and decision making (Ancona, 1987). The basic argument of the second current -- the demographic approach -- is that, instead of looking at processes, which cannot be measured reliably, we should look for proxies that can be measured (e.g. age and tenure as indicators for experience and maturity). The demographic stream reached a high in the “upper echelons perspective”, where demographics are applied to top management teams. Although the demographic approaches implicitly acknowledge that (behavioral) processes form the link between demographic characteristics and performance, they largely treat these processes as a black box. The need to open this box and study the underlying processes has been stressed by many researchers (see Birley and Stockley, 2001) but to date relatively few studies have attempted to do this (e.g. Smith et al., 1994). It is clear that very little research has focused on how founding teams form and evolve during the first critical stages of a venture. This research is one of the first attempts we know of to fill this gap in the literature, following up longitudinally a research-based spin-off over a period of 20 months, taking an entrepreneurial team perspective.
3. RESEARCH SETTING

Our research site is a spin-off from the Université Catholique de Louvain la Neuve (UCL): “CINE” (pseudonym). UCL is the largest French-speaking university in Belgium and the number of students has increased with 7% between 1997-1998 and 2000-2001. The university has ten faculties, comprising 50 departments and 200 research groups. The annual research budget is $85.10^6$ EURO, of which $12.10^6$ EURO is provided by companies. In 1985, a technology transfer office was created: SOPARTEC SA. This is a limited liability company, which is majority owned by the UCL. Its main corporate purpose is to promote the transfer of technology from UCL by several intertwined means: (1) provision of seed capital for innovative developments based on UCL research (2) the provision of equity financing to start-up companies using university technology (3) filing, prosecution and maintenance of patents and (4) licensing patents and related technology. The technology transfer and seed capital company has 12 companies in its portfolio, of which 2 are public. The size of the fund today (2001) is € 12.5 million and the value of their portfolio amounts to € 35 million. SOPARTEC actively plans to build an incubator in the Science Park of Louvain-la-Neuve (planned operation: 2003). From 1998 up to 2001 the university has spun off 6 ventures.

CINE was initiated in the telecommunications and microelectronics department of the UCL. Different European projects⁴ are at the basis of the development of the spin-off, starting as of 1994. In 1997 the CINE project started, focusing on datacasting and protection of authors' rights. The emphasis of the project was clearly on commercialising the research results, more specifically by means of creating a spin-off company. “CINE” was formally incorporated in June 2000, with 200 K EURO start-capital and 150K EURO deferred loan. The main characteristics of the technology transfer office and the spin-off are presented in Table 1.

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⁴ European funded projects are a common feature in the Belgian University research landscape. Since universities have suffered from budgetary cuts, research has increasingly become financed by external sources on a contract research basis.
Table 1: Characteristics of UCL and CINE (2000)

<table>
<thead>
<tr>
<th></th>
<th>UCL</th>
<th></th>
<th>CINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total research budget</td>
<td>85.10^6 EURO</td>
<td>Capital</td>
<td>200K EURO</td>
</tr>
<tr>
<td>Research funded by companies</td>
<td>12.10^6 EURO</td>
<td>Deferred loan</td>
<td>150K EURO</td>
</tr>
<tr>
<td>FTE* researchers</td>
<td>2151</td>
<td>No. founders</td>
<td>6</td>
</tr>
<tr>
<td>FTE technicians</td>
<td>1648</td>
<td>Total employees</td>
<td>7</td>
</tr>
<tr>
<td>Spin offs generated since 1998</td>
<td>4</td>
<td>Sector</td>
<td>Telecom</td>
</tr>
<tr>
<td>Reported invention disclosures</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filed patent applications</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total license income**</td>
<td>0.2.10^6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Full time equivalents
** Not including capital gains

The spin-off reflects the aforementioned “keynesian mode” of trajectory coaching intensity, in which the university exerts control to a certain extent via representation in the Board of Directors and via the appointment of a Company Coach, which was officially delegated with the responsibilities of a CEO. This function included the structuring of the team in which everybody gets a role and the attraction of competencies into the team if they were not yet available (e.g. Business developer or CEO). In fact, the fund did not have enough manpower at the time to invest in different young start-ups, which need a lot more coaching than companies further along the line. So, having a person in whom they had confidence was a prerequisite for them before they wanted to invest. Another consideration that informed the decision for having an external coach was related to the fact that the investor did not believe in the management capabilities of the project leader. In the next section we will discuss the method we employed for studying this venture in depth.

4. **Method**

The aim of this research is to inductively describe and explain the nature of new venture team formation and development in a research-based spin-off. Since processes are involved a longitudinal approach is required. To track and analyse changes over time, some researchers have adopted well-accepted business history approaches (see e.g. Cusumano et al., 1992; Cusumano and Selby, 1995). Herein, the tracing of historic company documents and project data is central, often complemented with extensive interviews about the company’s history and current operations. Studying the
early phases of a research-based spin-off we could not adopt this methodology for at least two reasons. First, there is a clear absence of track records and archives that document on these particular companies’ very early stages. Second, since we are interested in team formation and development, it is important to get information from the original founding team and from relevant stakeholders in the parent organisation and environment. It is very difficult to identify these individuals or to get the relevant information post facto.

As a result, we decided to adopt a prospective qualitative approach (see e.g. Perlow, 1998, 1999), in order to discover more about “how” and “why” teams affect performance and growth (Birley and Stockley, 2001. We collected real time longitudinal, qualitative data and attempted to extract theory from the ground up (Eisenhardt, 1989; Yin, 1994; Langley, 1999). The total time we closely followed up the venture amounted to a period of 20 months (October 1999–May 2001).

5. Data Sources

The two authors followed up the development of the venture closely. The progress was observed and recorded from the idea phase through start-up until the planning of the second round of financing. As described below, multiple methods of data collection procedures were used to address these issues, enabling to cross check results obtained from observations and recorded field notes.

5.1. Participant Observation

During the idea phase and the time during which capital was attracted, having different contacts with the researchers of university followed up the process of new venture creation. We visited the researchers several times at university, until formal legislation of the company. The researchers got to know us and we agreed that we would come over “on site” of the venture to engage in participant observation. The actual time of participant observation ranged from August 2000 to June 2001, about 3 days per week, observing the engineers at work, during meetings and informal conversations. As time permitted, we typed out field notes throughout the day. Where possible, we engaged in social activities with the team members: every now and then
we had lunch with them and travelled with them for a socialising weekend. Early in the research process, it was very important to make ourselves useful for the team, in order to gain confidence and a "raison d’être" at the site. Helping out with proof reading documents enabled more personal contacts with the team members. Although the team was rather small, the degree of our involvement with the different team members varied still, adopting alternately an "active-member-researcher" and a "peripheral-member-researcher" profile (Schultze, 2000). We attended most of the company’s internal meetings. In CINE, two formal meetings per week were held: a week planning for discussing the objectives to be reached and a technical meeting to discuss particular technical problems and developments. The meetings were prepared and led by the business manager. Attending these meetings was crucial to provide us a clear insight in what is perceived as relevant by the team.

5.2. Interviews

We interviewed each of the seven team members, the CEO, and the research assistant that helped with the preparation of the business plan. Some broad questions guided us throughout the interviews ensuring that we would get comparative data. Each interview took about two hours. The interviews provided us with background information about the group (who initiated the business, how they got together, why they wanted to start a spin-off,…). Additionally, we questioned the team about how they perceived the role of the business manager, the Coach (officially delegated with CEO responsibilities) and the Board of Directors, and probed in such a way that they would prevail the most prevalent difficulties -- if any -- they were experiencing. There was a weekly discussion with the Coach-CEO, communicating his perceptions about how the venture and its team evolved.

6. Data Analysis

Following the guidelines of Miles and Huberman (1984) and Glaser and Strauss (1969) we performed data analysis throughout data collection. In order to arrive at a processual view and empirically grounded themes, the data were analysed sequentially. First, field notes were typed out consequently and after a period of participant observation, all issues and reflections were condensed in an interim site
summary. This draft provided a general picture of what was going on in the venture and helped to focus the interviews. The interview notes were used in order to abstract issues raised by the different team members. Second, analyzing the field notes and interviews notes, we dotted down the most important issues as perceived by the different team members. The first order issues and events that emerged from this exercise (Table 2) were then grouped in second order issues (Table 3) for some important themes).

Table 2: Sequence of venture development - first order issues

<table>
<thead>
<tr>
<th>Date</th>
<th>Issues</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 – Spring 1999</td>
<td>Path dependency: availability of FIRST subsidies and creation of other spin-off</td>
<td>Interview John1 and Company Coach</td>
</tr>
<tr>
<td></td>
<td>Three technical researchers, of which one decides not to get involved in kick off of the spin-off</td>
<td>Interviews with team members</td>
</tr>
<tr>
<td></td>
<td>University department head has not been very supportive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Once the business idea really became concrete, colleagues at university became rather envious</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Looking for business plan coaching and start capital</td>
<td></td>
</tr>
<tr>
<td>Spring 1999 – June 2000</td>
<td>First draft of business plan</td>
<td>Interviews with team members</td>
</tr>
<tr>
<td></td>
<td>Two technical researchers (John1 and John2, complemented with Daniel, John3 and Jésus)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pedro and May were attracted externally</td>
<td></td>
</tr>
<tr>
<td>June 2000</td>
<td>Formal legislation of the company</td>
<td>Formal company documents</td>
</tr>
<tr>
<td>July – August</td>
<td>Installation of office space</td>
<td>Interviews</td>
</tr>
<tr>
<td></td>
<td>Prepare IBC: brochure, technical specifications (International Broadcasting Conference): great expectations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Opportunities in security</td>
<td></td>
</tr>
<tr>
<td>September 2000</td>
<td>Daniel and Pedro become officially “employees” of the company (i.e. on the pay roll of the spin-off)</td>
<td>Start participant observation (2 days per week)</td>
</tr>
<tr>
<td></td>
<td>IBC</td>
<td>Participant observation</td>
</tr>
<tr>
<td></td>
<td>No consensus about hierarchical structuring</td>
<td>Interviews</td>
</tr>
</tbody>
</table>

5 The issues are categorized in the period during which they first became prevalent. It does not mean necessarily that their importance vanished later on.
<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>Data Collection Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 2000</td>
<td>Everybody needs to find a role in the venture</td>
<td>Interviews and meetings</td>
</tr>
<tr>
<td></td>
<td>Company Coach appointed Daniel as responsible for following up the projects</td>
<td>Participant observation</td>
</tr>
<tr>
<td></td>
<td>In deciding for a responsible for project follow up, human factors should not be neglected</td>
<td>Informal talk with Daniel</td>
</tr>
<tr>
<td></td>
<td>Daniel is convinced that John1 has not the appropriate profile to be the business manager, neither to represent the team in the Board of Directors</td>
<td>Informal talk with Daniel</td>
</tr>
<tr>
<td></td>
<td>John1 is crucial regarding team spirit and team motivation</td>
<td>Informal talks with team members, including Daniel</td>
</tr>
<tr>
<td></td>
<td>Construction of website is considered as very urgent, including internal documentation system and shared calendar</td>
<td>Meetings</td>
</tr>
<tr>
<td></td>
<td>Disagreement about whether or not a new employee should be attracted with graphical competence for developing the website, proofreading English documents, ...</td>
<td>Meetings</td>
</tr>
<tr>
<td></td>
<td>Work hours (disagreement about whether or not everybody should be present in the company between 12am and 5pm)</td>
<td>Meetings, informal talks</td>
</tr>
<tr>
<td></td>
<td>Strategic re-orientation of projects: 1 FTE is re-allocated to security, given market opportunity</td>
<td>Meetings</td>
</tr>
<tr>
<td></td>
<td>Lack of human resources for the Broadcasting project</td>
<td>Meeting John1, John2, May and company coach</td>
</tr>
<tr>
<td></td>
<td>Commercialisation /marketing of broadcasting project should be first priority</td>
<td></td>
</tr>
<tr>
<td>November 2000</td>
<td>Strategic discussions regarding broadcasting project, within the coming weeks a whole range of questions needs to be clarified: is the market ready? What about partnerships?</td>
<td>Participant observation, Meetings, informal talks</td>
</tr>
<tr>
<td></td>
<td>Putting in place a discussion scheme for the broadcasting project (to speak a “uniform” language)</td>
<td>Observation, informal talks, meetings</td>
</tr>
<tr>
<td></td>
<td>John1 seem to monopolise external information from potential customers: he has to communicate more what is really going on</td>
<td>May, meetings</td>
</tr>
<tr>
<td>December 2000</td>
<td>John1 still takes care of most external communication, he has all the relevant contacts</td>
<td>Observation, interview research assistant, interviews team members</td>
</tr>
<tr>
<td></td>
<td>John1 realises that the broadcasting project can not be commercialised within the coming two-three years (after meeting with stakeholder from the Broadcasting Industry)</td>
<td>Briefing after trip of John1 to Geneva</td>
</tr>
<tr>
<td></td>
<td>Preparation of a meeting of the Board of Directors</td>
<td>Strategic team meeting</td>
</tr>
<tr>
<td></td>
<td>Preparation of a demand for capital increase (permission</td>
<td></td>
</tr>
</tbody>
</table>
is obtained, capital needs to be attracted externally, the university seed capital fund is not willing to invest)

January 2001  The business manager starts questioning his role and position in the venture. Therefore he wants a talk with the company coach.

March 2001  Internal communication problems are reaching a high Demo Datacasting flops

April 2001  Prototype Digital Cinema to main partner

Start discussing internal organisation of the venture: job descriptions, organizational flow chart

Daniel re-allocated to security

May 2001  Decision of Board of Directors to stop all developments in datacasting: firm focuses on security

John2 starts looking how parts of developments for datacasting project can be commercialised (three months)

Pedro re-allocated to security

Summer 2001  Daniel becomes CEO

Company Coach exits company

Finally, at the conclusion of the field work, we integrated the analysis of the interview transcripts, field notes and the interim site summary in order to address the following question: How does the entrepreneurial team get formed and evolve in a research-based spin-off?

Table 3: Team related second order issues

<table>
<thead>
<tr>
<th>SECOND ORDER ISSUES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>The venture champion</td>
<td>The importance of the role of the business manager, being here the venture champion</td>
</tr>
<tr>
<td>Role development</td>
<td>All team members communicated that “finding their roles in the company” was crucial in this start-up phase</td>
</tr>
<tr>
<td>Work Time flexibility</td>
<td>Different issues were communicated related to work hours and whether or not they should be controlled: source of conflict</td>
</tr>
<tr>
<td>Project management and technological evolutions</td>
<td>Groups the issues related to the projects and the way they evolved. The data are indicative to prone that the way the team developed is inherent to the strategic evolution of the projects</td>
</tr>
</tbody>
</table>
The basic argument of this paper is that shocks in the founding team and the position of its champion coexist with shocks in the development of the business, along the life cycle of the new venture. Our analysis shows four distinct phases of development of the venture and its entrepreneurial team (see Figure 1). A first phase is related to the *idea phase*. Herein, the CINE project team consists of three technical researchers, with one clearly delineated project leader. The latter is in charge of planning, follow up and proposal writing. The *pre-start-up* phase is introduced by the actual decision to spin-off from university. The project leader proved to be the “champion”, driving the idea, looking for business plan coaching and putting a team together: “managing the idea all the way through completion”. After formal legislation, introducing the *start-up* phase, our observations and interviews supported the well-accepted view that champions often do not make good managers. This paradox can be explained by the fact that the team needed time to accept that the initial champion is actually not the appropriate person for being the business manager. Triggered by speedy technological evolutions, the *post-start-up* phase is characterised by gaining strategic focus and professionalising the organisation of the team. In the next section, we discuss these empirically derived phases in more depth.

*Figure 1: Development of the venture along the organisational life cycle*
6.1. THE PROJECT PHASE: a project team at university

The spin-off that we followed up was built on a project that started in 1997 for the planned duration of 3 years. Within the project requirements, there was a clear objective of research commercialisation in general and the creation of a spin-off in particular. At the same time, there was a policy shift at university, urging researchers to commercialise their research results. This change in policy was informed both by international trends as by recent success stories in the Walloon region (e.g. IPO of IBA in 1997).

The project manager from the department since 1996, became the project leader of the CINE project. He was not only responsible for planning and follow up, but also for establishing and maintaining contacts with industry. Two other technical engineers were working on this particular project. When the project was half way (spring 1999), two situations stimulated the actual development of the spin-off. Firstly, there was the availability of a FIRST SPIN-OFF scholarship. “First spin-off” was created in 1998 as a part of the ‘FIRST’ PROGRAMME, established by the Walloon government in 1989. It has an operating budget for providing 20 grants, offering researchers the possibility to work during 2 years on the completion of a product, a procedure or an innovative service concept, to carry out an economical and technical feasibility study, and to write a business plan for the creation of a spin-off. It is a measure initiated by government for providing pre-seed capital to academic entrepreneurs. Secondly, the creation of another spin-off from the premises of the university (April 1999) also led to the final decision and preparations to start up CINE. Thus, a new phase in the spin-off process is introduced: the pre-start-up phase, in which the business opportunity needs to be further validated. Moreover, the business plan is developed, start capital is negotiated and the entrepreneurial team is formed.

6.2. THE PRE START-UP PHASE: Championing the business idea into a new venture

Early 1999 the three technical researchers working on the CINE project started looking for business plan coaching, as none of them had any business experience. After having established different contacts they got business coaching from a University professor, who would eventually become the company coach with CEO
responsibilities (see Research Setting). Between September 1999 and April 2000 also recruiting started on the premises of university. From October 1999 onwards we started to follow up the venture, gaining insight in recruiting decisions. The technology platform of the future spin-off would be datacasting (CINE project) and during the project, contacts had been established with two local companies (NEWTEC en EVS) that had made explicit their interest to co-operate. Since EVS had communicated that a security module was necessary in datacasting, John3 was involved in the start-up effort. Jesús, sharing the office with the three original project researchers and John3, joined the team as well. Next to the skills that were developed in the CINE project by the three technical project-researchers, there was a need for a hardware specialist for enabling the co-operation with NEWTEC. Daniel was attracted to serve this purpose and a concrete project was started with NEWTEC. Although the team members communicated that "matching personalities" are important for getting together in the business, the composition of the team was mainly technologically driven. After a while an engineer with some industry experience was attracted.

During the pre-start, the project leader (John1) was the driving force behind the spin-off process. Without him, start-up would probably not have taken place. This supports the well-accepted notion that an "idea either has a champion or dies". Identifying John1 as the champion of the venture resulted from different accounts. First, we came to this conclusion observing his position as a project leader and looking at how he profiled himself in the team along the development of the business idea. He put himself automatically into the role of the one who steered the idea and motivated others to join. Second, the other team members clearly pointed to John1 as the one who "started it all". He inspired the idea, motivated people to join and put in a lot of energy in order to arrive at start-up of CINE. Third, although we did not specifically test John1 for the champion related characteristics described by Howell and Higgins (1990), his personality, charisma and early and ongoing informal leadership role in the spin-off process was obvious.

In April 2000, the first draft of the business plan was provided at the university's seed capital fund. Because of personal (family) issues, one of the project researchers decided not to engage in the kick off of the business, and left the department late
1999. The spin-off was formally legislated in June 2000, with six founders. Peer nomination and the distribution of the founders' shares reflect that the six engineers are all considered as founders. However, two of them only got on the pay roll of CINE in September 2000. Support from university consisted of the use of PC material and the fact that two other engineers remained on the pay roll of the university. At the time of writing (summer 2001) CINE employs seven individuals, of which one part time function is still paid by university and two full time engineers are financed by the FIRST Program. The operations manager was attracted externally and started working for the company in July 2000. At start-up, the team members are not organised hierarchically and each had a high degree of control over his work. In Table 4, we provide an overview of some demographic characteristics of the founders/employees.

<table>
<thead>
<tr>
<th>Team members</th>
<th>Founder</th>
<th>Nationality</th>
<th>Education</th>
<th>Age</th>
<th>Academic experience</th>
<th>Industry experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>John1</td>
<td>Yes</td>
<td>Belgian</td>
<td>Civil Engineer, telecommunication specialist</td>
<td>31</td>
<td>6 yrs.</td>
<td>No</td>
</tr>
<tr>
<td>John2</td>
<td>Yes</td>
<td>Belgian</td>
<td>Licentiate in Sciences</td>
<td>30</td>
<td>3 yrs.</td>
<td>No</td>
</tr>
<tr>
<td>Pedro</td>
<td>Yes</td>
<td>Spanish</td>
<td>Civil engineer</td>
<td>27</td>
<td></td>
<td>4 yrs in multinational</td>
</tr>
<tr>
<td>John3</td>
<td>Yes</td>
<td>Spanish</td>
<td>Civil engineer</td>
<td>26</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Jésus</td>
<td>Yes</td>
<td>Spanish</td>
<td>Ph.D., Civil engineer</td>
<td>28</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Daniel</td>
<td>No</td>
<td>Belgian</td>
<td>Ph.D., micro-electronics</td>
<td>29</td>
<td>5 yrs.</td>
<td>No</td>
</tr>
<tr>
<td>May (F)</td>
<td>No</td>
<td>Belgian</td>
<td>Economist</td>
<td>28</td>
<td>3 yrs.</td>
<td>2 yrs fiscal consulting</td>
</tr>
</tbody>
</table>

The formal legislation of the company introduces a new era: the champion automatically becomes the business manager and the team members need to find their place in the newly formed company. Although the investor put in place a company coach formally delegated with CEO responsibilities, the business manager / champion seemed to negatively affect the speed at which the strategic technological focus was
adapted to the actual needs of the venture. In the following paragraphs we discuss these issues in more depth.

6.3. THE START-UP PHASE: The champion as business manager and inducer of strategic inertia

During the start-up phase the business manager keeps “championing” the new venture, arranges the physical infrastructure and related operational matters, makes sure internal agreements are made and held by all team members, and manages -- in co-operation with others -- the development of a certain communication structure. Although the investment fund did not want the “champion” to be the formal CEO, they did not question his role as business manager, nor did the team members. Every team member clearly agreed about the fact that the project leader and inspirer of the research lab at university would become the business manager of the spin-off. All team members clearly accepted the champion as the informal leader of the venture.

The automatic evolution of the champion role into that of the business manager is in line with Burgelman’s (1983) longitudinal study of internal corporate venturing projects, where it is noted that the transformation process from product champion to the venture manager occurred almost naturally and automatically. Although normative theory might question this practice, there seem to be very strong pressures to let the technically oriented product champion become the venture manager. In this study, the pressures were in part motivational, because the champion was attracted by the opportunity to become a general manager, but it also resulted from the fact that apparently there was nobody else around who could do the job.

Although the company was formed on one core technology platform (datacasting), the work of the engineers was organised around three "projects", resulting in three work groups: one for the broadcasting project (three persons), one for security (one person) and a hardware project (one person). The business manager (although intrinsically connected to the Broadcasting project) is not included in these work groups, neither is the operations manager. The goal was to commercialise the datacasting system, in which first the International Broadcasting Conference (IBC) (September 2000) and then an industry demo planned in March 2001 were expected to play a crucial role in
the commercialisation of the system. Next to this, a security module would be
developed and introduced in the system "on the way". However, shortly after start-up
a large firm and potential customer requested a security module, which was
technologically not linked to the datacasting activity. This market opportunity was
based on the Ph.D. of John3 and accepting it would possibly allow CINE to enter the
security market. Moreover, developing a prototype for a third party would generate
revenues. This was an unexpected evolution for the team. Changing -- or broadening -
the focus was very difficult for the group. First, because a priori, changing an initial
business idea "does not seem to fit with human nature". Second, because of the
“security” opportunity, the available manpower for the broadcasting project
diminished6, which had implications for the throughput time needed for the
development of the broadcasting project. Third, not having a very clear idea about the
market for security made things even more complicated. Concurrently, the insight
grew that the market segments for which the broadcasting prototype was developed
are actually not ready to adopt the technology. The expectation that after the IBC the
venture would be able to sell the datacasting technology, was not met. Conversely,
people seemed to be interested in the technology but stated that it would be something
to acquire, say, in a few years time. Moreover, with regard to their ONLY potential
client, decision making is too slow and bureaucratic, adopting the technology would
require a substantial mentality change,…
It was not before the champion visited the main potential customer group (December
2000) that he finally came up with the conclusion that "our broadcasting technology
cannot be commercialised before three years time...". However, the team was
convinced that it would be possible to commercialise parts of the system (e.g. router,
IP/TCP gateway, ...) after a successful demonstration of the fully integrated system in
March 2001. Hence, the venture remained active in datacasting.

As a result, a time lag occurred before the technological focus of the venture was
adapted to the actual needs and realities of the market. One of the engineers stated that
one of the most difficult things in CINE relates to the fact that they are not
specialising in one single technology. Ideally, he goes on, we should have two
independent structures, but still belonging to the same company. The broadcasting

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6 One engineer was re-allocated to the security team and an additional developer was hired.
market s not expected to generate huge revenues, but it seems a secure market. Conversely, as for security, the market is much more uncertain but potential revenue streams are expected to be substantially higher. Hence, it is argued that having both in one company is good to spread the risk. We checked this view with other team members, and the opinions seem to converge in this respect. During this period, the work groups are divided in such a way that three persons are working on the security project and two persons are developing for the broadcasting project. The hardware specialist (Daniel) is involved in hardware projects that are rather distinct from the others, but which are generating cash flow.

The business manager also seemed to be too much occupied with operational matters and did not communicate efficiently with the operational manager (May). Since she is a non-technical person, it was very important that she and John1 would team up, to follow up on commercial contacts. This seemed to be impossible. Moreover, when the Coach asked him to make a planning, or to get in touch with potential customers, other practical things always came first. Next to these practical worries, the business manager adapted the technical requirements continuously without consulting his fellow workers involved in the Broadcasting project. Consequently, the other engineers developed certain aspects “because John1 told them to”. Often this need for “sudden and urgent” adaptations was initiated by a phone call of a contact in the Broadcasting industry. What is clear from these examples is that John1 monopolised the information that came into the venture, thus trying to put himself into the position of CEO.

Thus, the venture champion did not function adequately as business manager and slowed down strategic decision-making, by monopolising essential information and by sticking too long to the original, commercially non-viable business idea. At first, the lack of managerial -- and more specifically, strategic and commercial -- competencies of the venture champion were only observed by the Coach. As a result, the Coach got so fed up with the situation that he decided to put Daniel in charge as a project manager and to help with establishing commercial contacts (mid September 2000). Moreover, the Coach wanted him in the Board of Directors. John1 did not agree, resulting in a conflict with the Coach. Eventually the team decided democratically that every Friday, each individual would present his project in a technical meeting, without one person being "in control". The underlying assumption
was that the "social control" mechanism would work to follow up project planning as strictly as possible. In an informal conversation with Daniel, he stated that human aspects should not be neglected in issues like this:

"In totally new teams -- where members are unfamiliar with each other before start-up -- you can move responsibilities easily. However, when team members know each other for a longer time, personal aspects matter too much. Although I still believe that John1 is not the most appropriate person to be in the Board, it is the only option at this time. John1 is too important a person regarding team spirit and motivation. If this conflict would not have been solved like this, John1 would definitely become demotivated, with clear negative consequences for the team and on the company in general."

In the meanwhile the preparation and developments for the demo in March continued and the security project was on scheme. From December 2000 onwards, Daniel helped out with the Broadcasting project, especially from a strategic perspective. For example, Daniel took up the initiative to construct a general overview of the stages of development of the broadcasting project. Because of the complexity of the project, everybody seemed to interpret things differently and -- he argued -- a roadmap was necessary to ensure that "we all speak the same language". Daniel, the only engineer in the team who had according to the Coach the capacity to become a future CEO, had become increasingly accepted as a business developer. His lack of industry and management experience however, does not make him the most suitable CEO candidate. As for John1, although he had lost most of his champion and business manager appeal, the coach believes him to be valuable in the company as a technological gatekeeper. Among the engineers, he is the only one who professionally scans the “technological popular literature”, he is very aware of all movements in the Walloon IT sector. In addition, he likes to go for lunches and dinners with technical people of different associations, universities and administrations…

In conclusion, although the investor and the Company Coach did not believe in the managerial competencies of John1 from the onset, the team needed time to realise this. A dual tension emerged. On one hand, he is their friend … On the other hand, team members realised that he is not capable for leading the company. Since his role became increasingly unaccepted by the fellow team members, it was only during that time that the team members were ready to accept the necessity for a full time CEO.
The Coach himself had no interest to fulfil this function. His objective is to leave the venture after a full time CEO can be put in place …

As we mentioned earlier, the company remained active in datacasting and prepared for the March 2001 demo. This datacasting demo turned out to be a flop: the system was not stable and too slow. From a business point of view, the system seemed to be of little value. In the entrepreneurial team, the feeling arose that John2 was consuming the capital of the company while security booked successes both financially (pre-royalty revenues from a co-development partner and a subsidy of 500 000 EURO) and in terms of business opportunities.

As a result of the increased and successful security activity, the Company Coach suggested that Daniel would be involved in the business development part, which included time-consuming interviews in the US. Therefore, Daniel needed to scale down his hardware activities and his supporting activities for datacasting. Since John1 was still spending a large amount of time on datacasting relations, he could not do this. Hence, Daniel built a network in security, which decreased the power of John1. Also Pedro was reallocated to the security activities. Next to this, mid May the Board of directors decided to stop the datacasting developments and requested that John2 would look for opportunities to commercialise existing components of the system. As a result of this, John1 had become in practice the business manager of a terminated activity.

Successful demonstration of the security system in digital cinema in June, July and September resulted into letters of intent of potential clients and co-development parties. Although no revenues were generated yet, the business risk had decreased significantly. CINE had become a “name” in the world of digital cinema and potential clients in related businesses were asking CINE to make a proposition for their security problems; However, since real revenues were not to be expected in the first year and since the business development efforts, including different contracts with lead users, had to be intensified, the board of CINE decided that a capital increase was needed. The search for new capital could be accompanied by a major restructuring of the

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7 John1 in the Board and using the social control mechanism for ensuring project follow up.
company’s internal organisation. Since the team considered Daniel as a successful business developer for the security module, he was accepted as the CEO of the only business that remained in life: security. Also the financial investor was convinced this was the best choice since Daniel had established all contacts with the potential clients. Once revenues were generated, he could be assisted by an experienced COO to manage the internal operations of the company.

In conclusion, the external shocks facilitated the internal reorganisation of the company. Only after the flop and the subsequent abandoning of the datacasting activity and after the successful demonstrations in security, the organisation and the external parties that control this organisation were ready to appoint a new CEO and re-organise the team.

6.4. THE POST START-UP PHASE: Technological evolution as trigger for strategic focus and professionalising the organisation of the team

Clearly, the technological evolution in the company -- successful developments in security and flopped datacasting -- take CINE to another level of business functioning. The most important focus is now to further develop and follow up (existing) business opportunities in security, whereas until now the venture had been active in convincing potential customers of the datacasting technology. Different interested customers and partners need to be contacted and related businesses further developed.

Although we have noted that Daniel might not the best CEO candidate, finding an external, experienced CEO for a high tech start-up like this is extremely difficult. A person like this needs the skills to negotiate at a very high level (middle or senior management of big companies), needs international contacts, needs experience with international VC investors. Thus, it is more likely to look for a professional management / coaching organisation of a small team of persons, which unite this experience to back up a CEO like Daniel, who is internally the best option.

In conclusion, during the post start-up phase the emphasis is on business development and CINE’s strategy and structure is clearly agreed upon. The core business of CINE is SECURITY with two strategic lines: conditional access systems for business to
business and the implementation of cryptographic modules. Consulting activities are only accepted if these are in line with the strategic objectives. Figure 2 shows the organisational structure in September 2001.

Figure 2: Structure of the new venture team

7. Contributions to Theory

In the remainder of the paper we point to the relevance of the research for theory.

7.1. Unfolding the paradox of the entrepreneurial champion: enabling experiential team learning

As aforementioned, the champion is a crucial person during the pre-start period and a part of the start-up period of the venture. It has been argued -- empirically as well as theoretically -- that the "champion role" is absolutely necessary for organisations to develop successfully new products (Chakrabarti, 1974), new technologies (Howell and Higgins, 1990; Lawless and Price, 1992), and new businesses (Burgelman, 1983; Day, 1994). Without champions, product innovations and corporate venturing are unlikely to occur. It is interesting to note, however, that in this context we are not focusing on the typical engineer in an R&D department that cannot be promoted vertically given his lack of managerial interest and / or competence. The technical

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8 To overcome motivational problems related to this, organizations have been implementing “dual career paths”, promising equal rewards to equivalent levels in two parallel hierarchies: one provides
person we are talking about, clearly distinguishes himself by acting as a “champion”, demonstrating typical personality characteristics, transformational leadership behaviours and influence tactics (Howell and Higgins, 1990). Next to the focus of researchers on (personality - behavioural) characteristics distinguishing champions from non-champions (see also Shane, 1994), other emphases include political processes at stake in the championing process (Frost and Egri, 1991; Markham, 2000) and cultural differences in innovation strategies (Shane et al., 1995). Moreover, Maidique (1980) states that the entrepreneur is important as a champion of the new technology, as vigorous promotion is needed to overcome resistance to the idea and the creation of the new venture.

Although the entrepreneurial champion plays an essential and valuable role in creating the new venture, he is often considered unsuited to providing the stable base needed for long term growth (Burgelman, 1984). Conventional wisdom and small business literature hold that new firms rapidly outgrow the founder's managerial capacity. It is argued that unless the founder is replaced or supplemented by professional management, performance is predicted to stagnate or decline. A similar observation has been made when it comes to technological champions: they as well do not seem to make good managers. Therefore, companies have tried to establish career tracks for those technical people who see themselves or are viewed by others as less interested or less capable of carrying out managerial responsibilities. Thus, dual ladder promotional settings have been implemented.

The literature does provide some insight on how champions / entrepreneurs relate to other individuals part of their team. However, the group contexts in which champions (intrapreneurs) and entrepreneurs are embedded represent separate streams of inquiry with their own particular emphases (new product development teams versus entrepreneurial teams). In practice, however, these streams and their corresponding managerial relevance go hand in hand. Other innovation roles -- next to the champion -- include a "technical expert", a "sponsor", a "projectleader" and a "gatekeeper"
(Brown and Eisenhardt, 1995; Frohman, 1978; Katz and Tushman, 1981; Markham, 1998) -- all considered as important additional roles in managing projects successfully. Each from diverse methodological and theoretical stances, different streams in the New Product Development (NPD) literature have clearly indicated that the project team is at the heart of the product development process. Team factors such as team composition (functional heterogeneity, team tenure and size), team group processes, including the team’s actions and behaviors (internal and external communication) and psychological dimensions, and finally, problem solving styles, have received considerable attention (e.g.: Ancona, 1990, Ancona and Caldwell, 1992; Smith et al., 1994; Jehn, 1997). Recently, attention has shifted from the lone entrepreneur / founder to the whole entrepreneurial team (e.g. Cooper and Daily, 1996).

An apparent paradox thus emerges: Although "founders" of organisations as well as champions of technological innovation are often perceived as being no good managers, in practice these individuals often do function in one of the key management positions. Our data suggest that the champion’s paradox can be explained by the fact that the team needed time to come to the insight that the champion is actually not the appropriate business manager. Initially, John1 is accepted as an informal leader. The CEO -- who is functioning as a company coach -- is accepted as well but experiences opposition from the business manager, in order to gain formal authority. Actions on behalf of the coach could not be undertaken before this “learning” occurred. It is clear that this process can’t be forced. Learning by doing seems to be essential in order for the team to understand the need for external formal leadership. Unfortunately, the business manager seems to need even more time to accept his role. His beliefs about becoming the CEO remain very strong. Collective team learning seems to precede individual learning of the champion.

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Brown and Eisenhardt (1995) distinguish between three particular streams: NPD as rational plan, NPD as disciplined problem solving and NPD as communication web.
7.2. Toward a midrange theory: entrepreneurial team formation as a process of self-organising punctuated equilibria

Numerous researchers have described life cycle stages ranging from three to ten phases (Kazanjian 1988; Hanks et al. 1993). However, for new ventures the organisation’s life cycle has traditionally been divided in three stages (Van de Ven et al., 1995; Roberts, 1991, p.126). Roberts, for example studied the life cycle of MIT spin-offs and labelled the three stages in their growth path as: (1) start-up, (2) initial growth and (3) sustained growth.

However, looking at entrepreneurial team formation during the spin-off process of a research-based spin-off, we empirically elaborated the “start-up” phase discussed in the traditional life cycle models. Although consistent with the models found elsewhere in the literature, our model, grounded in one in depth case study, differs in that it explicitly describes stages as linked to the spin-off process. Encompassing an idea phase, a pre start phase, a start-up phase and a post start-up phase, our model adds value by pointing to the process character of “founding” a research-based spin-off. However, our case data suggest that shocks in the environment precipitate the shift from one stage to another. More specifically, entrepreneurial team formation seems to evolve through the alternation of periods of equilibrium, in which underlying structures permit only incremental change, and periods of revolution, in which these underlying structures are fundamentally altered (Gersick, 1991). Although organisational stage models postulate a set of distinct and historically sequenced stages, we integrate Romanelli and Tushman’s (1984) view, stating that organisations may reach their respective strategic orientations through systematically different patterns of convergence and reorientation, with a life cycle perspective of the spin-off process.

The first period of equilibrium that emerged form the data, represents the idea and pre start-up phase, in which the different founding team members and the business idea converge steadily towards the formal legislation of the venture. During that time the level playing field and the rules of the game get designed. The formal start-up of the company can be viewed as a first “revolution”, implying a whole new context and changing expectations towards the team members. The champion becomes business
manager, each engineer is assigned to a particular project with distinct responsibilities, … People try to find their respective places in the company. Although during this equilibrium period team learning is crucial, it comes to an end when a capital increase is decided upon after a reorientation of the company strategy. From then on, professionalising the management structure becomes a key element.

This process however, can not be forced to quicken its pace, since the team needs a sufficient amount of time to understand the team related implications of strategic orientations and vice versa.

8. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

We have provided a processual, empirically grounded view on how entrepreneurial team members, including the “champion”, evolve within a new venture. Although empirical research has focused on entrepreneurial characteristics from different perspectives\(^{10}\), we did not find that researchers looked at how entrepreneurs or founders of companies outgrew their champion roles and how such teams are formed and develop during the spin-off process. Our data support the view that champions / entrepreneurs often do not make good managers, but we extend the theoretical and managerial relevance by pointing to the necessity of managing this individual effectively, in order to keep a motivated entrepreneurial team and to increase the likelihood of survival of the company. The basic argument of this research is that the development of the champion role and the entrepreneurial team as a whole clearly interrelates with life cycle stages of the venture and that it takes time before a founding team finds its role and accepts the need for an experienced CEO. Changes in the team go hand in hand with shocks in the emerging business, pointing to a self-organising process of punctuated equilibria.

\(^{10}\) Empirical research focusing on entrepreneurial characteristics generally falls into one of two generic types. (1) Those that attempt to associate various characteristics with the state of entrepreneurship (individual characteristics separating entrepreneurs from non-entrepreneurs) (Herron and Robinson, 1993). (2) Those that attempt to use characteristics to predict performance among entrepreneurs or the businesses they run (e.g. Roure and Keeley, 1990). Despite the large number of studies of both types, it is notable that neither has had much success in achieving statistical associations that are of practical and replicable significance.
The data show further that the “learning” processes, which take place in the team, are very important. In an environment, which is not very well developed in terms of entrepreneurial activity such as the one in which our research site is located, the collective knowledge of the environment is not sufficient to facilitate learning processes. Instead, experiential learning seems to take place. Interestingly, the team learns faster than the individual champion himself. However, real changes seem only to be possible when external factors cumulate and cause a shift in the organisation structure.

Gaining understanding in entrepreneurial team formation during the spin-off process is particularly relevant for investors as well as technology transfer officers. Research has shown that venture capitalists state that the quality of the founding team is one of the most important criteria when they decide to invest in a start-up. High tech spin-offs, especially academic spin-offs, tend to be founded mostly by homogenous teams including only engineers. Often, one of these engineers is acting as a champion and perceives himself as a future CEO of the company. CINE’s team clearly coalesced around technical competence and interest. "Getting along" was very important. Venture capitalists tend to react against these start-ups in two ways: either they look for a CEO themselves and change the founding team drastically before investing or they do not invest at all. The second solution results in a number of valuable, potential business proposals that are lost. The first measure often results into harsh tensions between the newcomers and the initial team, and is thus seldom easily accepted by the original founders. Moreover, most CEO’s with business experience do not establish the “technical authority” needed to run a team of engineers. The most straightforward solution for venture capitalists seems to be the most exceptional one: someone in the entrepreneurial team has management capacities and becomes a CEO of the company. As shown in the paper, this is not necessarily the champion of the business plan. It can even be an engineer added to the team upon suggestion of the financial investor. The major lesson here is that the new individual has a technical role in the start-up and does not act as a CEO since the initial team only accepts the idea of a newcomer as a CEO once they clearly experienced the incapability of their “friend” as a “boss”. It seems thus a good idea, from a team efficiency perspective, to start a company – with a small amount of capital – in order to let the team members find their respective roles
in the independent company. Once everyone accepts his strengths and weaknesses and agrees with the structure, the company is ready for a capital increase.
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PAPER 2:

INSTITUTIONAL CHANGE AND THE RESOURCE ENDOWMENTS OF SCIENCE-BASED ENTREPRENEURIAL FIRMS: THE CASE OF IMEC

MORAY, N. AND B. CLARYSSE

WORKING PAPER GHEMT UNIVERSITY AND VLERICK LEUVEN GHENT MANAGEMENT SCHOOL.

UNDER REVIEW AT RESEARCH POLICY
III. INSTITUTIONAL CHANGE AND THE RESOURCE ENDOWMENTS OF SCIENCE-BASED ENTREPRENEURIAL FIRMS: THE CASE OF IMEC\textsuperscript{11}

ABSTRACT

This study takes an institutional perspective on spinning off ventures as a venue for commercialising research. The central question dealt with is the following: are the resource endowments of science-based entrepreneurial firms at time of founding influenced by the way in which technology transfer is organised at the parent organisation? We have selected a research institute known for its international research excellence and with a track record in spinning off ventures: IMEC (Leuven, Belgium). We questioned all senior managers involved in technology transfer and the founders of all science-based entrepreneurial ventures set up between 1987 and 2002. The basic argument of the research is that changes in the internal institutional environment -- and the technology transfer policy in particular -- goes together with a changing overall tendency in the amount of resources endowed to the science-based entrepreneurial firms. More specifically, we identify three generations of IMEC ventures displaying the main organisational changes in technology transfer policies and showing distinct resource characteristics at time of founding.

1. INTRODUCTION

How do institutional practices change? Researchers from different perspectives on organisations have directly or indirectly addressed this aspect of organisational reality. The question is important because it points to whether and how organisational order is maintained. The primary objective of this paper is to address this issue at the organisational level, in the context of a research institute’s technology transfer policies with regard to new science-based entrepreneurial firms (SBEF). More specifically, we investigate the interplay between changes in the micro institutional technology transfer policies regarding SBEF and the resources endowed to these companies. We also reflect to what extent this matters in terms of the social-economic role these companies play today.

Although different authors have proposed stage models providing insight in the dynamically interrelated activities connected to spinning off ventures (Vohora, Wright and Lockett, 2004; Clarysse and Moray, 2004), only few have looked into the

\textsuperscript{11} We want to gratefully acknowledge the help and support of numerous persons during this research. We thank Johan Van Helleputte, Ludo Deferm, André Vinck, Herman Maes, Bénédicte Haven and Bart Van Bael for sharing their knowledge about IMEC, the spin out policies and disclosing the evolution of the capitalization of the IMEC starters. Without sharing their experience and reflections about past, present and future this study would not have been possible. Thanks to Els Van De Velde for her help in collecting the survey data from the IMEC start-ups.
specifics of internal strategies enacted by the research institute and how this influences the commercialisation of research results by setting up ventures (Markman, 2003; see for example Clarysse, Wright, Lockett et al., forthcoming). Through an historical process analysis, this study extensively documents the organisational level institutional changes regarding the spin-off policies of one research institute, IMEC, since its inception in 1984 up to 2003. Although these changes need to be partly understood in their broader environmental context, our objective is specifically to investigate the link between these organisational changes and the resources endowed to new SBEF.

IMEC, the Inter University Micro Electronics Centre (Leuven, Belgium) has evolved significantly in its technology transfer policies over the years and has set up 23 new ventures up to 2002. Selecting one case for this topic is appropriate because tackling the question of interest requires a detailed intra organisational understanding of the processes involved. Moreover, researchers have successfully used single sites studies to increase understanding about particular issues related to technology transfer and spinning out ventures (e.g.: Shane and Stuart, 2002, studying MIT spin-offs and Jacob et al., 2003, studying Chalmers University of Technology). IMEC has evolved to Europe's leading independent research centre in the field of microelectronics, nanotechnology, enabling design methods and technologies for ICT systems. Studying a centre of excellence is particularly useful because several researchers have argued that the successful commercialisation of technology and the emergence of new firms very often happens in close co-operation with organisations where top science is being performed (see for example the work of Zucker and Darby, 1996, 1998).

In the realm of spinning off ventures from research results two institutional templates coexist. The public research sector – which is an important source of research and technological opportunities – is largely taken for granted, and often largely mindlessly enacted. However, the private sector template, and the entrepreneurial process entailing the emergence of new ventures is often argued to function as an efficient market model, leading to the rational acquisition of sets of resources. This study attempt brings together these two realms in the context of creating SBEF. More specifically, we want to increase understanding as to how changes in institutional technology transfer policies co-shape the resources going to firms established to exploit research results.
To anchor the scope of our investigation, we frame questions from three perspectives, each representing subsequent steps in addressing the problem of interest: How is the process of spinning off ventures organised within a public research institute? How did this process change over time? Do the nature and the origin of resources going to the science-based entrepreneurial firms co-evolve with changes in technology transfer policies made by the parent institute? Using interviews and secondary data sources we reconstructed the life history of the institute’s commercialisation trajectory. Several researchers have used historical analysis successfully in the study of institutions and institutional change (Cusumano, 1995; Leblebici, 1991; Sini and David, 2003).

The remainder of the paper unfolds along the following lines. First, we discuss the context of science-based entrepreneurial firms from public research institutions in Europe and point to the importance of studying the interplay between the micro-institutional environment and the ventures that emerged from these. Second, we discuss the research and methodology of the study. Third, we present the data and findings. We position IMEC in the Flemish landscape of public research organisations, describe in detail the spin-off process as it is organised in IMEC and argue that three generations of science-based entrepreneurial ventures can be distinguished according to different eras in the management of technology transfer.

2. CONTEXT: SCIENCE-BASED ENTREPRENEURIAL FIRMS FROM EUROPEAN PROS

Since the mid-nineties, European public research organisations have been increasingly involved in commercialising their research results and spinning off new ventures (OECD, 1998; Purvis, 2002). More specifically, generating new companies has been viewed as an alternative to licensing and contract research. However, one caveat in many studies on science-based entrepreneurial firms has been the lack of a clear definition. In practice, science-based entrepreneurial firms often denote all the ventures that are “listed” as having emerged from public research organisations. However, these listings often include firms with different types of links with university or the research institute at time of setting up the firm. Roberts (1991, 103-107) already described the large variety in the high technology entrepreneurial firms that emerged from MIT. More specifically, he rated the importance of technology transferred to the new firm, representing the degree of dependence on source
technologies: direct, partial and vague\textsuperscript{12}. In these categories learned technology is unquestionably important; the difference is only in degree. In the first two categories, the company would not have been started without the formal transfer of Intellectual Property Rights; either from the parent institute or from another source of know-how. These categories represent the (IP based) spin-offs. These companies received a formal transfer of technology by means of a license agreement in return for royalties or IP in return for equity. The category “vague” represents those companies that are categorised as spin-off by the parent institute for other reasons than transferred technology. Following the UNICO/NUBS (2003) classification we label the latter category of firms academic “start-ups”: the firms based on know how developed at the PRO without formal transfer of technology. It is possible however, that the PRO has an equity stake through the provision of capital. The start-ups clearly use source learned (but often non protected and non formally transferable) knowledge and/or technologies.

We can find at least two major reasons why the formation of new companies – start-ups and spin-offs alike -- has become much more central to the mission of PROs. First, the creation of new enterprises is increasingly being used as a performance indicator for evaluating public investment in PROs. Second, the ‘hausse’ in the stock markets at the end of the nineties and, related, a number of extremely successful trade sales has attracted the attention of the management of these public research organisations. Professional organisations such as ASTP\textsuperscript{13} have repeatedly presented best practice examples of spin-offs as significant sources of income for public research organisations.

Because of the perceived increase in importance to commercialise technology, universities, national laboratories and other research organisations receiving significant public research funds started to develop internal systems to support this. These systems comprise activities such as the management of contract research, the protection of intellectual property, the negotiation of licenses and the support of independent start-ups. The development of procedures and systems to support and stimulate the creation of independent start-ups is in line with the contemporary notion

\textsuperscript{12} Since Roberts (1991) studied high technology entrepreneurship generically, he also included a category “none” to capture the firms that were set up apart from knowledge acquired during a research process in the context of the university (e.g. MIT graduates that started a car repair shop).

\textsuperscript{13} ASTP = Association of European science and technology transfer professionals. See http://www.astp.net
of science-based entrepreneurship, which is shifting from serendipitous and individual to being perceived as social and organised (Jacob et al., 2003). At the same time, the development of such procedures evokes the question of imprinting, dealt with in institutional theory. New firms founded to exploit intellectual property emerging from science are typically embedded in a parent organisation, bringing about its own culture, rules and procedures. In this perspective, institutional theorists argue that emerging firms build internal consistencies that are in alignment with their institutional context (Dacin, 1997). Intuitively, isomorphic forces might even be especially true in new ventures, which typically have a limited resource base: science-based entrepreneurial firms may incorporate legitimating structural elements in order to gain the legitimacy needed and to attract the necessary resources.

Concurrently to the development of this stream of thought, researchers have also urged to depart from their focus on organisations as tightly bounded entities, shifting their attention to the surrounding environment. However, ever since, a long debate has been going on among researchers whether it is strategic choice or environmental forces alone that are most important in creating new businesses (Venkataraman, 1997). Increasingly, researchers have viewed the degree of fit between the entrepreneurial efforts and environmental forces as crucial in the successful development of new businesses. Authors have suggested that these two perspectives are two ends of a continuum, which are interdependent and interacting, and theoretical and empirical work has been performed in this direction (e.g. Goodstein, 1994). Similar efforts have also been applied to the study of new ventures (e.g. Gersick 1994; Eisenhardt & Schoonhoven, 1990).

Some researchers have undertaken some steps in studying the organisational institutional context in which technology transfer activities take place. For instance, Bercovitz et al (2000) looked at the effect of institutional structures and policies on the patenting and licensing behaviour. Di Gregorio and Shane (2002) related the institutional determinants with the spin out rate of (public) research organisations. These institutional determinants include, among others, characteristics relating to
reward systems, entrepreneurial / academic culture, IP policies and the overall organisational structure of the research organisation.

In this paper, we want to go one step further and look at how institutional changes influence the resource endowments of ventures that are set up to exploit research results. Since the value chain of technology transfer by spinning off science-based entrepreneurial firms encompasses different parties -- scientists, technology transfer personnel, senior administrators and the founders of the companies – we employ a dual case study methodology (Leonard-Barton, 1990), combining historical and prospective case analysis. Based on 40 face-to-face interviews, 20 standardised questionnaires, archival searches and a database with evolutionary financial data about the companies, we analyse three interrelated issues. How the spin-off process is organised, how this changed over time, and finally, if these institutional changes have an impact on the resources endowed to the science-based entrepreneurial firms at time of founding.

The remainder of the paper discusses subsequently the research design and methods employed and the data and the findings of the study. We also point to the implications of the study.

3. RESEARCH DESIGN

We have selected a research institute known for its research excellence and with a well-established track record in spinning out ventures: The Interuniversity Institute for Microelectronics (IMEC, Leuven, Belgium). Over the years, IMEC has developed a pro-active and professional technology transfer and spin-off policy. It has been shown that new science-based entrepreneurial firms are most often started in the proximity of or from within research institutes with an excellent research base (e.g. Zucker et al., 1998). Therefore, it makes most sense to select an institute with sufficient critical mass regarding the issue of interest. Data collection is performed at different levels and using a mix of techniques, avoiding common method bias. Using archival data sources, standardised questionnaires and semi-structured interviews, we collected regional data on spin out activity, data about technology transfer policies and data about the science-based entrepreneurial ventures that emerged from the institute since 1991. These data collection efforts resulted in a combination of quantitative and
qualitative data, allowing triangulation (Jick, 1979). Our overall methodological perspective is a dual case study method (Leonard-Barton, 1990) focusing at the data level on historical analysis. The remainder of this section elaborates on the research site and the methods employed.

3.1. Research site

In 1982 the Flemish Government set up a comprehensive program in the field of microelectronics to strengthen the microelectronics industry in Flanders (Belgium). This program included the establishment of a laboratory for advanced research in microelectronics (IMEC), the establishment of a semiconductor foundry and the organisation of a training program (now INVOMEC & MTC). IMEC was founded in 1984 as a non-profit organisation led by Prof. R. Van Overstraeten and under the supervision of a Board of Directors, with delegates from industry, Flemish universities and the Flemish Government. Today, IMEC is Europe's leading independent research centre in the field of microelectronics, nanotechnology, enabling design methods and technologies for ICT systems. The research organisation’s principal mission is "to perform R&D, ahead of industrial needs by 3 to 10 years".

The research budget of a research institute as well as the patent activity, are two important indicators to position the magnitude of technology transfer. Despite the weak economical situation and the severe downturn of the telecom and semiconductor industry since 2001, IMEC’s self generated income in 2002 increased by 15% up to € 105 million or 76% of the institution’s total budget (€ 138 million). Almost half of this research happens with International Industrial Partners and about a third with Flemish Industrial Partners. The remaining 24% of the total budget comes as a subsidy from the Flemish Government.

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14 www.imec.be
Figure 3 shows that the patent activity has increased significantly since the mid-nineties. Research in an “IP mode” has increasingly become the core of IMEC’s activities.

Figure 3: Patent Activity at IMEC

From its inception in 1984, IMEC pursued being an internationally recognised centre of excellence in microelectronics. To achieve this goal, the institute has been participating in a multitude of collaborative efforts, including European R&D programs, European Networks and collaboration with leading-edge companies and R&D organisations in Flanders and internationally. In 1991, a new business model was introduced to manage R&D partnerships: IMEC’s Industrial Affiliation Program (IIAP). This model of joint R&D partnerships is based on shared costs and risks while expertise, talent and IP are brought together. This concept is now recognised worldwide, as one of the most successful international partnership models for research on next generation technologies addressing generic industrial problems in fields of rapid technological change.

With 85% of IMEC’s 1263 staff members actively involved in R&D, IMEC has developed strategic know-how ("background information"), a unique business model of managing industrial relations (intellectual property), visionary research programs and world-wide networking (Jaarverslag, 2002). Over the years, this centre has developed a professional technology transfer policy, including rules and procedures for establishing SBEF. Up to 2002, IMEC has set up 23 ventures, of which 20 since 1991.
3.2. Data collection and methods

We deliberately choose to use a wide range of data collection methods because looking at the interaction between institutional changes in spin-off policies and the SBEF generated from the PRO involves a multitude of actors, inherently requiring a combination of different data sources and methods. First, we collected data on the rate of establishment of SBEF from other PROs in the region\(^1\). We found this was crucial since this study is in its pure form “one case”. Although in “single” case studies analytical generalisation is of primary importance – instead of statistical generalisation – these regional data allow contextualising the findings and discernment about the scope of analytical generalisation. We position IMEC to other PROs in Flanders in terms of its relative importance in technology transfer indicators, setting up ventures from their research base and the extent to which start-ups versus spin-offs are generated. Second, we have interviewed all senior managers involved in technology transfer policies at IMEC. The interviews took place in 2002 and 2003 and the persons interviewed have significant experience in the organisation in general and in business development and technology transfer activities in particular (>10-15 years). Key issue in these interviews was to gain insight in the magnitude of technology transfer activities and how the spin out trajectory is positioned in the broader research commercialisation strategy. We also asked the respondents to explain how this strategy evolved over time. Third, we collected some numeric institutional data that have been widely recognised as informative when drawing inferences about the nature and the magnitude of technology transfer related activities. Different indicators are of particular interest: research budget, patent applications, revenues generated from license agreements, amount of companies set up from research results, …

Fourth, we interviewed one or more representatives (founder and/or CEO) of the 20 science-based entrepreneurial firms that emerged from the institute since 1991. Face to face interviews at the premises of the venture helped us to understand the organisational context. During these 1,5 hour interviews, attention was given to the start-up history of the firm in terms of technology transfer from IMEC, the inventors involved, how capital was attracted and how the company evolved since then. Fifth, \(^1\) We updated data collected by Clarysse et al. (2003) in a study on Spin outs in Flanders. We add to this effort by complementing the list of academic starters, distinguishing between academic start-ups and academic spin-outs and complementing the data on the capital these companies attracted at time of start up.
we performed more detailed process studies of 3 spin-offs, to better understand the
dynamics of venture formation and development as it is embedded in this particular
research organisation. One venture was prospectively studied over a period of 20
months, by interviewing the 3 founders over a 15-month period. The company entered
the incubation phase in December 2001 and was formally set up in February 2002.
Two ventures (both set up in 1996) were studied retrospectively by interviewing the
persons involved in the start-up process\textsuperscript{17}. We deliberately decided to select a
successful exit and a failed company that were established in the same year, to control
for broader environmental / economic conditions. Finally, in order to understand the
resource conditions of science-based entrepreneurial firms at time of founding and
how this evolved over time, we surveyed the ventures using a structured, standardised
instrument. Data on the financial resources at time of founding and evolution of the
capitalisation, the human resources in the firm and the maturity of the technology are
collected.

Table 5 provides a summary of the different data sources and the respective methods.

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|c|}
\hline
\textbf{Face to Face Interviews} & \textbf{Standardized Survey} & \textbf{Secondary sources} \\
\textbf{(N = 40)} & \textbf{(N=20)} & \\
\hline
\textbf{PRO} & \textbf{9} & \textbf{UNICO/NUBS TTO survey Total: 20} & \textbf{Press releases, Year reports, IMEC website} \\
IMEC Management & Total: 31 & & \textbf{Longitudinal database of financial data of 23 companies} \\
\textbf{Science-based entrepreneurial firms} & & & \textbf{Press releases, Year reports, company website} \\
\textbf{(20 since 1991)} & & & \textbf{Press releases, Company website} \\
2 spin-offs set up in 1996 & \textbf{8} & \textbf{Standardized survey} & \textbf{Press releases, Company websites, Year reports} \\
1 spin-off set up in 2002 & \textbf{6} & \textbf{Standardized survey} & \\
17 other SBEF & \textbf{17} & \textbf{Brief phone survey and standardized survey} & \\
\hline
\end{tabular}
\caption{Overview of Data Collection at IMEC}
\end{table}

\textsuperscript{17}One of those companies achieved a successful trade sale to a large corporate technology company in 2001. The
other company failed in 1999, after it did not succeed attracting Venture Capital.
4. DATA AND FINDINGS

This section presents the data and the main findings of the study. First, we briefly position IMEC to other PROs in Flanders. Second, we hone in on how IMEC’s spin out trajectory is structured and how it evolved over time. Third, we compare the IMEC starters with other science-based entrepreneurial firms and high tech start-ups in Flanders, in terms of start capital, founding team and technology development at time of founding. Fourth, we argue that three generations of IMEC ventures can be distinguished, mirroring the way organisational technology transfer policies evolved.

4.1. Science-based entrepreneurial firms in Flanders

The budget for Science, Technology and Innovation in Flanders amounts to 1322 million € in 2003, 57% of which is geared towards R&D activities (compared to 49% in 1996). The Flemish PROs – the universities and research institutes -- rely significantly on government financing for their activities either directly through subsidies or contract research. Moreover, since the mid-nineties there is an increasing attention for technology transfer activities. This trend was formalised in a number of university decrees that put the return and services to society equally high on the agenda of universities as education and research\(^ {18} \). Moreover, since 1998 the PRO legally owns the IP generated from research\(^ {19} \) and government started subsidising the interface services. In this context, PROs set up seed capital funds to facilitate investments in science-based entrepreneurial firms and interface services worked towards professionalising their activities. In Flanders, there are 9 Public Research Organisations, of which 3 are research institutes and 6 are universities. Siegel et al. (2003), identified a number of input indicators related to university – industry technology transfer, internal to the research organisation: invention disclosures (a proxy for the set of available technologies), labour employed by the Technology Transfer Office (TTO), and the legal fees incurred to protect the university’s IP. Table 6 gives an overview of these input indicators for all the Flemish PROs.

\(^ {18} \) Decree of February, 22, 1995 (B.S. 19 juli 1995)
\(^ {19} \) University decree of August, 29, 1998, art 103 (B.S. 29 augustus 1998); Cfr. Bayh-Dole Act in the US in 1980
Table 6: Characteristics of Research-Industry Technology Transfer in Flemish Public Research Organisations

<table>
<thead>
<tr>
<th>Research Institutes</th>
<th>Age of TTO (years)</th>
<th>Research Expenditure, K€</th>
<th>N TTO employees (new ventures)</th>
<th>External legal fees for IP protection, K€</th>
<th>Invention Disclosures</th>
<th>N academic ventures 1991 - 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMEC</td>
<td>9</td>
<td>136707</td>
<td>42 (12)</td>
<td>1600</td>
<td>103</td>
<td>14 / 6</td>
</tr>
<tr>
<td>VIB</td>
<td>7</td>
<td>52000</td>
<td>10 (1)</td>
<td></td>
<td></td>
<td>3 / 0</td>
</tr>
<tr>
<td>VITO</td>
<td>8</td>
<td>45000</td>
<td>19 (0)</td>
<td>180</td>
<td>0</td>
<td>0 / 1</td>
</tr>
<tr>
<td>Universities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KUL</td>
<td>32</td>
<td>183000</td>
<td>23 (3.5)</td>
<td>9</td>
<td>21</td>
<td>21 / 17</td>
</tr>
<tr>
<td>UGent</td>
<td>4</td>
<td>75902</td>
<td>3 (1)</td>
<td>400</td>
<td>25</td>
<td>2 / 12</td>
</tr>
<tr>
<td>VUB</td>
<td>5</td>
<td>48000</td>
<td>5.5 (2.5)</td>
<td>120</td>
<td>25</td>
<td>9 / 0</td>
</tr>
<tr>
<td>UA</td>
<td>4</td>
<td>44400</td>
<td>4 (3)</td>
<td>51</td>
<td>19</td>
<td>1 / 2</td>
</tr>
<tr>
<td>LUC</td>
<td>4</td>
<td>18700</td>
<td>1 (0,4)</td>
<td>2.5</td>
<td>0</td>
<td>3 / 2</td>
</tr>
<tr>
<td>KUB</td>
<td>0</td>
<td>816</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0 / 0</td>
</tr>
</tbody>
</table>

The Katholieke Universiteit Leuven (KUL) and IMEC are the largest research organisations in terms of research expenditure, the size of the technology transfer office and the science-based entrepreneurial firms generated from their knowledge base. Together, they account for 54% of the science-based entrepreneurial firms generated in Flanders between 1991 and 2002. Not surprisingly, it are exactly these two institutions that set the professionalisation trend among the interface services in Flanders. In total, 93 science-based entrepreneurial firms emerged from Flemish universities and research institutes from 1991 to 2002. The majority of these firms are spin-offs (56% or 52 companies). Given IMEC’s importance as a research institute in terms of research budget, liaisons with local as well as international industry, researchers employed and spin outs generated, IMEC is of high interest to the region as well as internationally.

Different authors have suggested that public research organisations differ significantly in relative productivity in transferring technology to industry and that studying the organisational practices in PROs management of IP would be a useful complement to studies focusing on numeric variation amongst institutes (Siegel et el. 2003; Di Gregorio and Shane, 2002). The next section elaborates in detail on the technology transfer practices related to spinning out new ventures in IMEC.
4.2. The spin-off process at IMEC: a centrally led technology push model

This section specifically sheds light on the spin-off process in IMEC and how it evolved over time. What is the decision making process and which structures does a potential project go through before it is actually spun off? Different activities of a proactive spin-off management process have been identified by Degroof (2002) and elaborated by Clarysse et al. (forthcoming). Following these authors’ conceptualisation, we discuss subsequently: (a) How IMEC has set up structures to enable the identification of technological opportunities. (b) How IMEC bridges the time between the identification of the opportunity and the start of the incubation phase. (c) The specifics of the incubation phase: which activities is IMEC actually engaged in? (d) The internal strategies towards IP assessment and transfer to the spin-off. (e) How IMEC finances the commercialisation process. Interviewing each senior manager at IMEC, we used these activities to structure the data and ask the respondents to also provide an historical account of how the implementation of these activities evolved over time. Figure 4 serves as a roadmap throughout this section.

Figure 4: The commercialisation process at IMEC by setting up science-based entrepreneurial firms.
a. Opportunity recognition

The recognition of entrepreneurial opportunities has been identified as one of the central features in the study of entrepreneurship (Shane and Venkataraman, 1999). How are these identified at IMEC? Since the mid nineties there is an increasing awareness at IMEC that knowing the pool of technological opportunities is a first step in the commercialisation process. Most recently, IMEC has been discussing opportunities to establish an Idea Board that has a technological orientation: what are the hot topics that are at most 3 years away from the application phase? Which industry standards are likely to be implemented? This Board wants to enable the proactive identification of new, potential intellectual property and ideas from a technological point of view. IMEC plans the establishment of this vehicle because they conclude that currently too small an amount of entrepreneurial ideas are brought to the fore. However, the commercial orientation of opportunity recognition for technology transfer in general and spinning off ventures in particular, seems to have a much longer history. Since business development Flanders started to exist as a formal structure and separate entity (1991), this division has undergone major changes and shifts in responsibilities. In the early years (1992-1993), business development was organised in its most generic form. Two persons, the heads of IMEC’s business development division, managed the commercialisation of research through setting up ventures. The most important shift happened in 1996-1997, when a separate “Incubation” cell was established. This cell moved a couple of times in the organisation structure of IMEC, showing that IMEC went through an important learning phase in the second half of the nineties as to where to position these “venturing activities”.

Senior management of the different departments is still very much involved today in the “Sales Board”. This structure takes the form of a communication platform that brings together the heads of department from the Scientific Divisions, the Incubation and Industrialisation Division and the Business Development Department. These Sales Boards are specific for each scientific division (DESICS, MCP and SPDT) and meet every eight weeks to discuss overall business development opportunities: technological developments that can be structured in contract research through IMEC’s Industrial Affiliation Programme with industrial partners, licensing agreements or opportunities for establishing SBEF. Compared to the Idea Board, this
platform has a commercial orientation. An idea is considered appropriate for a spin-off if the application phase is less than two-three years away and if IMEC can freely use the IP associated to the idea. Most of the time, this is an iterative process. If the Sales Board deems an idea or project feasible for spin-off creation, the project is administratively transferred to the division Incubation & Industrialisation (I&I).

b. From first market analysis to incubation

This phase during the spin out process as well as the actual incubation phase has gained momentum ever since a division "Incubation” was set up (1996-1997). Since then, the department has professionalised its activities from an organisational and methodological perspective. Currently, the I&I Division is a team of 8 persons of which 3 persons are directly engaged in evaluating and supporting specific spin-off projects. A project manager, who performs a preliminary market analysis and IP evaluation, is assigned to an idea to assess the market potential of the idea. Each of these 8 business developers have a PhD in engineering / sciences and are assigned to a project based on their acquaintance with the project’s technology. The project leader performs a preliminary market analysis and a first evaluation of the intellectual property position. This evaluation phase takes 4-6 months and happens in collaboration with the inventors/researchers that are interested in commercialising the technology through a spin-off. The result of this evaluation is a “Go / No Go” decision: If it is decided that an idea cannot be structured in a spin-off (yet), the idea is sent back to the Sales Board with specific feedback. If the results of the market analyses are positive, the project manager writes an Incubation Plan, again in close collaboration with the researchers(s)/inventor(s). Different aspects are taken into account: the financial requirements, milestones in technology development, (temporary) strategy of the project to reach market maturity. Interesting during this stage is that the role of the researcher – entrepreneur remains limited. The market analysis seems to be primarily a technical and methodological process. Input from the market is very limited. Ideally, some experienced business developers could be involved or a series of interviews performed with specialists from potential (industrial) customers or partners. Also, at this point the Vice President (VP) of I&I will have a meeting with the patent office (structured in the department Business Development Division) to evaluate the use of Intellectual Property components by
other companies, including the extent of exclusivity. The Vice President of I&I co-
ordinates this.

c. Incubation and business plan development

Once a project enters the incubation phase, the researchers involved get separate
offices on the IMEC Campus in order to start their first (commercial) activities.
Depending on the particular case, an ‘Incubation Company’ is set up. Sometimes it
may be important that the “incubated” project is set up as an independent company to
attract subsidies for technology development and to gain legitimacy towards potential
partners and / or clients. For the spin-offs established since 1999, this is always the
case and also reflects an increasing structuring and visibility of the incubation process
within IMEC.

The spin-off project is managed as follows: First, there is operational support to
develop the business plan. At the onset of the incubation phase the project leader of
I&I passes the incubation plan on to his colleagues from the Enterprise Cell within the
Financial Department (3 Full Time Equivalents). This Cell supports the project from a
“corporate” perspective: juridical / IP matters, accounting and fiscal issues. Second,
the project gets some strategic support. Although during this stage there is not a Board
of Directors, the researchers – entrepreneurs are coached in the development of the
company’s business model by a Steering Committee. This Committee meets monthly
and consists of the Vice President and the Project Leader of I&I, the Vice President of
the Financial Department, the Vice President Business Development and (one of) the
inventors / researchers - entrepreneurs. During these meetings the progress of the
company is discussed. Most of the time, the first concern is technology development
to arrive at a workable alpha prototype. Related to specific technology milestones,
these discussions also serve as a sounding board for the researchers – entrepreneurs to
define the business model and commercial strategy.

The technology driven character of the public research institute is also clearly
reflected in the profile of the employees from the division Incubation and
Industrialisation. Each of them has a strong scientific background, without or with
very little commercial, industrial experience. The project leaders prepare the spin-offs
and the activities during this process are developed via procedures and software
packages. Consequently, the market analysis and the development of the business plan
have a strong methodological orientation. However, various studies argue that ‘trial and error’ is at the heart of defining the market in these early stages: a team of entrepreneurs / business developers introducing prototypes / products on the market incrementally and learning from the feedback of (potential) clients (Herstatt and Von Hippel, 1992). Enabling this requires that from very early in the commercialisation route individuals with complementary, commercial skills are recruited and that already during the opportunity recognition phase entrepreneurs – researchers in close contact with industrial partners are involved. Currently, the “external CEO’s” are recruited at best during the incubation phase, which is rather late from the perspective of developing the business model. Despite IMEC’s policy to attract experienced, external management for its SBEF, this has only happened in two companies within the year after founding.

The incubation phase usually takes 12-18 months\(^{20}\) and should result into a venture capital investment in the “Incubation Company”. It is also at this time that the intellectual property is formally transferred to the spin-off and that the incubation costs are discounted. The Enterprise Cell follows up the company after external capitalisation and provides feedback to the Vice President of the Financial Department.

d. Transfer of intellectual property:

One of the most important shifts IMEC went through since the mid-nineties is an increasing focus on positioning IMEC as an international player through programme driven partnerships (Imec’s Industrial Affiliation Programme). The specific IPR policy of IMEC was a central facilitating factor in the internationalisation process. Moreover, it has led to an increase in intellectual property (“background information”) with new commercialisation routes in Flanders. Hence, IMEC is a research institute that wants to maximise the commercialisation of her intellectual property.

In the context of spin-off companies, the valuation of the IP traditionally happened at the start of the incubation phase through a licensing agreement. Since 1999-2000,

\(^{20}\) There is one particular company that, at the time of writing, entered the 24\(^{th}\) month of incubation. Venture capitalists could not (yet) be convinced and IMEC decided the invest 1 million € in the company themselves.
IMEC stopped her non-exclusive and exclusive “licensing for royalties” strategy towards spin-offs and decided to move to a model based on the exchange of IPR for equity. The context for this change is that since the mid-nineties IMEC increasingly wanted to manage the spin-out process in an integrated way, instead of only focusing on the management of IP. With the change in approach to valorising IPR, the institutional incentive for exploiting the research has changed. In the first model, the incentive was ‘income generation’ through royalties from licensing. The second model implies that IMEC spins off an existing research activity (and the corresponding revenues) and that the financial return is much more dependent on the success or failure of the new firm. Concurrently though, in a model based on IP for equity, venture capitalists require a maximum input of IP in return for their investment. This imposes a risk on IMEC of losing a complete research stream: a “cash” and “brain” drain IMEC exactly wants to prevent. Fillfactory, for example, a spin-off established in 1999, was set up with the whole team of IMEC researchers working on CMOS imaging. An advantage here is that the company is profitable and growing.

Moreover, given the economic downturn started in 2000-2001, VC’s are not willing to assign high values to IP from the start, since most of the IP’s potential remains to be proven. This introduces a conflict since it also essential that the full IP is brought into the company from the beginning in order to have freedom to operate. Therefore, IMEC has adopted a strategy in which the valuation of the IP happens in different phases.

It is a huge challenge for IMEC to address two broad goals: establishing SBEF AND maintaining momentum in its leading research streams, without jeopardising both parties. In its vein to keep a critical mass of know how and technology within IMEC, the research institute has developed a unique “Intellectual Property Fingerprint Model”. The model implies that the partner gets a unique “fingerprint” of IP from IMEC, including exclusive and non-exclusive components. The necessity and mix of each of the components is evaluated on a case-by-case basis. Since the mid-nineties

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21 For example, in a first stage, a lower boundary is defined based on the historical costs incurred to develop and maintain the IP (e.g. 750 000 €). In the subsequent stages, the increase in IP valuation is connected to specific milestones until the ‘full value’ that has been negotiated between the parties has been reached (e.g. 1 500 000 €). The valuation of IP is performed within IMEC and the scientific division is compensated for the value of the IP at time of establishment of the spin out.
this model has worked well with IMEC’s corporate industrial partners, since it enables them to develop their own product line independently from each other, even in an environment where competition is fierce. IMEC wants to apply this model in the context of technology transfer to their spin-off companies. However, venture capitalists require exclusivity, which often means stopping the research activities in this particular domain.

Applied to spin out companies, the “unique fingerprint” would be developed during the incubation phase. At the beginning the spin-off would receive non-exclusive licenses for all technologies they potentially need throughout incubation. After the incubation phase, ideally when a first injection of external capital takes place (VC, BA, corporate, …), exclusive licensing agreements would be negotiated for these technologies specific for the spin-off and for the developments, improvements made during this stage. To date, this model has not been applied yet for spin-offs.

e. Funding process

The financial environment has changed significantly since the early nineties and IMEC has attempted to follow the trends proactively. Since in Europe the venture capital industry and financial markets financing technologies in the (pre)seed stage were rather immature in the early nineties, the “funding gap” (see Cressy, 2002) was a major challenge facing science-based entrepreneurial firms. Thus, in order to deal with financial constraints, some European PROs increasingly set up seed capital funds to address the funding needs of projects they evaluated as promising technologies in their portfolio of contract research. In addition, this attention to the issue of finance was shared by governmental institutions through the provision of alternative sources of risk capital – i.e. governments creating their own (pre)seed funds.

In the early years, the main financial partners for the science-based entrepreneurial firms were large, corporate firms. Also IMEC – and the universities from the associated labs – brought in a part of the capital. During the mid nineties venture capital in Europe had become a more legitimate source of funding for start-ups and late professor Van Overstraeten, championed the establishment of a venture capital fund called IT Partners in 1997, which would target the semiconductor industry. By setting up this IMEC “friendly” venture capital Fund, IMEC wanted to consider only those projects requiring capital in the range of € 750 000 - € 1 000 000. The management of ITP consists of former VC’s. The idea behind the establishment of IT
Partners was to meet the need for funding for the potential IMEC spin-off projects and to manage more professionally IMEC’s portfolio of participations. ITP only invests 25-30% of the required capital and requires the ventures to attract complementary (VC) money.

In 2000, IMEC decided to launch an Incubation Fund because of the increasing difficulty in securing venture capital for early-stage, high potential projects that have not yet made a working prototype or drafted a long-term business plan. IMEC’s Incubation Fund was established in October 2001 with € 5 million\(^{22}\) to stimulate new possible spin-off initiatives by providing the necessary (pre)seed capital to prepare prototype products and early market introductions during the incubation period. The Fund only considers project proposals based on IMEC technology. These proposals must include a first feasibility analysis of the idea, work plan and required budget. Once a project is approved by the Fund, budget is released for setting up a company dedicated to realise the project, work out an extensive business plan and attract the needed skills. Then, the venture should attract external capital to realise its business plan. Under the terms of the Fund, they may provide up to 60% of the required capital. Up to 1999 the cost of the incubation phase was completely incurred by IMEC. They fully carried the risk. Since then, the costs associated with the incubation phase (i.e. the physical infrastructure and administrative support) is discounted to the firm at the time a first round external investment takes place.

The problem of the IMEC Incubation Fund seems to be a contradiction in terms: the Fund wants to meet the need for capital in early stage technology but also seems to be a bottleneck for the young companies. A first explanation for this is that the fund was confronted with much larger proposals than initially targeted: invest maximum 20% of the Fund in a project and up to 60% of the required capital\(^ {23}\). Moreover, due to the small size of IMEC’s Incubation Fund, they could not secure (part of) the follow up financing for the incubated projects. Finding a lead investor for follow up financing is

\(^{22}\) De financial partners are KBC Investco, Fortis Private Equity N.V., Software Holding & Finance N.V. and V.E.M. Chaudfontaine CVBA.

\(^{23}\) This is because IT Partners formally has the right to invest up to 40% of the capital (postmoney, after which IP is brought in and VC’s stepped in)
practically impossible in the current financial – economic climate in Belgium, especially when the existing shareholder does not co-invest. Finally, IMEC’s IP policy is such that IP is only brought in at the time of external capitalisation, which makes negotiations with potential venture capitalists even harder. Currently, the Fund’s shareholders decided to shift the investment focus of the Fund to early stage investment, i.e. at the moment that IMEC brings in its IP and other Venture Capitalists step in\textsuperscript{24}. IMEC is actively planning to set up a seed Fund (40-60 million €), in which the Incubation Fund could be absorbed\textsuperscript{25}.

4.3. Resource Endowments to IMEC ventures

IMEC spun off its first venture in 1986 and up to 2002, 23 ventures were established. The majority of these firms are spin-offs (14).

Table 7 provides an overview of the population of companies that originated from IMEC up to 2002\textsuperscript{26}. The majority of these firms are spin-offs (14).

\begin{table}[h]
\centering
\begin{tabular}{|l|l|l|}
\hline
\textbf{Start-ups} & \textbf{Spin-offs} \\
\hline
& 10. Xenics (2000) \\
& 13. Loranet (2002) (B, as incubation company) \\
\hline
\end{tabular}
\caption{Science-based entrepreneurial firms from IMEC}
\end{table}

B = Bankrupt; A = Acquired; MBO = Management Buy Out

\textsuperscript{24} In total, the Fund invested about 1.2 million € in 2 projects.
\textsuperscript{25} The first closing of fund raising is planned during the third quarter of 2004.
\textsuperscript{26} In 2003, 4 other spin outs were in the incubation phase at IMEC: Magwel, Andel Systems NV, PowerEscape Inc. and Gemidis. These firms had not started business yet at the time of questioning the IMEC representatives and the spin-offs’ founders / CEOs (January – August 2003).
Table 8 gives an overview of some characteristics of these companies in terms of financial resources (capital after 12-18 months), the human resources (number of founders and employees) and the technology resources (the maturity of the technology at time of founding). Resource based scholars have traditionally pointed to these three types of resources as significant assets (Barney, 1996; Heirman and Clarysse, 2003). We compare the SBEF that emerged from IMEC to other Flemish SBEF (Moray, 2004) and other high tech start-ups (Heirman and Clarysse, 2004) set up from 1991 up to 2002.

Table 8: Resource endowments to IMEC ventures at time of founding compared to other science-based entrepreneurial firms and high tech start-ups in Flanders

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>MEASURES</th>
<th>SBEF FROM IMEC</th>
<th>OTHER SBEF</th>
<th>OTHER HIGH TECH START-UPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DATA</td>
<td>N</td>
<td>DATA</td>
</tr>
<tr>
<td>Capital after 12-18 months (K €) (*)</td>
<td></td>
<td>1957.2, 671.8, 2585.8, 75 – 9940</td>
<td>20</td>
<td>688.5, 198.3, 1362.4, 3 – 6000</td>
</tr>
<tr>
<td>Number of founders (*)</td>
<td>Mean</td>
<td>3</td>
<td>19</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Min-Max</td>
<td>0 – 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of employees at time of founding</td>
<td>Mean</td>
<td>5</td>
<td>19</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>3.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>St.dev.</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Min-Max</td>
<td>0 – 25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maturity of technology (0-3)</td>
<td></td>
<td>1</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0 – 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Min-Max</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) Differences between groups significant at p < 0.01 (Kruskall Wallis test)

1 Moray (2004), IN: Clarysse, 2004
2 HITO Database, Steunpunt Ondernemingen, Ondernemerschap en Innovatie

The average SBEF from IMEC established since 1991 raises almost 2 million € of capital within 12-18 months after founding. If we take the three firms into account established before 1991, the average capital is 1.6 million €. This is significantly higher than the other science-based entrepreneurial ventures and high tech start-ups

27 For the other high tech start ups, we use the definition of ‘research based start ups’ as conceptualised and sampled by Heirman and Clarysse (2004).
28 Founders are the persons who have a hands-on function in the company AND/OR who have equity at time of formal incorporation.
29 Measured on 0 - 3 scale: idea phase (0), alpha prototype: proof of concept; the technological idea works in a lab environment (1), beta prototype: prototype that works in a real life environment (2) and market ready product (3).
established in the same region and time period. About 7 IMEC ventures attracted venture capital at founding or within the 12-18 months after founding; 4 of those were incorporated in 1999 or later. Moreover, Coware, established in 1996, is the only IMEC spin-off that received US venture capital (from a Boston based VC firm). Thus, 16 IMEC starters were not VC backed at the onset of their activities. A group of IMEC starters received the majority of their founding capital from large corporate firms (N=9). The other companies were financed either by IMEC (or IMEC’s Incubation Fund since 2001) and individual, private investors (N=7). If we look at the human resources with which the venture starts, i.e. the number of founders and the number of employees the IMEC ventures seem to start-up with larger founder teams. Looking at the maturity of technology, IMEC ventures are generally set up as legal entities at the time an alpha prototype is nearly ready (score 1 = alpha prototype). At time of founding, they still needed 1-3 years of product development before reaching the product stage. However, 8 firms were set up with a technology still in the idea phase.

The previous section sets out that the SBEFs from IMEC display rather unique resource characteristics compared to other science-based entrepreneurial ventures and high tech start-ups established in the same region and period. Since IMEC has developed its technology transfer and incubation activities significantly over the years, we investigated if changes in these activities co-evolve with the nature of the resources endowed to the science-based entrepreneurial firms.

4.4. The interconnectedness of institutional context and resource endowments: Three generations of science-based entrepreneurial firms at IMEC

Following the evolution within IMEC regarding the transfer of IP and the investment policy, we distinguish “three generations” of science-based entrepreneurial firms at IMEC. The first generation of starters runs up to 1995. The second generation of companies are those firms established in the period 1996-1998. From 1999 onwards, a third generation emerges. These “generations” are conceptualised based on their level
of financial, technological and human resources at time of founding. For the financial resources, we both look at the founding capital and the capital the ventures were able to attract within the first 12 – 18 months. This is important, since legal founding is in some cases only a vehicle to raise credibility and only requires a legal minimum capital to be injected. For the technological resources we discern whether or not technology was transferred formally (start-up vs spin out) and the maturity of the technology, adopting Roberts’ scale (1991) from basic research (1) becoming increasingly developmental (8) until alpha prototype (9)\textsuperscript{30}. Although on average IMEC ventures are set up with an alpha prototype ready, we wanted to be able to measure the maturity in more detail before technology development reached that stage. We also add some detail in evaluating the human resources. There is a general consensus that investors often emphasise the quality of the human resources more than other factors as they make investment decisions (e.g. Cyr et al., 2000). At least two issues are of crucial importance in terms of establishing a critical mass of human resources in a high tech firm: the researchers developing the technology and professional management. Clearly, researchers acquainted with the technology are important intangible assets since the legitimacy of the technology often resides in its intellectual carrier(s), but they often need to be complemented with professional business developers. Therefore, we also looked at the extent IMEC researchers were involved in the science-based entrepreneurial firm and the number of external managers attracted in the venture within 12 months after founding.

Table 9 provides an overview of the resources at time of founding of the three generations of science-based entrepreneurial firms.

\textsuperscript{30} We decided to use another measurement scale as compared to table 8, to gain more insight in the diversity in technological maturity among the SBEFs from IMEC. Since half of the firms start activities without an alpha prototype, we believe it was interesting to understand the relative positioning of the these companies in technological maturity (1-8; 9 represents an alpha prototype).
Table 9: Resource endowments of three generations of IMEC ventures at time of founding

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Financials (mean, K€)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Founding capital</td>
<td>457</td>
<td>293</td>
<td>1621</td>
</tr>
<tr>
<td>Capital after 12-18 months</td>
<td>594</td>
<td>1163</td>
<td>3026</td>
</tr>
<tr>
<td>Technology (median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maturity</td>
<td>9</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Involvement inventor</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>People (median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N founders</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Mean experience founders (years)</td>
<td>17,5</td>
<td>35,8</td>
<td>41</td>
</tr>
<tr>
<td>FTE employees</td>
<td>2</td>
<td>3</td>
<td>4,5</td>
</tr>
<tr>
<td>N External management</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N IMEC researchers in company</td>
<td>1,5</td>
<td>1,5</td>
<td>4</td>
</tr>
</tbody>
</table>

* Difference between groups significant at p< 0.05 (Kruskall Wallis test)

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For all the companies established up to 1995, IMEC only brought in (a limited amount of) cash. The main source of external capital, were incumbent firms. Especially interesting is that these firms' capital levels did not raise significantly after 18 months. Moreover, IMEC did not have much experience in setting up companies and it was difficult to evaluate the concrete capital needs. As a result, some of these firms – all academic start-ups -- were largely undercapitalised. Destin for example was set up in 1992 with 75 000 €. The company specialised in developing high resolution test equipment for electronic components. The first years, Destin generated revenues by selling services and projects to large microelectronics companies. From the start the company was operationally break even and managed to realise small profits. Revenues increased from 100 000 € in 1993 to more than 800 000 € in 1999. At that moment, Destin was ready to introduce a set of products to the market. It was crucial to attract capital in order to realise the growth potential of the firm. Since different attempts for capital increase failed, the board of directors decided to liquidate the firm. Destin was officially liquidated at the end of 2000.
Most of the companies set up during this era were based on a clear need from a corporate firm. As a result, most of these firms had a working alpha prototype ready at the time they started their business activities (9 represents an alpha prototype). Only few IMEC researchers joined the start-up (on average 1.5 full time equivalents).

From the 7 start-ups established up to 1992 (from 1993 up to 1995 no science-based entrepreneurial firms were set up), only 1 is still in operation as an independent entity today (Soltech). 4 companies have been acquired (UCB Electronics, Matrix/Cobrain, Alphabit en Easics) and 2 went bankrupt (LCI SmartPen en Destin). Easics for example was set up in 1992, acquired by TransWitch in 2001 and now operates as an R&D subsidiary.


During the early nineties, IMEC went through some major changes in the organisation of her business development activities. The introduction of IMEC’s Industrial Affiliation Programme was a prominent change. This professionalisation trend in industrial liaisons affected the way IMEC set up new ventures: during this era IMEC increasingly grows attentive for bringing in IP in the firms. We observe a careful shift to the transfer of IP through licensing agreements, but IMEC does not engage in this effort (yet) in a systematic way. Of the 8 firms established from 1996 to 1998, 3 are spin-offs (i.e.: IP based) and also received some start capital from IMEC (Oligosense, C-Cam Technologies en Coware NV). IMEC brought in only cash in the 5 other firms at the start of their activities. In most cases though, license agreements were negotiated during the lifetime of the start-up.

We observe a significant increase of the capital that the second-generation IMEC starters can attract during the first 12 – 18 months. The average company established during this time started operations with 293 000 €, whereas after 12-18 months the capital level increases up to more than 1 million €. The fact that this generation of firms can attract additional capital can be explained by the overall shift from industrial capital providers to seed capital funds, business angels and venture capitalists as main sources of capital for the first round of external financing. Apparently, these firms needed to ‘survive’ the first 18 months with low levels of capital and prove the workability of an alpha prototype, in order to convince investors to bring in the
required capital. Although IT Partners was set up during this period, the Venture Capital Fund did not invest in any “second generation spin-off” at time of start-up\(^{31}\). The founders setting up these ventures seem to have more cumulative sector and business experience than their colleagues from the first generation starters have (36 years compared to 17 years). In addition, the inventor or principal investigator that triggered the initial research is in most cases part of the core management team (CEO or CTO) (score = 5).

c. Third Generation: 1999-2002

The third generation starters are characterised by the fact that all but one are spin-offs whereas during the first era only start-ups could be noted and the second generation showed a balanced mix of start-ups and spin-offs. Additionally, these firms seem to start business activities with a less mature technology (score 5, compared to 7 and 9 in the two previous generations. This evolution clearly reflects the increasing technology push model adopted by IMEC. We can expect that the IMEC spin-offs will be formally incorporated in an earlier phase through internal capitalisation (via FIDIMEC – IMEC Holding managing the bulk of participations since 2000 – or via the new seed fund). This should enable the spin-offs to get easier access to EU/ESA and project financing from the Flemish government. From 1999, the IP policy of IMEC gets up to speed: IP is brought into the spin-off for equity. Also, the incubation costs / investments from are discounted at the time an external capitalisation takes place.

IMEC researchers that were involved in the research project are more prone to join the company, instead of remaining an employee at IMEC. The mean start capital increases significantly during this period. Fillfactory started the trend, followed by Septentrio and Xenics, which have closed different successful capital rounds to date. IMEC stopped bringing in cash into the companies. Between 1999 and 2003 IMEC did not invest cash in its spin-offs at time of founding\(^ {32}\). However, with the crash of the technology stock markets during the first half of the year 2000, potential IMEC spin-off projects increasingly experienced difficulty to attract capital. As aforementioned, it was in this context that the IMEC Incubation Fund was established.

\(^{31}\) ITP did invest in 2 third generation IMEC ventures at time of start up: Fillfactory and Septentrio

\(^{32}\) During this period, IMEC did perform a number of follow up investments to defend its investment and get the young companies through the economic downturn.
and two companies received capital from this fund. Since the mid nineties, IMEC wanted to focus on technology platform companies that are riskier than other technology companies and that have higher capital needs.

In conclusion, the founding resource endowments of the SBEFs that emerged from IMEC seem to co-evolve with the way IMEC transfers knowledge or technology. Since IMEC devotes substantial attention and resources to developing incubation initiatives, we should also consider how do these firms perform in terms of multiplying investment value and ensuring employment. The next section sheds some light on this.

4.5. Financial-economic added value of IMEC’s science-based entrepreneurial firms

Over the years IMEC strongly developed and professionalised its business development activities in general and spin out activities in particular. The majority of the entrepreneurs underscored the importance and the value of IMEC during the start-up process as a way of building legitimacy. Nevertheless, what role do these companies have today? How ‘successful’ are they? We discuss a number of financial-economic performance indicators of these science-based entrepreneurial firms.

Table 10: Performance indicators of three generations IMEC ventures

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Realised multiple</strong> (Actual exits)</td>
<td>2.54</td>
<td>0.69</td>
<td>0</td>
</tr>
<tr>
<td><strong>Estimated multiple, incl. TS</strong></td>
<td>2.88</td>
<td>1.47</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Estimated IRR</strong></td>
<td>11.10%</td>
<td>8.75%</td>
<td>42.97%</td>
</tr>
<tr>
<td><strong>Employment Q3 2003 (N FTE)</strong></td>
<td>48</td>
<td>271</td>
<td>126</td>
</tr>
<tr>
<td><strong>Total invested capital, Q3 2003, K €</strong></td>
<td>9,915.40</td>
<td>81,897.90</td>
<td>29,293.65</td>
</tr>
</tbody>
</table>

Data last updated January, 1, 2004
a. Multiples and internal rate of return

An important indicator to calculate performance is the “fair market value”: the estimated valuation of a company based on the guidelines of the European Venture Capital Association (EVCA)\(^{33}\). To have an idea about the creation of financial value added over the years, we calculated the average multiple for each generation of IMEC starters. We divided the total fair market value today for all companies in the group by the total cumulative capital invested in the companies\(^{34}\). Next to the estimated multiple, we also calculated the realised multiple, taking into the account the value of the trade sales realised during each generation.

Since multiples do not take into account the different time perspective over which investments are made, we also calculated the internal rate of return per year for each company and averaged it per generation of SBEF. In this calculation, we decided not to use the capital invested at time of formal incorporation of the company because for a lot of firms first round of external capitalisation was already in preparation at time of formal establishment of the company. Since some firms would not have been set up without successful negotiations about external capitalisation prior to founding the company, it is more correct to use these capital levels for all firms.

In general, the SBEFs from IMEC set up between 1986 and 1995 generate almost three times their investment value. A multiple of 2.88 for the first generation SBEFs reflects an estimated gross return of 11.1% per year on seed and follow up investments\(^{35}\). This return seems to be higher than the average return realised with other seed investments (about 5%) (Murray and Mariott, 1998). However, for an early stage venture capitalist this is rather low. With an average gross return of 11% the venture capitalist will be able to provide about 7% return to his investors, which is a risk neutral investment. Taking into account the actual realised investments an average multiple of 2.5 can be noted for the 5 ‘first generation’ companies exited up till today. For the second and third generation IMEC starters we mainly rely on the estimated valuation, since only 2 trade sales took place during this time. The estimated multiple based on the fair market value for the second generation (1996-

\(^{34}\) This is not necessarily the multiple realised by IMEC: this depends on the capital investment of IMEC and their equity position.
\(^{35}\) Before deduction of the costs incurred to set up the companies, to incubate them and to participate in different boards of directors.
1998) shows a multiple of $1.5^{36}$. The estimated internal rate of return is about 8.75%. Especially interesting here is that after 5 to 8 years hardly a trade sale has been realised whereas venture capitalists have time horizons of 5 to 10 years. Obviously, the estimated multiple and IRR for the third generation of starters is indicative, since the IRR assumes that all investments are valorised in 2003, which is not the case. That is why the latter is misleadingly high. More informative here is the estimated multiple, which is 1.9. Somewhat higher than its equivalent for the second generation, but much lower than the expectation of a professional VC.

b. Exits and employment

From the 23 science-based entrepreneurial firms that were set up, 14 were still active in 2003. IMEC realised 5 trade sales, of which 2 were successful. In total 5 bankruptcies took place up to 2003. Only five companies are operationally break even. This seems to scare investors, especially given the current financial – economic conditions. Two companies established after 1999 were successful in closing new capital rounds in 2003, after they showed a plan to the investors to control the burn rate.

Today, the 14 active IMEC start-ups and spin-offs employ about 450 full time equivalents (12/2003). In general, every investment of about 250 000 € results in the creation of a full time job. If we assume that about 10% of this investment is done with public money (through the subsidy of the Flemish government to IMEC), then a job is created for every 25 000 € public money invested.

5. DISCUSSION

In this study, we offer an integrative perspective on how the venturing process is organised in a public research organisation, which is recognised as being a worldwide centre of excellence in the field of microelectronics. We show how the technology transfer policy adopted over time seems to affect the resource endowments going to science-based entrepreneurial firms (SBEF).

Spinning out ventures has clearly become an alternative way of commercialising technology in many public research organisations, including IMEC. However, setting

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36 Acunia closed the books in December 2003. The bankruptcy of Acunia was not taken into account (still valued at fair market value), since the curator is still negotiating for a potential acquisition of the firm.
up an organisation to implement a coaching model for SBEF is a complex issue, which needs strategic support by the top management and commitment of the board to invest resources in the long term. In the paper, we have described in detail how IMEC has developed a structure to enable the establishment of new ventures.

The strategic choice to stimulate SBEF in general and spin-offs in particular had major implications. First, IMEC has been confronted with the need to finance these firms. The financing issue is often the first barrier, which is tackled by universities and public research organisations because it is a visible problem not related to the organisation’s core business. IMEC participated in the capital of a venture capitalist (VC). Despite IMEC’s presence in the board, the VC only invested in 2 IMEC spin-offs within 12 – 18 months after incorporation. IMEC learned that the seed phase is not interesting for venture capital firms and tried to tackle this by setting up an Incubation Fund dedicated to invest in pre-seed and seed capital. Again, the fund expectations were not in line with those of IMEC, mainly because the fund’s shareholders had similar expectations as the VCs about the exit potential of business plans.

The financing problem was only the first issue that IMEC tried to solve. We have shown in the paper how IMEC changed its IPR management. The organisation developed and recently implemented a specific IP management model to guarantee enough freedom to operate and valuable proprietary technology for the spin-off in order to attract financial investors but without being forced to divest a full research stream within IMEC. As described in the paper, the “IP fingerprint model” seems to be a promising solution but has not been applied yet to spin-offs and will have to prove its merit in the years to come.

The third set of resources, next to the financial and technology resources, are the human resources. Gradually, IMEC has set up a coaching organisation to assist SBEF during their incubation period. As in the two previous cases, the development of this resource has proven to be a learning process. First, some formal aspects of business plan support were developed. Next, IMEC initiated the recruitment of experienced external managers from its network. However, also this proved to be very difficult and only in two cases such a manager could be attracted. In the meanwhile, business
development remained mainly lacking. Recently, IMEC attracted internal business developers to coach their projects in the incubation phase.

The main question that emerges is whether IMEC’s initiatives affect the resource endowments of the SBEFs that are created. This question is not only interesting from a practical point of view it is also inspired by theoretical considerations. In entrepreneurship research, the institutional context from which SBEF emerge is often implicitly neglected by lumping together firms from diverse institutional parents, without controlling for these differences. Overall, SBEF from IMEC start at a significantly larger scale than SBEF from other public research organisations and other high tech start-ups. The differences are the largest for the financial resources (nearly € 2 million vs € 650K vs € 250K). Because the population of IMEC’s SBEFs is biased towards the IT based and microelectronics technology might be a main explanatory variable. However, the lacking group are biotech ventures, which are generally considered to start at a larger scale. Since IMEC has undertaken most efforts to set up a sound investment system and to attract venture capital, it is not surprising that the SBEFs from IMEC start up with a significantly larger capital base. It indicates the impact of the institutional choices made but it does not necessarily imply that the companies really need this amount of money.

Next to the financial resources, we also find that the SBEF from IMEC have significantly more founder-entrepreneurs than the other high tech start-ups, but not more than the SBEF from other public research organisations and universities. Founding teams of 3 people on average seem to be characteristic for SBEF. Although we have no clear direct explanation for this, one suggestion might be that the centrally managed and controlled technology transfer might cause this. Usually a small team of researchers is at the basis of the technology. The project leaders from I&I guide the researchers for starting a company. The cost benefit question only comes in later. As aforementioned, we observe a lack of heterogeneity in the founding teams, which is generally argued to be important for attracting external capital.

Also in terms of technology, a difference is found although not significant. There is some indication that SBEF are started with a less mature technology than the other high tech start-ups. Although the cross sectional comparison of the population of SBEF from IMEC with other SBEF and high tech start-ups gives a first intuition
about the potential impact of IMEC on the resource endowments, it remains a crude analysis. Since this descriptive analysis does not take into account the changes in policies that have taken place over time, we analysed whether changes in IMEC policy resulted in changes within the IMEC population of science-based entrepreneurial firms over time.

We have described that IMEC has three generations of SBEF, each reflecting a particular shift in IMEC’s technology transfer policy. Although IMEC’s venture capital fund was not a straightforward success in itself, it raised the interest of other local venture capitalists for the (potential) SBEFs from IMEC. This is clearly reflected in higher capital levels these ventures were able to attract during the first 12 months of operations (less than € 600 K for the first generation up to over € 3 million for the third generation).

Its change in technology transfer policy and management is also clearly reflected in the maturity of the technology at which the different generations start, the involvement of the inventors in the SBEF and the number of researchers recruited in the new venture. Whereas the first generation SBEF were started by researcher-entrepreneurs, who envisaged a nearby market opportunity, the third generation, consisting mainly of spin-offs, are clearly the result of a strategic choice to commercialise a part of the technology through spin-offs instead of contract research or licensing. Spin-offs are based on a technology that is far from market ready and seems to be too marginal as a basis for contract research. Different researchers-entrepreneurs seem to step into the new company. The transfer of part of the research team is reflected in a larger number of founders and employees coming from IMEC.

Overall, we can conclude that the decisions taken at IMEC to change its venturing policies have an effect on the type of companies created. The resource endowments to SBEFs have changed as a result of these changes. Companies have become larger, start up with more employees and a technology further away from an alpha prototype. As a result, they need more coaching and incubation support before they can start up and the screening mechanism has become more selective. Although we could potentially infer from this that a smaller amount of projects will be started, it seems that IMEC wants to upscale its technology push strategy: IMEC wants to realise 3-4
spin-offs per year. The underlying rationale of IMEC is that in fact the opportunities are there but that an increasing pro-active role needs to be played in recognising these technological and market opportunities in the labs.

Finally, we asked the question about the role of IMEC’s SBEF from a socio-economic perspective. We calculated the multiple (and related IRR) realised by the SBEF from IMEC (first generation) and compared it to the multiples found in the venture capital literature. The IRR of 11.8% for the first generation of SBEF is double the IRR of 5.2% (Murray and Mariott, 1998) which was found to be an average for seed investments in high technology sectors. Still, this financial performance is below the expectations venture capitalists had during the mid- and late nineties when they wanted to invest in high technology. In Belgium, these expectations were between 30 and 35% for seed investments, meaning that only few projects seemed attractive enough for investment (Manigart et al., 2002). Moreover, in other European countries, expectations were even higher. The conclusion seems to be that the IMEC approach works and renders more gross profit than an average approach, but the organisational cost to realise this is very high and the average IRR is still much lower than the one that is expected by venture capitalists. As a result, IMEC has major difficulties to convince institutional investors to invest in its own fund.

Further, we observe that the science-based entrepreneurial ventures from IMEC create a total employment of about 450 full time equivalents. From a socio-economic perspective, this is significant. On the other hand, however, the total employment of a much less time consuming initiative such as the TOP programme at the university of Twente (The Netherlands) to stimulate science-based entrepreneurial firms was about 1200 people in 2001 (Van der Sijde et al. 2002). Total employment created by small start-ups might be higher than employment created by a few large spin-off companies.
Stimulating academic entrepreneurship has been high on the political agenda since the mid-nineties (e.g. OECD, 2003). In its shareholder agreement with the Flemish government, IMEC needs to set up one SBEF per year. Introducing such key performance indicators to encourage public research institutes and universities to take part in the entrepreneurial process has become increasingly popular among policy makers all over Europe.

However, given the complexity of setting up such an entrepreneurial process, it seems questionable whether most public research organisations have the necessary resources and top management commitment to do so. Moreover, from a public policy perspective it remains even uncertain whether targeting one venture per year is a good idea. There are other models for stimulating entrepreneurship that seem to create much more employment and socio-economic return at a significant lower cost (see Clarysse et al, 2004).

At the micro level, the study clearly shows that being a centre of excellence in a certain technological domain is no guarantee to have a network in the financial and business community. In fact, we observe that IMEC had little or no impact on the decisions made, even by the venture capitalists in which the organisation participated as a shareholder, to invest in its SBEFs. The financial market follows its own logic and the research organisation can at most present its jewels to the client. This implies that the incubation period either has to be financed by the research organisation itself or by a form of public seed capital. If a policy maker decides that public research organisations have to spin-off a fixed number of companies per year, it has also to make sure that the local financial environment can support this.

Not only the financial resources are difficult to manage, also the human resources often form a barrier. IMEC does not succeed to attract people with a clear business background in its SBEF. Usually these people are recruited very late in the process, once most decisions are already made about the concrete market opportunity. More importantly, at the moment of opportunity seeking, no persons with experience in different industries are involved. Although the organisation might be a leading research institute, it is not necessarily attractive as an employer for young high business potentials. In fact, if policy makers enforce public research organisations and universities to commercialise their technology by imposing numbers, it is not
sufficient to subsidise part of the technology transfer activities or even provide some seed money. Conversely, one of the most important assets of a start-up company—its human resources—should originate in the organisation’s core business. But most public research organisations have no strong middle management of high potentials with business skills. Usually, they have a strong top management of professors or top managers (in public research institutes), many bright researchers at junior level and a few as project leader at senior level. These are embedded in a culture where intellectual capacity is appreciated among peers, much more than emotional intelligence, which typifies most business high potentials. It is very uncertain whether these structures and cultures are fruitful soils for new business opportunity ideas. Interestingly, Van Dierdonck et al. (1990) already pointed to the necessity of liaison offices for being main contact facilitators with industrial players, instead of focusing on the ‘structuring’ the technology transfer process at the institution. Thus, if the government wants to stimulate the recognition of business opportunities in a research setting, there is a need for a well-balanced view of what entrepreneurship entails and it needs to be integrated in the organisation culture. More specifically, employees need to be recruited with a strong entrepreneurial orientation and commercial interests. It is important that the government also takes into account these facilitating indicators for stimulating entrepreneurship, instead of solely focusing on the amount of ventures to be generated per year. These observations are in line with Goldfarb and Henrekson’s (2003) findings, who argue that a top down approach in stimulating the commercialisation of technology potentially impedes the freedom to interact with industry and new firms, which are in turn an important source of experienced business people.
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PAPER 3:

INSTITUTIONAL LINKAGE AND RESOURCE ENDOWMENTS TO SCIENCE-BASED ENTREPRENEURIAL FIRMS: A EUROPEAN EXPLORATION.

MORAY, N. AND B. CLARYSSE
IV. INSTITUTIONAL LINKAGE AND RESOURCE ENDOWMENTS TO SCIENCE-BASED ENTREPRENEURIAL FIRMS: A EUROPEAN EXPLORATION

Abstract
This paper addresses theoretical and empirical gaps in the relationships between the nature of institutional linkage, firm resources and growth in the context of spinning off ventures from public research organisations (PROs). Institutional linkage is considered a two dimensional construct consisting of the formality of technology transfer and the research specificity of a PRO. In this perspective, both categorical variables are hypothesised to predict the resource endowments of science-based entrepreneurial firms. Additionally, given the widespread attention from academics and policy makers to IP based science-based entrepreneurial firms, the formality of technology transfer is expected to be associated with growth.

Empirical tests of hypotheses derived from this view are based on data from about 100 science-based entrepreneurial firms, representing 24 public research organisations. The research sought to identify how the variables interrelate at the multivariate level. Multivariate analysis of variance shows that institutional linkage predicts firm resources in general, showing significance levels for start capital and the degree in which the technology is embodied in a product. An ordinal interaction effect shows that companies established with a formal transfer of technology start with higher resource levels when started from a PRO with a specific research base. Contrary to expectations, two-stage regression analysis indicates that the formality of technology transfer has no single direct effect on growth in employees, although it is mediated by start capital. A formal transfer of technology however does affect the propensity to attract additional capital, independent of the start capital of the firm.

1. INTRODUCTION

The insights that resource based theories and the new institutionalism in organisation studies have contributed to our understanding of firm founding and survival suggest that these distinct perspectives are in fact complementary. Resource based theories suggest that firms make economically rational choices that are shaped by the economic context of the firm. According to institutional theory, firms make normatively rational choices that are shaped by the social context of the firm. Although Oliver (1997) already suggested that resource based and institutional views actually converge, very few have investigated how combined insights from these distinct perspectives can explain firm similarities and differences.

The purpose of this paper is to investigate the extent to which institutional linkage has an impact on the resource endowments of science-based entrepreneurial firms, which are founded from the research base developed at public research organisations. We
define institutional linkage as the nature of the relationship between the science-based entrepreneurial firm and the PRO. More specifically, we consider institutional linkage as a two-dimensional construct consisting of the formality of technology transfer (formal or informal) and the research specificity of the PRO (generic or specific) from which the venture emerges. We also assess the extent to which institutional linkage affects the growth of science-based entrepreneurial firms.

Investigation of the influence of the nature of institutional linkage to PROs on the resource endowments of science-based entrepreneurial firms at time of founding is potentially important for different reasons. First, public research organisations are increasingly argued to play a key role in knowledge creation, knowledge dissemination and economic growth (OECD, 1998; 2003) and the US was the first country to set the stage. The successes of Route 128 and Silicon Valley led to wider endorsement about the US model and the central role of public research organisations in such regional successes (Saxenian, 1994). In this perspective it has been recognised that the economic sectors with the most rapid growth are those closest associated with the ‘science base’: microelectronics, software, biotechnology and new materials (Van Looy et al. 2004). As a result, policies have been put in place to stimulate the commercialisation of research and, more specifically, the creation of science-based entrepreneurial firms. New regulations gave PROs ownership of IP arising from their research base and the right to commercialise the results obtained.

Second, both the early neo-institutional framework and resource dependency view have been criticised: the institutional framework for its focus on homogeneity and persistence of organisational forms (Dacin et al, 2002); the resource dependency view for not taking into account the context of resource acquisition (Oliver, 1997). Thus, combining elements from both an institutional and resource-based perspective in a conceptual model of firm heterogeneity and similarity may shed light on how institutional linkage of science-based entrepreneurial firms partly explains the resource conditions of these companies. Integrating both perspectives in an empirical analysis helps addressing the seemingly paradoxical challenges new science-based entrepreneurial firms face: although they rely a lot on the entrepreneurs’ initiative to attract the necessary resources, we expect them to be also partly determined by their institutional linkage at time of founding. To our knowledge, this study is one of the
few attempts focusing on the investigation of the specific institutional relations that science-based entrepreneurial firms have at time of founding and the predictive capacity of this linkage on firm resources and growth.

Finally, this study is also important because it typically focuses on the founding conditions of companies. More specifically, the question of initial resource endowments has been argued to be of significant interest in organisational ecology, evolutionary theory and entrepreneurship research (Shane and Stuart, 2002). At the organisational level, Stinchcombe (1965) was the first to stress the “imprinting effect” of initial conditions at founding, including the institutional environment. Later research has confirmed this view. Population ecologists as well as institutional theorists, for example, have confirmed that the main organisational characteristics when an organisation is established tend to become institutionalised (Hannan and Freeman 1977; Meyer and Rowan, 1977; Boeker, 1989). Over the years, a general consensus has been growing about the fact that initial (founding) conditions are likely to have an effect on firm survival and growth.

The remainder of the paper is organised as follows. First, we describe the context in which the phenomenon of science-based entrepreneurial firms has increasingly gained momentum. Second, we develop the conceptual model combining elements from both institutional and resource dependency perspectives, hypothesising that institutional linkage explains firm resources and growth. Third, we discuss the data and methods employed. Fourth, we present the analyses and the results, developing the main findings of this research. We conclude with a discussion section pointing to the main implications of this study.
2. SCIENCE-BASED ENTREPRENEURIAL FIRMS, INSTITUTIONAL LINKAGE AND RESOURCE DEPENDENCY

2.1. Background: Science-based entrepreneurial firms in Europe

Science-based entrepreneurship looms large in the public arena (Henrekson and Rosenberg, 2001). There is a large tendency among public research organisations to add ‘entrepreneurial’ objectives to their mission, including a spectrum of evolutions such as more involvement in social and economic development, more intense commercialisation of research results, patent and licensing activities, the institutionalisation of spin-off activities and managerial and attitudinal changes among academics regarding collaborative projects with industrial partners (OECD, 1998; Van Looy et al. 2004). A marked increase in the number of companies created from PROs has been observed in North America as well in Europe since the early nineties. The creation of new companies from PROs has become central to research and innovation policy and policies have been put in place to promote the development of these ventures (Chiesa and Piccaluga, 2000; Mustar, 1997). Regulatory constraints have been removed or loosened so as there are now more possibilities for an academic to create a company. However, different studies in different countries use a variety of definitions of what exactly constitutes a spin-off company. Terms used include (academic) spin-outs, university based start-ups, (academic) spin-offs, firms created by researchers, research-based spin-offs, … A common definition has been developed by authors such as Roberts and Malone (1996), Smilor et al. (1990) and Steffenson et al. (1999):

A spin-off is a new company that is formed by a faculty member, staff member, or doctoral student who left university (research organisation) to found the company or started the company while still affiliated with the university, and/or a core technology (or idea) that is transferred from the parent organisation.

This definition leaves room for inclusion of a variety of firms and a lot of researchers to date have adhered to this definition, albeit using it in diverse ways. The heterogeneity in the interpretation of this definition partly reflects the fact that researchers have indeed observed that research-based spin-offs are not a homogeneous group of companies (Stankiewicz, 1994; Mustar, 1997; Druihle and Garsney, 2003), urging them to make empirical choices as to whether or not firms are
to be included in sample frames. As a result, in Europe, spin-offs often comprise all
the ventures that are “listed” or “identified” by researchers and / or technology
transfer officers as having emerged from PROs (Moray and Clarysse, 2004).

The remainder of this paper will use the term “science-based entrepreneurial firm”
(SBEF), following authors such as Henrekson and Rosenberg (2001) and Murray
(2004). We choose this term to denote an inclusive concept for the companies that
have been identified by researchers or technology transfer officers as having emerged
from the research performed in public research organisations. This paper develops
hypotheses about the effect of institutional linkage on resource endowments at time of
founding and venture growth. The basis assumption is that institutional linkage at time
of founding has potential explanatory capacity for the heterogeneity that is observed
among science-based entrepreneurial firms, both in terms of resources at time of
founding and growth.

In the remainder of this section we combine elements of institutional and resource
dependency perspectives to the study of science-based entrepreneurial firms. The
basic, rather intuitive value of combining the ‘material’ with the ‘institutional’ lies in
the observation that science-based entrepreneurial firms emerge from within diverse
public research organizations, and that new firms typically need to attract the
necessary resources to start and develop their activities. We develop hypotheses
taking into account both aspects of this reality.

2.2. Institutional linkage and science-based entrepreneurial firms

Researchers have stressed the importance of institutional characteristics in the
commercialisation of innovation (e.g. Lynn et al, 1996). In the context of science-
based entrepreneurial firms, this is particularly apparent because these companies
display different types of links with the institutional parent at the moment the venture
is set up.

One of the common features of PROs is that they have, in varying degrees,
commercial ideas in their research portfolio. However, they differ substantially in the
extent to which they actively search for these business opportunities as well as in the
extent to which the trajectory of business development is guided and supported, if at
all. Previous researchers have studied the differences in technology transfer activities in a range of European public research organisations and have developed useful classifications. Clarysse et al. (Forthcoming), for example, have developed a typology of interface services based on the resources they employ and the activities they actually engage in for supporting new businesses. Together with other authors (Siegel et al. 2003), they also come to the conclusion that technology transfer activities are difficult to measure, especially as it is an intrinsically evolutionary phenomenon: public research organisations can be in transition, evolving of one ‘incubation’ model to another. In spite of a general convergence, the practical implementation of these models and the regional / national regulatory details are very diverse and make it difficult to judge whether and under which circumstances such models are effective.

Therefore, we decided to focus on one particular element that can be informative about the nature of technology transfer activities in the PRO: institutional linkage with the science based entrepreneurial firm at time of founding. Baum et al. (1991) already pointed to the importance of institutional linkage when they studied the impact of institutional linkage on mortality rates of service organisations. Focusing our analysis on institutional linkage at time of founding has at least two advantages. First, it empirically overcomes the intrinsic evolutionary nature of technology transfer activities as they are practiced in the PROs. This pace of change has been quickened since the mid nineties and a lot of European PROs have not reached equilibrium. Second, taking into account “institutional linkage” will prove to be helpful to categorise science-based entrepreneurial firms, potentially leading to a better understanding of the characteristics and the relative role of different types of science-based entrepreneurial firms.

In this research, institutional linkage is considered a two dimensional construct, consisting of formality of technology transfer to the science-based entrepreneurial firm and the research specificity of the parent research organisation from which the venture emerges. The formality of technology transfer refers to the extent in which a company is formed based on a formal transfer of intellectual property. Roberts (1991, 103-107) already noted the variety of linkages of science-based entrepreneurial firms with MIT. He questioned the entrepreneurs about the link of the firm with the research organisation and, more specifically, about the importance of technology transferred to
the new firm. He asked the respondents to rate the degree of dependence on source technologies: direct, partial and vague. In these categories learned technology is unquestionably important; the difference is only in degree. Where technology is transferred directly, the company would not have been started without the formal transfer of Intellectual Property Rights (by means of a license agreements or transfer of a patent). “Partial” means that the company was founded based on the formal transfer of Intellectual Property rights; however, this know-how needed to be expanded with some other source of know-how (i.e. IP coming form another institute then the parent institute). We label the companies that received a partial or direct transfer of technology as the IP based spin-offs. The category “vague” represents those companies that are categorised as a SBEF by the parent institute for other reasons than formally transferred technology, for example because academic staff co-founded the company based on know how they acquired at the parent organisation or because the PRO provided some start-up capital.

The Association of University Technology Managers\(^{37}\) has made an explicit distinction between “start-ups” and “spin-offs”. The first group of companies are based on know how developed at the PRO without formal transfer of technology. It is possible however, that the PRO has an equity stake through the provision of capital. The start-ups clearly use source learned (but often non-protected and non-formally transferable) knowledge and/or technologies. Conversely, “spin-offs” received a formal transfer of technology by means of a license agreement in return for royalties or IP in return for equity (i.e. they were directly or partially dependent on source technologies at time of founding).

Next to the formality of technology transfer we define institutional linkage by an intrinsic characteristic regarding the research base developed at the PRO. Some of PROs have a specific technology focus while others perform research in a variety of technological domains and the humanities. In Europe, the majority of the research that is publicly financed is organised in universities or research institutes. In practice we observe that research institutes are more likely to have a specific technology focus, whereas the universities can have either a generic research portfolio or be quite specific in a few domains. Chalmers institute of Technology for example has five

\(^{37}\) www.autm.org
explicit strategic research streams: biotechnology, information technology, the environment and micro- and nanotechnology. Intuitively, one can expect PROs with a specific research base to be able to specialise in the commercialisation of these research results, which have a rather delineated scope. Since these PROs often have contract research with industry as core competence, these PROs are expected to be more involved in intellectual property issues and technology transfer activities, since they seem to operate much closer to industrial partners. As the propensity of research and technology transfer can be captured in a number of indicators, (Siegel et al, 2003), we use these indicators for empirically validating this conceptual distinction (see section 3.2 for specification of the variables). Since the specific – generic distinction regarding the research base of PRO has not been validated and generally acknowledged to date, in contrast with the ‘formality of technology transfer’ dimension (AUTM), our first hypothesis addresses this issue:

Hypothesis 1: A public research organisation with a specific research focus (one or a number of clearly delineated technological domains) is more actively engaged in technology transfer related activities than a generic PRO.

2.3. Resource dependency and science-based entrepreneurial firms

Resource Dependency Theory is generally characterised as the necessity of extracting resources from the environment (Pfeffer and Salancik, 1978). This perspective holds as premise that firms will act in self-interest, trying to gain access to, and ultimately control over, needed resources. Science-based entrepreneurial firms are especially sensitive to this issue, as they need to build their resource base from the ground up. It has also been argued that ventures originating from public research organisations display a variety of resource configurations (Druhle and Garsney, 2004). Researchers studying the diversity of science-based entrepreneurial firms often focused on internal characteristics associated to the business model of the company. Bullock (1983) already identified two categories: “soft companies”, the technical consultants solving customised problems, and “hard companies” that sell standardised products to a general market. In parallel, Stankiewicz (1994) classifies science-based entrepreneurial firms according to the way they operate. He identifies three different operation modes: consultant and R&D boutique mode, product-oriented mode, and technological-asset mode. Still others have suggested defining science-based
entrepreneurial firms according to specific types of resource transfer from their environment (Carayannis et al., 1998). Although these studies have significantly contributed to our understanding of the diversity of science-based entrepreneurial firms, most studies have not extended their approaches to looking for potential predictors “external” to the firm as an organisational entity that can help explain the diversity in resource configuration. Additionally, most of the categories described above are intrinsically developmental and overlapping, so that it is hard to integrate them in an empirical research design. This research hypothesises that the nature of institutional linkage will affect the resource endowments of a science-based entrepreneurial firm at time of founding.

**Hypothesis 2: The nature of institutional linkage affects the resource endowments of a science-based entrepreneurial firm at time of founding**

Following resource based scholars we focus on the financial, human and technology resources (Barney, 1996). More specifically, we expect ventures that are established with a *formal transfer of technology* (the ‘spin-offs’) to start with higher capital levels and a more productised technology. We hypothesise that starting business activities with a formally transferred technology is intrinsically more capital intensive since the technology needs to be valued as part of the transfer agreement between the PRO and the new venture. Consequently, these types of science-based entrepreneurial firms are expected to start with a more productised technology, that is to say, further developed along the product development cycle and closer to market. Clearly, the higher the capitalisation and valuation of the associated technology, the more productised one expects the technology to be. As a result of the higher start capital and the more productised technology, we expect ventures starting with a formal transfer of technology also to have more researchers working in the firm. The human resources in a science-based entrepreneurial firm are intrinsically tied to the research and technology they bring into the company. When one employs researchers, it is the researcher’s labour and scientific and technical human capital that is actually brought into the company: the formal educational endowments, but also the skills, know-how and "tacit knowledge," embodied in individual scientists and engineers (Bozeman and Mangematin, 2004). The relation between the different resources however, cannot be clearly stipulated. For example, an argument can be made that more capital is needed in “spin-offs” because they need more researchers / employees to further develop and
maintain the technology (platform) on which the firm is built. Although there is an increasing awareness that resources are interrelated with one another, the direction and order of these interrelations have not been examined extensively. Therefore, when formulating our hypotheses, we put the resource variables at one level.

H2a: When know how is transferred formally to a science-based entrepreneurial firm, the firm will display higher capital levels, a more productised technology and a higher number of employees as compared to ventures that start activities without formal transfer of technology.

Similarly, we expect ventures emerging from specific PROs to start with a greater resource base as compared to companies that emerged from a generic PRO. The reason for this is twofold. First, building on the results of hypothesis 1, we infer that specific PROs seem to have the commercialisation of research and technology more central to their activities as compared with generic PROs. As a result, one can expect that the ventures set up from these institutes will have more often transferred protected technology at time of founding as compared to ventures coming from generic PROs. Since we do not have complete data sets of the full population of ventures emerging from the PROs in the sample, we could not test this intuition in the context of this paper. However, Moray (2004, IN: Clarysse, 2004) has shown this for the full population of science-based entrepreneurial firms in Flanders (Belgium): generic PROs set up significantly more science-based entrepreneurial firms without formal transfer of technology (“start-ups” according to AUTM) as compared with the specific PROs which seem to have the establishment of IP based science-based entrepreneurial firms as core strategy (“spin-offs” according to AUTM). Second, PROs that put the commercialisation of research and technology to the core of their mission are expected to have more developed systems and trajectories to guide and support these types of ventures. This potentially increases the legitimacy of these companies and subsequently the amount and the nature of the financial, technological and human resources they attract at time of founding (Pfeffer and Salancik, 1978; Suchman, 1995). These observations lead to the formulation of the following hypothesis:

H2b: A science-based entrepreneurial firm originating from a PRO with a specific research portfolio will display higher capital levels, a more productised technology and a higher amount of employees as compared to ventures that start from a PRO with a generic research base.
2.4. Growth of science-based entrepreneurial firms

While science-based entrepreneurial firms are argued to be a key feature of the modern economy, our insights into their growth and productivity remain limited (Murray, 2004). Growth of start-up companies in general is a complex and multidimensional phenomenon and factors such as firm age and industry affiliation have been argued to be important characteristics predicting growth (Delmar, 2003). It is likely that the conditions at time of founding are related to growth of these science-based entrepreneurial firms. Since policy makers have been emphasising the commercialisation of intellectual property through setting up science-based entrepreneurial firms as an important engine for economic growth (OECD, 2003), we hypothesise that the formality of technology transfer will affect the average growth of the company. We argue that the research specificity of a PRO is of much less importance in predicting the potential economic contribution of a science-based entrepreneurial firm, given the time lag between founding the company and assessing growth. More specifically, we expect “spin-offs” to display higher average growth as compared to “start-ups”, given policy makers’ substantial focus on IP based science-based entrepreneurial firms. The following hypothesis summarises this:

**Hypothesis 3:** A science-based entrepreneurial firm receiving a formal transfer of technology will display higher average growth in capital and employees as compared to a science-based entrepreneurial firm that is established with intangible know-how.

Figure 5 summarises the hypotheses developed in the previous section.
3. Method

The following section elaborates on the construction of the European sample, the data collection procedures and the variables included for both univariate and multivariate analyses.

3.1. Sample and data collection

One of the main problems in performing studies on science-based entrepreneurial firms from PROs is the difficulty to randomly sample either a number of PROs or science-based entrepreneurial firms across Europe. This would require a large up-front knowledge base about the composition and the nature of the population of PROs as well as science-based entrepreneurial firms in the respective countries. This is not the case at both levels. For the PROs, because each country has its own specific context of organising and financing research and development activities in public research organisations. Estimating the population of PROs that rightfully represents the majority of publicly financed research in a region or country in a comparable international dataset is a research project in itself. For the firms, because researchers involved in the domain of science-based entrepreneurial firms have only very recently launched initiatives to integrate data sets from respective countries. Moreover, at the micro-institutional level, PROs often are not knowledgeable about the full population of science-based entrepreneurial firms that are set up from their research base. This is especially true for the firms that start without formal transfer of technology\(^{38}\) and in countries with a strong decentralised system for different types of technology transfer related activities such as Germany and Sweden.

\(^{38}\) In this perspective, some researchers are strong advocates to only include science-based entrepreneurial firms in empirical analyses that start with a formal transfer of technology (focusing on ‘spin-offs’ only). Although empirically, this is probably the ‘purest’, it intrinsically denies the issue that in a lot of countries samples are constructed as a mix of different types of firms having a link with the parent institute. This does not only make research results hard to compare internationally, it also takes not into account that whether or not technology transfer happens, is an evolutionary phenomenon: some firms that were started in the early nineties as ‘start-ups’, would today be established as ‘spin-offs’, given the upsurge of the phenomenon. We explicitly argue that sample frames should be all-inclusive, representing particular regional contexts, BUT that the science-based entrepreneurial firms should be coded as to the nature of institutional linkage at time of founding to better understand the heterogeneity among these firms and their relative importance, both at the firm, the micro-institutional and the regional/national level.
To date it has been very difficult to construct comparative European sample frames and this has urged researchers to construct theoretically sampled data sets to address particular questions of interest (see for example Clarysse et al. forthcoming). It has been argued that theoretical sampling is a valid alternative to random sampling as long as the research design is determinate and if the conditions of unit homogeneity and conditional independence are met (King et al., 1994), issues contributing to making scientifically sound inferences.

This research is performed in the context of a European collaborative effort between researchers from 7 European countries: Belgium (Flanders), France, the United Kingdom, Germany, Sweden, Italy and Hungary. Theoretically sampling a number of PROs we arrive at a research design ensuring maximum variety regarding the organisation of R&D in PROs. A three-step approach was utilised for sampling and data collection at the PROs and the science-based entrepreneurial firms in the respective countries.

First, for each country an analysis was performed looking at the broader context of the national innovation systems and start-up activity. How is research organised and financed? What is the R&D expenditure and patent activity? Table 11 shows that the countries included vary significantly in their share in R&D activities and patent activities. Most of the countries studied are in the top 10 in their share of triadic patent families (except Belgium and Hungary). Since we analyse institutional linkage and its potential impact on resource endowments, this variety of contextual constellations improves external validity of the findings, i.e. improves the probability that the hypotheses at the level of the public research organisation and the firms hold true across national contexts.
Table 11: Investment in R&D and output from the research sector

<table>
<thead>
<tr>
<th>Selected regions in Europe</th>
<th>R&amp;D expenditure as % of GDP, 2001 (1)</th>
<th>Number of Researchers / 1000 labour force (2)</th>
<th>Articles per researcher (2)</th>
<th>Number of triadic patent families per million population (3)</th>
<th>Share of triadic patent families in total applications (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU-15</td>
<td>1.93</td>
<td>5</td>
<td>0.3</td>
<td>36.61</td>
<td>32.39%</td>
</tr>
<tr>
<td>Sweden</td>
<td>3.78</td>
<td>8.6</td>
<td>0.37</td>
<td>102.39</td>
<td>2</td>
</tr>
<tr>
<td>Belgium</td>
<td>1.96</td>
<td></td>
<td></td>
<td>37.66</td>
<td>11</td>
</tr>
<tr>
<td>Germany</td>
<td>2.52</td>
<td>5.9</td>
<td>0.25</td>
<td>73.02</td>
<td>5</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>2.13</td>
<td>6</td>
<td>0.29</td>
<td>35.23</td>
<td>13</td>
</tr>
<tr>
<td>Italy</td>
<td>1.04</td>
<td>3.2</td>
<td>0.36</td>
<td>12.4</td>
<td>19</td>
</tr>
<tr>
<td>UK</td>
<td>1.84</td>
<td>5.1</td>
<td>0.44</td>
<td>30.26</td>
<td>15</td>
</tr>
</tbody>
</table>

(1) GDP = Gross Domestic Product  
(2) OECD, MSTI Database, 2000  
(3) OECD, Patent Database, July 2003, 1999 estimates; Patents all applied for at the EPO, USPTO and JPO.

Given these contexts, we discussed with the national experts / researchers what is the best way to sample public research organisations and the science-based entrepreneurial firms that emerged from their knowledge base ensuring ‘real life’ but ‘controlled’ diversity so as to maximise comparison and external validity. There was a general consensus that the common denominator for public research activities across Europe, is that the majority is organised in universities or research institutes. In relatively small samples – as compared to the total population – this controlled diversity is key in making scientifically sound inferences. Thus, the second step involved the selection of a small number of PROs in each country that is representative for the way research is organised. Moreover, the technology transfer office needed to be at least three years old and the PRO needed to have a significant track record in setting up science-based entrepreneurial ventures since the mid nineties. Data on each PRO was collected through personal interviews with technology transfer managers. Each public research organisation in the sample (N = 24) was interviewed using the UNICO-NUBS questionnaire specifically designed for collecting quantitative indicators from Technology Transfer Offices of Public Research Organisations (UNICO-NUBS, 2003). Sampling the PROs first was crucial since we are typically interested in micro institutional linkage with the research base at time of founding the science-based entrepreneurial firm. The data on the PROs is used to test hypothesis 1.
Third, for each PRO about 4-5 science-based entrepreneurial firms were sampled. Companies established since 1991 were included. In some cases the national experts / researchers were able to identify the full population of science-based entrepreneurial ventures and sampled the firms as such that they can be seen as representative examples of companies set up from the research base of the particular parent. In most cases, populations were unknown and firms were included based on the ‘known’ science-based entrepreneurial firms and the willingness to participate in the study. Given our research questions, which want to explore the impact of institutional linkage on resource endowments and growth, this is appropriate, as we do not expect the willingness of founders/CEOs to cooperate or the (lack of) knowledge of the population of firms to influence both independent variables representing institutional linkage. We developed a standardised survey instrument that was used as a road map during face-to-face interviews with the founders and/or CEOs of the companies. During these 1 - 1,5 hour interviews, we questioned the respondents about the start-up history of the firm in terms of technology transfer from the PRO, the inventors involved, how (much) resources were attracted at time of founding and how the company evolved since then. Special attention was given to the resource endowments: the human, financial and technology resources. Our final sample consists of 24 PROs and 96 science-based entrepreneurial firms that emerged from these institutions.

3.2. Measures

To address the hypotheses outlined above we selected or developed measures regarding institutional linkage, firm resources and growth.

Institutional linkage

As aforementioned, we measure institutional linkage by two categorical independent variables, which are both coded at the company level: research specificity of the parent organisation and the formality of technology transfer at time of founding. Since the validity of the distinction between formal technology transfer and the informal transfer of research / know how has been launched and generally acknowledged by the Association of University Technology Managers, hypothesis 1 specifically addresses the empirical validation of the conceptual distinction between generic and specific PROs, using univariate Mann Whitney U tests. Siegel et al. (2003) identified
a number of input indicators related to university – industry technology transfer, internal to the research organisation: invention disclosures (a proxy for the set of available technologies), labour employed by the Technology Transfer Office (TTO), and the legal fees incurred to protect the intellectual property of the PRO. We augmented these measures with research expenditure, license income, patents filed and the number of science-based entrepreneurial firms set up in 2002 to get an idea of the nature of commercialisation activities at each of the groups of PROs. We compare the generic and specific PROs in the sample on this set of indicators.

Resource measures
Several researchers have traditionally pointed to the financial (Manigart et al., 2002), technological (Utterback et al., 1988) and human resources (Shane and Stuart, 2002) as significant assets in young firms and science-based entrepreneurial firms in particular. The entrepreneurship literature Roberts (1991) argued that the human, technological and financial resources are instrumental in the development of an initial resource base.

For each group of resources we selected one variable argued to be crucial for founding science-based based entrepreneurial firms (Heirman and Clarysse, 2004) and that rightfully represent the resource categories of interest. Choosing one variable for each resource category is appropriate given the relatively small sample and since there is a high inter item reliability\(^\text{39}\). For the financial resources we included the \textit{start capital} of the company, i.e. the total capital represented in the company during the first year of activities, including capital from entrepreneurs equity investors and debtors. Including the total capital is important, because for some firms the (high) valuation of the technology on behalf of the PRO need to be taken into account. We measured the technological resources at time of founding by the degree of \textit{productisation of the research / technology}, i.e. the extent to which the research / technology is deployed in a service oriented business models or if it is developed to

\(^{39}\) For the financial resources we evaluated inter item reliability between total capital at founding and the amount of external capital (Cronbach Alpha = 0.99). The inter item reliability for the technology resources is lower (Cronbach Alpha = 0.69), but still acceptable, given the fact that the degree of productisation of the technology (1-5) and the maturity of the technology until reaching an alpha prototype (1-9), are in fact complementary measures of which the latter precedes the first in (time) order. For the human resources, we are focusing on the amount of people actively involved in the firm, which is captured in one measure.
eventually reach the stage of a market ready product. More specifically, we measured
the degree of productisation using a scale of 1 to 5: the closer to 5, the more the
technology is embodied in a product. Since a lot of science-based entrepreneurial
firms develop and market technologically new or improved products, services or
processes, gaining understanding in where they are situated along a continuum of
productisation is particularly relevant in providing a sense of the nature and extent of
pre-founding efforts and the maturity of the research base. Finally, we measured the
human resources by looking at the size of the team that starts working in the newly
founded business, providing a crude indicator of firm size. We count the number of
active persons working in the firm, including the employees, active founders and
managers.

Growth measures
When measuring growth of high tech companies in general, authors have used a
variety of indicators (Heirman and Clarysse, 2004b) such as sales growth (e.g. Lee et
al., 2001), employment growth (e.g. Westhead and Birley, 1994), first product
shipment (e.g. Schoonhoven et al., 1990) or some composite performance indicator.
Delmar et al. (2003) argue that there is no “one best way” of measuring firm growth
because it is intrinsically multidimensional. Although different measures of growth
have been proposed in the entrepreneurship literature, the following growth indicators
seem to be listed most often: (return-on) assets, employment, market share, physical
output, profits, and sales. However, several scholars argue that traditional accounting-
based indicators of profitability and assets are inappropriate for relatively young
companies in high technology sectors (e.g. Shane and Stuart, 2002). However, for
science-based entrepreneurial firms, it is possible that capital levels and employment
will grow before any substantial sales and revenues are generated or profitability is
obtained, displaying the investment intensity that often entails these types of
companies. Therefore, we measure growth in terms of average growth in employees
and capital. Both growth measures seem to be suitable indicators if the specific
interest is assessing policy implications. Growth in capital is informative about the

40 The items on the scale represent the following stages: 1: Service oriented business model; 2:
Research / technology is in the idea phase specifically to develop it along a new product development
process; 3. The technology reached a proof of concept (working in a lab environment), i.e. a α-
prototype; 4. The technology reached a prototype that works in realistic environment, i.e. β-prototype;
5. There is at least one concrete market-ready product based on the research / technology.
propensity of the venture to attract investors for science-based entrepreneurial firms, which are established from largely publicly funded research. Growth in employees helps us understand the relative role of spin-offs and start-ups in their contribution to job creation. Moreover, resource-based scholars value employment based measures as a highly suitable indicator of firm growth (e.g. Kogut and Zander, 1992). Thus, both growth measures provide insight in the relative contribution of spin-offs and start-ups in regional development objectives: employment creation and attracting (foreign) capital. We do not use relative growth measures (%) since the smallest venture naturally ends up with highest relative growth even if in absolute terms its growth is negligible compared to the absolute growth of its larger counterparts. Instead we choose to include absolute average growth in our analyses (value today minus value during first year of operations, divided by the age of the firm).

The next section discusses the analyses performed for assessing the hypotheses developed above.

4. DATA ANALYSIS AND RESULTS

Different analysis techniques were used to test the three principal hypotheses. To test hypothesis 1, univariate Mann Whitney U tests were used to study the differences between the two conceptualised types of public research organisations. Hypothesis 2 is evaluated using a 2X2 factorial design for MANOVA in order to assess the predictive power of institutional linkage on resource endowments. Finally, we test hypothesis 3 performing a two stage least squares regression analysis, allowing to separate the individual effects of the formality of technology transfer and start capital on the growth of science-based entrepreneurial firms. This section presents the analyses and the results for each hypothesis.

4.1. Hypothesis 1: Specific PROs are more actively engaged in technology transfer activities than generic PROs

Our primary goal for testing the first hypothesis is to provide an empirical validation of the conceptualisation of ‘generic’ versus ‘specific’ PROs, as we developed earlier.
Table 12 displays the descriptive data of the PROs in the sample (N=24), as well as the respective p-values representing the significance levels for the differences in technology transfer related activities between the PROs with a ‘generic’ and a ‘specific’ research base. The non-parametric tests show that the two groups of PROs differ substantially in a variety of research and technology transfer indicators (supporting hypothesis 1). The results mostly point to the hypothesised direction: specific PROs score significantly higher on IP protection expenditure, invention disclosure, patent applications, active license agreements and license income. Additionally, the technology transfer offices seem to be somewhat older and they employ significantly more personnel managing the start-up process of science-based entrepreneurial firms.
There are a number of interesting observations to make from this table. First, the age of the technology transfer office -- as a proxy for experience of the PRO in the organisation of technology transfer activities -- is not significantly different for both types of institutes. Although the technology transfer offices of the generic public research organisations are somewhat younger, the difference is not significant. In a recent survey of TTOs from the OECD (2003, p. 38), it was found that most TTOs from public research organisations are less than 10 years old. Second, the specific PROs have significantly more invention disclosures as well as patents filed, suggesting there are intrinsic differences in the nature of the research activities,
technological domains and the commercialisation trajectories adopted in the two groups of PROs. Third, generic and specific research organisation do not seem to differ in the amount of R&D expenditure they have. This suggests that in terms of research size and TTO experience, the generic and specific PROs are quite similar, providing a seemingly logical explanation for the fact that they do not differ from each other in terms of spin-offs and start-ups they generate.

However, when we relate some input and output indicators from the previous table, some clear differences emerge. Table 13 summarises some comparative output indicators for generic and specific PROs. For one out of every three inventions that is disclosed, specific PROs seem to file a EU and/or US patent. The same ratio for generic PROs is 25:1. Moreover, generic PROs tend to patent almost only in the EU, while the specific institutes seem to have a much more global strategy, covering also the US. This indicates that specific PROs have a much more elaborated and professional staff involved in intellectual property issues: the IP staff tends to be three times a large in the specific group of PROs as compared to the generic ones, which is in turn reflected in the license income. Specific PROs generate more than 20 times the license income per full time equivalent employed in licensing activities as compared to the generic PROs.

Table 13: Comparative output indicators for generic and specific PROs

<table>
<thead>
<tr>
<th>Median</th>
<th>Generic PRO</th>
<th>Specific PRO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invention disclosures / patent EU (US)</td>
<td>25 (NA)</td>
<td>2,7 (3)</td>
</tr>
<tr>
<td>License income / FTE in licensing</td>
<td>70 000 €</td>
<td>1 550 000 €</td>
</tr>
<tr>
<td>License income / patent EU (US)</td>
<td>90 000 € (NA)</td>
<td>189 000 €</td>
</tr>
<tr>
<td>License income / IP protection expenditure</td>
<td>0,3 €</td>
<td>0,78 €</td>
</tr>
<tr>
<td>SBEF / patents EU (US)</td>
<td>3 (NA)</td>
<td>0,13 (0,14)</td>
</tr>
<tr>
<td>FTE SBEF / SBEF</td>
<td>0,3 FTE</td>
<td>1 FTE</td>
</tr>
<tr>
<td>FTE TT, licensing en SBEF / SBEF</td>
<td>2 FTE</td>
<td>6 FTE</td>
</tr>
</tbody>
</table>

(1) The median for filed US patents in the generic PROs is 0

Although there is a clear input-output relation between IP expenditure and staff employed in licensing on one hand and license output such as number of licenses, patents and license income, the input-output relation between staff and science-based entrepreneurial firms is less clear. Generic PROs employ 2 full time equivalent employees for every venture that is created as compared to 6 in specific PROs. This
potentially suggests that the technology transfer offices of specific PROs are more intensely involved in the establishment and incubation of science-based entrepreneurial firms. Since there are three times as much people involved in the creation of these companies, we might expect that the coaching and support will be more elaborated.

Overall, we find that specific PROs show clear indicators of a more professionalised technology transfer office: they significantly patent more and if they patent it is at a global rather than at a EU level; they generate significantly more license income; they have a larger staff, … Interestingly, they seem to generate about the same amount of science-based entrepreneurial firms in general and spin-offs in particular as the generic research organisations. However, if a specific PRO engages in establishing a SBEF, the data suggest that specific PROs put more effort in incubating and / or coaching the project.

4.2. Hypothesis 2 and 3: Institutional linkage predicts founding resources and growth of SBEF

Whereas the first hypothesis is tested at the level of the PRO in order to empirically validate the conceptual distinction between generic and specific PROs, the second and third hypothesis are tested at the level of the science-based entrepreneurial firm. Each company in the sample is coded for the two dimensions of institutional linkage at time of founding the company: the formality of technology transfer (two levels: formal transfer of technology – informal transfer of know how) and the research specificity of the PRO from which the venture emerged (two levels: generic PRO – specific PRO).

Table 14 shows the descriptive data and the correlations of the variables used to test both hypothesis 2 and 3. The data display a huge variety in the companies in the sample, mirroring observations from academics and practitioners that science-based entrepreneurial firms differ substantially in their resource conditions and growth patterns. We included age and technology domain as contextual variables, as it is

---

41 Technology domain was coded according to the following categories: 1= Life sciences and biotechnology, 2= Hardware and Microelectronics, 3= IT, 4= other
possible that these characteristics produce variation among the variables used to test the hypotheses. For example, life sciences ventures are generally argued to start with higher capital levels (Mangematin et al. 2003). Nevertheless, the coefficients do not display significant correlations between the variables of interest and the firms’ age, nor technological domain.

The next section elaborates on the multivariate analyses and results for both hypothesis 2 and 3.

Table 14: Means, standard deviations, ranges and correlations (of variables used to test hypothesis 2 and 3)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources at time of founding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Total Capital, K €</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Employees, N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Productisation of the technology, 1-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Average annual growth in capital, K€</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Average annual growth in employees, N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>SD</th>
<th>Valid N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources at time of founding</td>
<td>786</td>
<td>100</td>
<td>0.149</td>
<td>6,137</td>
<td>1522</td>
<td>87</td>
</tr>
<tr>
<td>Growth measures</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>42</td>
<td>5,3</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>1,2</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>859</td>
<td>84</td>
<td>-1003</td>
<td>1838</td>
<td>2771</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>7</td>
<td>-2</td>
<td>57</td>
<td>7</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>5,4</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>91</td>
</tr>
</tbody>
</table>

* p < 0.05
4.2.1. Hypothesis 2: Science-based entrepreneurial firms with a formal transfer of technology and emerging from specific PROs will display higher resource levels

In order to assess the nature and the magnitude of the potential effect of institutional linkage on the resources endowed to science-based entrepreneurial firms at time of founding, a 2X2 factorial design for Multivariate Analysis of Variance is used. MANOVA is appropriate since we want to assess the effects of independent, categorical predictor variables on multiple dependent variables. More specifically, we test the effect of the formality of technology transfer (formal – informal) and the research specificity of the PRO (generic – specific) on the start capital, the productisation of the technology and the number of employees of the science-based entrepreneurial firms.

We preferred a MANOVA to a series of separate ANOVA’s primarily because it has been argued that resources are intrinsically multidimensional and interacting (Brush et al., 2001; Heirman and Clarysse, 2004a). Moreover, MANOVA has a number of empirical advantages over performing separate ANOVAs on each dependent variable (Bray and Maxwell, 1990, 9; Hair et al. 1995). For example, MANOVA protects against inflated type I error due to multiple tests of likely correlated dependent variables. However, MANOVA has some strict assumptions that need to be met before this type of analysis can be performed. The assumptions of normality of the dependent variables, homogeneity of variances, sufficient correlation between the dependent variables and a balanced design (Hair et al., 1995), are all tested for and the results allow us to proceed with the planned analysis (see appendix for an overview of the tests).

Table 15 gives an overview of the components of the multivariate analysis of variance used to test hypothesis 2.

<table>
<thead>
<tr>
<th>Main effect</th>
<th>Interaction effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formality of technology transfer</strong> (a in Table 16)</td>
<td><strong>Formality * research specificity</strong> (c in Table 16)</td>
</tr>
<tr>
<td>-&gt; Start capital * productisation of technology * employees</td>
<td>-&gt; Start capital * productisation of technology * employees</td>
</tr>
<tr>
<td><strong>Research specificity</strong> (b in Table 16)</td>
<td></td>
</tr>
<tr>
<td>-&gt; Start capital * productisation of technology *</td>
<td></td>
</tr>
</tbody>
</table>

Table 15: Overview of Multivariate Analysis to test hypothesis 2
In the course of the discussion, we assess the interactive or joint effects between the two categorical variables on the dependent resource variables collectively. First, we evaluate the interaction effect between formality of technology transfer and the research specificity of the parent PRO. More specifically, this analysis addresses the question whether or not spin-offs and start-ups differ in their resource endowments at time of founding, depending on the research specificity of the parent PRO. Second, we evaluate the main effects of each independent variable separately on the resource variables as a group.

The MANOVA design, constructed as 2X2 combinations of institutional linkage, produces 4 groups of firms: (1) spin-offs (receiving formal transfer of technology) from specific PROs, (2) spin-offs from generic research organisations, (3) start-ups (receiving an informal transfer of know-how) from specific research organisations and (4) start-ups from generic PROs. The null hypothesis that the four groups of firms do not differ across the mean scores of the dependent variables can be rejected at the 0,05 level (F=2,5), suggesting that institutional linkage is significantly associated with variations in founding resources.

Table 16 contains the MANOVA results for testing the interaction and main effects. Evaluation of the interaction effect is important because it is a condition to correctly interpret the main effects. The multivariate tests -- Wilks Lambda and Pillai’s criterion\footnote{Wilks Lambda and Pillai’s criterion represent multivariate F values. Wilks’ Lambda is the most commonly available and reported test statistic in a MANOVA setting. However Pillai’s criterion is more robust and more appropriate when there are small or unequal sample sizes.} -- indicate that there is a significant interaction effect: the differences between the groups of the first categorical variable (formality of technology transfer) vary depending on the level of the second independent variable (research specificity). This indicates that the main effects to not operate independently: the differences between spin-offs (formal technology transfer) and start-ups (informal transfer of know-how) are not equal across their origin from generic or specific parent organisations.
Table 16: MANOVA for founding resources: Start capital, Productisation of technology and number of employees

<table>
<thead>
<tr>
<th>MANOVA</th>
<th>Wilks Lambda</th>
<th>Pillai’s criterion</th>
<th>df</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formality of technology transfer (a)</td>
<td>0.743</td>
<td>0.257</td>
<td>3</td>
<td>7.601</td>
<td>0.000</td>
</tr>
<tr>
<td>Research focus (b)</td>
<td>0.977</td>
<td>0.023</td>
<td>3</td>
<td>0.518</td>
<td>0.671</td>
</tr>
<tr>
<td>Formality * research focus (c)</td>
<td>0.889</td>
<td>0.111</td>
<td>3</td>
<td>2.5</td>
<td>0.049</td>
</tr>
</tbody>
</table>

Adjusted $R^2 = 0.25$
Power 64% at alpha=0.05

Figure 6 specifically documents the ordinal interaction effect that this entails. Spin-offs (with a formal transfer of technology) seem to be established with higher resource levels than start-ups (with an informal transfer of know-how), and this difference is reinforced by the research specificity of the PRO from which the science-based entrepreneurial firm emerges. Since the ordinal interaction effect is conceptually acceptable, we further evaluate the main effects separately and investigate the specific group mean differences using a post hoc procedure.

Figure 6: Plot of interaction effect in 2X2 factorial design MANOVA

First, we find a significant main effect of the formality of technology transfer and the resource endowments of the firms: the spin-offs -- the science-based entrepreneurial firms that received a formal transfer of technology at time of founding -- are founded

43 The lines are not parallel and do not cross between levels, indicating that the effects of both independent variables are not equal across the groups but the magnitude is in the same direction.
with higher resource levels as compared to the start-ups, which are launched based on an informal transfer of know-how. Conversely, we find no direct effect of the research specificity on the resource endowments -- i.e. start capital, productisation of technology and the number of employees -- of the science-based entrepreneurial firms at time of founding.

Second, we are also interested in the nature of the differences among the combinations of groups, for each dependent variable separately. This allows us to discern whether it is start capital, productisation of technology and / or the number of employees that accounts most for the observed differences between the groups. To analyse this, we use a post hoc procedure. To avoid inflated type I errors commonly prevalent in small samples such as ours, (Hair et al. 1995), we decided to use the Scheffe test, which is argued to be one of the most conservative post hoc tests (Winer et al., 1991). Doing so, we downsize the chance of obtaining false significance levels.\footnote{Moreover, Kruskall Wallis tests display results in the same direction (KW=19.5; p<0.001) for start capital en degree of productisation of the technology (KW=8.2; p<0.05). For both dependent variables box whisker plots show 1>2,3,4; 2>3,4 and 3<4.}

Scheffe tests show that the differences between spin-offs and start-ups across the research specificity of their parent PROs, holds true for start capital and the productisation of technology. Spin-offs originating from public research organisations with a specific research or technology focus start activities with significantly higher capital levels than the other three groups (p=0.02, p=0.000, p=0.004). However, for the productisation of technology the difference is only significant between the spin-offs from both specific and generic PROs on one hand and the start-ups from specific PROs on the other. The univariate results also indicate that the differences in employees are non significant across all groups.
Table 17: Post hoc tests for 2X2 factorial MANOVA (hypothesis 2)

<table>
<thead>
<tr>
<th></th>
<th>Spin-offs from specific PROs (1)</th>
<th>Spin-offs from generic PROs (2)</th>
<th>Start-ups from specific PROs (3)</th>
<th>Start-ups from generic PROs (4)</th>
<th>Total Sample</th>
<th>Scheffe test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start capital, K €</td>
<td>Mean (Sd) N = 26</td>
<td>Mean (Sd) N = 31</td>
<td>Mean (Sd) N = 11</td>
<td>Mean (Sd) N = 18</td>
<td>786</td>
<td>1&gt;2*, 1&gt;3 **, 1&gt;4 ***</td>
</tr>
<tr>
<td></td>
<td>1766 (2168)</td>
<td>606 (1141)</td>
<td>23 (27)</td>
<td>148 (221)</td>
<td></td>
<td>1&gt;2*</td>
</tr>
<tr>
<td>Productisation of technology</td>
<td>2,9 (1)</td>
<td>2,9 (1)</td>
<td>2 (1)</td>
<td>2,5 (1)</td>
<td>4</td>
<td>1,2&gt;3 *</td>
</tr>
<tr>
<td>Employees</td>
<td>4 (3)</td>
<td>4 (5)</td>
<td>2 (2)</td>
<td>5 (8)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

* p < or = 0,1  ** p < or = 0,05  *** p < or = 0,01  ****p < or =0,001

Descriptive data are reported in real values; for significance testing the log of variables start capital and employees is used.

These results potentially indicate that spin-offs are the result of a clear strategic choice for commercialising intellectual property through setting up a new firm. Since these spin-offs start with the highest capital levels, this mirrors the professionalisation of technology transfer activities in the originating parent from an organisational point of view and the observation that these companies probably have higher IP valuations at time of founding. In other words, the professionalisation trend of technology transfer activities in specific PROs seems to have the largest impact on the start capital of the spin-offs.

One of the impediments of using a MANOVA, is that it is hard to control for potential confounding categorical variables, of which technological domain is particularly relevant for this research. More specifically, life sciences companies have been argued to generally start larger as compared to companies in other technological domains (Mangematin, 2003). In order to test the robustness of the MANOVA results across technological domain we separate the effect of ‘life sciences’ by providing the split sample ANOVA results for the life sciences sub-sample and the MANOVA results for the non-life sciences sub-sample. Given the small sample size of the first category (N=22) it is not possible to perform a 2X2 factorial MANOVA. As a result, we only test the main effect of formality of technology transfer on the dependent variables identified earlier.
The life sciences companies sub-sample shows that the formality of technology transfer is not significant (Wilks Lambda=0.79; F=1.6 p=0.22)\(^{45}\). Although the life science spin-offs start with somewhat higher capital levels (N=16, of which 3 come from a specific PRO) as compared to the life sciences start-ups (N=6, of which all come from generic PROs), the difference is not significant. This actually strengthens our finding from the MANOVA: spin-offs are significantly different from start-ups, even including the non-significant differences of the life sciences group. Further, we can make an argument that the life sciences spin-offs originating from generic PROs actually downsize the real differences between spin-offs from specific and generic PROs. Therefore, we can conclude that the significance levels found in the main MANOVA are valid across technological domain.

For the non-life sciences sub-sample (N=68), the ordinal interaction effect between formality of technology transfer and research specificity of the PRO is significant (Wilks Lambda=0.8; F=3.5; p=0.02), showing a significant main effect of the formality of technology transfer (Wilks Lambda=0.76; F=4.6; p=0.007). This is in line with what we found in the MANOVA for the complete sample: spin-offs have higher capitalisation and a higher degree of productisation than the start-ups. This is especially true for the spin-offs originating from specific research organisations.

To summarise, hypothesis 2a is supported in that the formality of technology transfer predicts start capital and, to a lesser extent, the degree to which the technology is embodied in a product. The effect does not hold true for the number of employees, which is remarkable. It means that spin-offs start with more capital but with an equal amount of human resources, as compared to the start-ups. However, it is usually the human resources that make up the capital intensity and value of the venture. This suggests that the higher capital level can mainly be explained by the valuation strategy of the intellectual property going into the venture. Hypothesis 2b is not supported. However, there is a significant interaction effect between the research specificity and the formality of technology transfer, for the three resource variables collectively. The spin-offs which have a formal transfer of technology, emerging from specific PROs start with significantly higher capital levels than the spin-offs from generic PROs.

\(^{45}\) Finding the additional discriminatory power of the effect of formality of technology transfer in the life sciences sub-sample could be solved by increasing the significance level. However, the p-value is too high (p=0.21) in order to do so.
Conversely, the start-ups -- that are established with an informal transfer of know-how -- from specific PROs have significantly less start capital that the start-ups from generic PROs. This indicates that technology transfer offices at specific PROs tend to focus on the support and/or incubation of science-based entrepreneurial firms that receive formal intellectual property of the research organisation at time of founding, whereas the generic universities seem to support both spin-offs and start-ups.

4.2.2. Hypothesis 3: Science-based entrepreneurial firms with a formal transfer of technology will display higher growth

Since institutional linkage seems to matter in understanding resource endowments of science-based entrepreneurial firms, we also need to address the issue whether institutional linkage at time of founding has an enduring effect on the growth of these firms. In other words, do the spin-offs grow more than the start-ups? Given the policy attention for IP based science-based entrepreneurial firms (the spin-offs), hypothesis 3 stipulated that companies founded with a formal transfer of technology are more likely to grow in employees and capital, as compared to firms that are started without formal transfer of technology (the start-ups)\(^\text{46}\). The main reason for hypothesising this is the fact that governments are increasingly giving attention to the creation, ownership and exploitation of IP emerging from publicly funded research organisations, given the evidence and awareness that IP that can be protected through patents and copyright, contribute to technological innovation and growth (OECD, 2003, p. 21).

We analyse the association between the formality of technology transfer, start capital and growth using regression analysis\(^\text{47}\). We control for ‘demographic’ variables in the

\(^{46}\) We deliberately choose not to focus on growth in revenues because it has been argued that traditional accounting based measures are not appropriate for young firms in high technology sectors (Lee et al., 2001; Shane and Stuart, 2002).

\(^{47}\) We choose not to include the growth variables as additional dependent variables in the 2X2 MANOVA for different reasons. First, it is conceptually confusing to combine resource variables at time of founding with growth variables that are inherently evaluated at a later stage. Second, the research specificity of the PRO will probably only impact the early stages of the companies’ existence, whereas the formality of technology transfer can be argued to have more enduring effects on the firm, since the firm need to maintain its acquired technology base. Thus, for assessing growth we specifically focus on one aspect of institutional linkage. Third, it is important to separate out the individual effects of formality of technology transfer and start capital on growth.
analysis that are generally acknowledged to potentially influence growth measures (Delmar, 2003): technology domain, age and firm size. First, we take into account whether or not the science-based entrepreneurial firm is a life sciences firm. Life sciences firms are argued to have a higher minimum critical scale (Mangematin, 2003) and therefore can be expected to display higher average growth. Second, since population ecologists have traditionally argued that firm growth is age related we also take into account the age of the SBEF. Empirical studies indicate that firm growth decreases with firm age (Barron et al., 1994). Thus, the growth potential of new firms seems to be most apparent during their initial phase of evolution. Third, we use the number of active researchers, entrepreneurs / founders and managers in the company as a proxy of firm size. For convenience, we label all the active people in the firm as “employees”, although not all of them are on the pay roll of the company. We take firm size into account because several noted studies have recently reached the conclusion that the basic tenet underlying Gibrat's Law - that growth rates are independent of firm size – actually does not hold (Audretsch et al. 2002). Estimating how the different factors affect growth would require the following regression equation:

\[
\text{Growth employees (capital)} = f(\text{Formality of technology transfer, Start Capital, Employees, Life sciences firm, Age})
\]

However, estimating the full model in one equation is not appropriate because there is strong mutual dependence between start capital and growth of the science-based entrepreneurial firm, both in terms of employees and capital. More specifically, ventures might look for a high level of start capital to be able to recruit a high number of employees in the years to come, which implies that a priori growth expectations determine the start capital. Conversely, start capital might be a reflection of the soundness of the business plan, which allows the company to grow in terms of employees and raising additional capital. Moreover, the results from hypothesis 2 indicate that the formality of technology transfer is highly predictive for the start capital of the firm, which makes separating its individual effects necessary to tackle the issue of interest. In these cases, it is generally advised to perform a two stage least squares regression (Pindyck and Rubinfeld, 1991, 298), in order to separate out the
effects of the problematic variables. Therefore, we estimate the following system of equations:

**Stage 1:** Start capital = f (Formality of technology transfer, Employees, Age of firm, Life Sciences firm)

**Stage 2:** Growth employees (capital) = f (Formality of technology transfer, Employees, Age of firm, Life Sciences firm, Residual of stage 1 regression)

The first regression estimates the extent in which the formality of technology transfer explains for start capital, taking into account some demographic characteristics. For assessing the significance levels of the variables included in the model on the growth of the SBEF, we include the residual of the first stage regression in the main regression. As a result, we include an instrumental variable in the main regression (stage 2), which is a proxy for start capital. More specifically, by taking the residual we include the variance of start capital that is not explained by the other independent variables in the model. This allows us to evaluate the exogenous effects of both formality of technology transfer and start capital on the growth of the SBEFs, both in terms of employees and capital.

Table 18 provides an overview of the regression results.

**Table 18: Two-stage least-squares regression to test hypothesis 3**

<table>
<thead>
<tr>
<th>Variables</th>
<th><strong>Stage 1</strong></th>
<th>Sign</th>
<th><strong>Stage 2</strong></th>
<th>Sign</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start capital</td>
<td>Beta (St. err.)</td>
<td>Growth in employees</td>
<td>Beta (St. err.)</td>
<td>Beta (St. err.)</td>
</tr>
<tr>
<td>Formality of technology transfer</td>
<td>0.44 (0.47)</td>
<td><strong>0.000</strong></td>
<td>****</td>
<td>0.03 (0.67)</td>
<td>0.79</td>
</tr>
<tr>
<td>Employees</td>
<td>0.29 (0.26)</td>
<td><strong>0.006</strong></td>
<td>***</td>
<td>0.07 (0.37)</td>
<td>0.55</td>
</tr>
<tr>
<td>Life sciences firm</td>
<td>0.17 (0.47)</td>
<td>0.11</td>
<td></td>
<td>-0.12 (0.64)</td>
<td>0.31</td>
</tr>
<tr>
<td>Age</td>
<td>-0.11 (0.08)</td>
<td>0.28</td>
<td></td>
<td>0.18 (0.1)</td>
<td>0.13</td>
</tr>
<tr>
<td>Residual</td>
<td>0.37 (0.17)</td>
<td><strong>0.003</strong></td>
<td>***</td>
<td>0.19 (0.42)</td>
<td>0.09</td>
</tr>
<tr>
<td>R Sq</td>
<td>31%</td>
<td></td>
<td></td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>R Sq adjusted</td>
<td>27%</td>
<td></td>
<td></td>
<td>12%</td>
<td>19%</td>
</tr>
<tr>
<td>F</td>
<td>7.38</td>
<td></td>
<td></td>
<td>2.76</td>
<td>3.95</td>
</tr>
<tr>
<td>P model</td>
<td><strong>0.000</strong></td>
<td>****</td>
<td></td>
<td><strong>0.027</strong></td>
<td><strong>0.004</strong></td>
</tr>
</tbody>
</table>

*p < or = 0.1  ** p < or = 0.05  *** p < or = 0.01  **** p < or = 0.001*
The first stage regression clearly shows that both the formality of technology transfer and the number of employees explain significantly for the start capital of science-based entrepreneurial firms. In line with the findings presented earlier, spin-offs start with higher capital levels as compared to start-ups. The second stage regression results indicate that start capital has an effect on the growth in employees, independent from the formality of technology transfer (p<0.01). However, the significance of the formality of technology transfer disappears, suggesting that start capital has a mediating effect between the formality of technology transfer and growth in employees. Baron et al. (1986) argue that at least two requirements need to be met for evaluating mediation. First, the initial variable needs to be correlated with the mediator (formality of technology transfer affects start capital, stage 1 regression). Second, the mediator affects the outcome variable (start capital affects growth in employees, stage 2 regression). Since a direct estimation of the effect of formality of technology transfer on growth is not appropriate given the mutual dependence between start capital and growth, a path from formality to growth in employees can be implied based on the two conditions that are met. The implied effect of formality of technology transfer on growth in employees however, disappears when the mediator start capital is controlled. Hence, being a ‘spin-off’ – with a formal transfer of technology at time of founding – does not necessarily mean that higher employee growth will be displayed as compared to the start-ups. The implied effect is largely mediated by the capital levels of these firms.

For the effect of formality of technology transfer on growth in capital a different picture emerges: both start capital and the formality of technology transfer have an individual effect on capital growth. The formality of technology transfer continues to explain the growth in capital. Thus, starting as a spin-off -- as opposed to a start-up -- has intrinsically higher potential to attract additional capital, irrespective of the capital at time of founding. This shows that investors in general, and the venture capital community in particular, seem to be more interested in companies with protected technology / intellectual property, favouring spin-offs over start-ups. Moreover, the individual effect of the formality of technology transfer on capital growth is intrinsic to the activities of the firm: spin-offs often need additional (venture) capital in order to further develop and maintain their acquired technology base. On the other hand, however, the high valuations of these companies at the onset of activities may blur our
perspective on the amount of working capital that is effectively available to develop the business. It may be that spin-offs – as compared to start-ups – start up with too small an amount of working capital as compared to the total capital of the firm. Concurrently, however, we observe that a higher number of employees also increase the propensity to attract additional capital ($p<0.05$), pointing to the capital intensity of the nature of the technological and business development. Figure 7 summarises the regression coefficients for the relationships we tested in hypothesis 3. The first path model documents evidence for a mediating effect of start capital between the formality of technology transfer and employee growth. The second path model shows that both start capital and formality of technology transfer have independently predictive capacity for capital growth.

Figure 7: Coefficients of regression equations: relationships between formality of technology transfer, start capital and growth in employees / capital (hypothesis 3)

```
   Formality of technology transfer 0.03 (stage 2) Growth Employees
     0.44 **** (stage 1) 0.37 *** (stage 2) Start Capital

   Formality of technology transfer 0.19 * Growth Capital
     0.44 **** (stage 1) 0.19 * (stage 2) Start Capital
```

* $p < or = 0.1$ ** $p < or = 0.05$ *** $p < or = 0.01$ **** $p < or = 0.001$

Hence, hypothesis 3 is partially supported in that the formality of technology transfer predicts growth in capital, independent from start capital. We have shown that this is not the case for employee growth, where the implied relationship is mediated by start capital. Drawing conclusions from this requires some caution. The growth measures used in this paper illustrate capacity growth, mirroring employment and the propensity to attract (foreign) capital. A link to financial performance is a step further along the line and cannot be evaluated from this analysis.
The remainder of the paper summarises the results from this study and discusses the arguments and contributions that can be drawn from this.

5. CONCLUSION AND DISCUSSION

This study explicitly recognises the heterogeneity of science-based entrepreneurial firms in Europe and provides a mutually exclusive categorisation for these firms denoting their institutional linkage at time of founding. More specifically, we attempted to understand whether institutional linkage affects the resource endowments of science-based entrepreneurial firms and whether this matters in terms of the growth of these companies. We operationalise institutional linkage as a two-dimensional construct, consisting of the formality of technology transfer (formal or informal) and the research specificity of the PRO (generic or specific). The main argument of the paper is that institutional linkage matters in predicting the resources a science-based entrepreneurial firm attracts at time of founding. Contrary to our expectations we found mixed results as to the effect of formal transfer of technology on the growth of science-based entrepreneurial firms. We tackled these issues in three steps.

First, we hypothesised that specific PROs are more active in technology transfer related activities as compared to PROs with a generic research base. In recent years, a lot of research organisations have attempted to formalise technology transfer and capture a larger share of the economic rents associated with technological innovation by establishing technology transfer offices (TTOs) (Siegel et al., 2003). Although TTOs have in common that they facilitate technological diffusion through the licensing to industry of inventions or intellectual property resulting from university research, research organisations seem to differ significantly in the magnitude of these activities. We have shown that specific PROs engage much more in commercialisation activities than generic ones. This is particularly reflected in the IP protection expenditure, invention disclosures, patent applications and license income. Looking at the relative productivity by comparing some input indicators to output measures, it was shown that the PROs with a specific research base file significantly more patents relative to the disclosed inventions as compared to the generic PROs. Apparently, the nature of the research base is important to contextualise the commercial use of research performed in PROs. Although inventions and licensing
activity have an impact on the entrepreneurial activity, these indicators could well be moderators for the particular research base of the PROs. What is especially intriguing is the fact that despite the larger critical mass of specific PROs in terms of persons employed in the technology transfer departments, the number of science-based entrepreneurial firms they start in a given year is not significantly different from the generic PROs which seem to have a less elaborated technology transfer office. This seems to suggest that the research portfolio is the critical factor in the establishment of SBEFs and that the TTO plays a mediating role.

Second, we tested whether institutional linkage predicts firm resources at time of founding. We found that spin-offs clearly display higher capital levels and a more productised technology than the start-ups in the sample. The fact that the spin-offs are established with higher capital levels reflects the fact that PROs want to value their technology by converting it into equity shares. In turn, this leads to a higher valuation of the venture at time of founding and, by definition, to higher capital levels (otherwise the PRO would own 90 + % of the company). In this respect it is interesting to find that the spin-offs from specific PROs start up at an even larger scale than the spin-offs from the generic PROs. Conversely, the start-ups from the PROs with a specific research base show the lowest resource levels. This might indicate two interrelated issues. First, setting up start-ups seems to be of less strategic importance for PROs that specialise in one or a number of technological domains. This would be in line in what we found in a parallel study (Moray and Clarysse, 2004): IMEC, for example changed its strategy the last 5 years to focusing on establishing spin-offs. But even when the research institute was only active in spinning off ‘start-ups’ (late eighties - early nineties), these companies were significantly ‘smaller’ as compared to the spin-offs from other PROs (Moray, 2004). Second, in the same study we found that the average starting capital of the science-based entrepreneurial firms from a specific PRO has more than quadrupled over the last ten years. This increase in capital went together with the professionalisation of the technology transfer office and an increasing focus on transfer of intellectual property into new companies. Thus, if PROs want to commercialise their technology using spin-offs as a vehicle, this usually means that they need to set up an equity relation with the new firm. However, doing this boosts the value of the company at time of founding and makes external capital a necessity to balance the shareholder structure. In order to attract capital, the business
plan needs to be more ambitious, more oriented on quick return and growth and more focused on exit related valuation. All this implies, however, that even more capital is needed while only a few of all invention disclosures have the intrinsic potential to establish such a growth path. This seems to be what professionalised TTOs at specific PROs are learning: if one wants to create spin-offs with the potential to become high growth ventures, scrutinised selection of ideas needs to be done, much support will be needed to incubate them and they will have to be established at sufficiently large scale. Ideas that do not match these criteria are much less likely to receive a formal transfer of technology and will probably be started as a small SME. This is much less true for generic PROs where also start-ups -- receiving informal know how – tend to be guided towards the public / private equity funds and start at a larger scale. A lot of these generic PROs are universities that want to meet today’s expectations of being an “entrepreneurial university”. Following a second academic revolution (after research had complemented their teaching mission), they also want to envision themselves as hotbeds of entrepreneurial activity. In this perspective, it is likely that they equally want to emphasise spin-offs and start-ups, resulting in a supportive structure for both types of firms. This interconnectedness of different objectives may partly explain the fact that start-ups and spin-offs from generic PROs do not differ as much in their starting resources as spin-offs and start-ups in general.

To conclude, the mechanism by which research organisations have traditionally developed and commercialised a technology, licensing of an intellectual property to a large, established firm who ultimately develops the technology in a saleable good (Powers and McDougall, 2004), still happens much more frequently than establishing SBEFs. The ratio for specific PROs however is larger (11:1) as compared to generic ones (6:1). Licensing or equity participation to a new firm has become a logical extension and potential trade off. This alternative commercialisation route represents research organisations’ efforts at increasing external prestige and legitimacy (Feldman et al., 2002) enhancing revenues streams (Bray and Lee, 2000). The Lambert Review of Business-University Collaboration (2003) raises concern that some public research organisations may be actually setting too high a price on their IP. It is argued in this respect that public funding for research, and for the development of technology transfer offices, is intended to benefit the economy as a whole rather than to create significant new sources of revenues for the research organisations.
Finally, without having the ambition of performing an in depth growth analysis, we looked at whether spin-offs display higher growth as compared to start-ups. This analysis is informed by the fact that European public research organisations have been strongly stimulated by policy makers to focus on the commercialisation of intellectual property, because of the greater awareness that results of scientific research, in the form of IP that can be protected through patents and copyright, contributes to technological innovation and economic growth (OECD, 2003, p21). Hence, for PROs having a critical mass of science-based entrepreneurial firms in general and spin-offs in particular seems to be an important signal to the broader environment and policy makers that PROs research activities provide sufficient return to society.

Our hypotheses – that spin-offs grow more in terms of employees and capital – receive mixed support. The regression results indicate that the formality of technology transfer does not have an isolated effect on employee growth; start capital seems to operate as a mediator. In practice this means that having a sufficient amount of start capital is a powerful predictor of employment growth in the subsequent years, irrespective of whether or not the company received a formal transfer of technology. Being a spin-off as opposed to a start-up however, has a single direct effect on the propensity to attract additional capital. In other words, receiving a formal transfer of technology does not only impact the start capital but also the capital that can be attracted in the years to come. This reinforces our finding that these ventures are under scrutinised selection procedures since most ideas have not the intrinsic potential to justify a large capital basis and subsequent capital injections. Further, these companies need be incubated or embedded in a supportive entrepreneurial / business development network, to raise their chance on success.

These results open the perspective for policy makers to be cautious for focusing their measures solely to (IP based) spin-off companies, which are argued to have most potential to become high growth ventures, given the breadth of their technology platform, the possibility of mass production of a revolutionary product / new material and / or the scope of their market. Technology transfer offices have often been established or re-structured exactly to serve this type of science-based entrepreneurial firms. Start-ups however, embody tacit know how and often do not require a full-fledged organisational structure to support the start-up process. However, in some
cases we observe that companies that could potentially start without formal transfer of technology from the PRO, are expected to do so given the upsurge of the phenomenon since the mid nineties, resulting in high valuations and necessary capitalisations. From a purely economic development perspective, stimulating start-ups could be argued to be equally important, especially given the lower costs involved in setting up these ventures.

**Contribution to theory and limitations**

This study contributes indirectly to theory in that it dynamically integrates elements of two theoretical perspectives in one empirical analysis that have traditionally been argued to emphasise competing aspects of an organisation’s struggle for viability and competitive advantage. Resource dependence theorists posit that firms differ in their possession of resources and that, if used effectively, this resource asymmetry can be a source of sustainable competitive advantage (Barney, 1996; 2001). Institutional theorists however, suggest that -- while resource based theory assumes that resource acquisition is guided by economically rational choices motivated by efficiency and profitability -- in fact, normatively rational choices are made for attracting the necessary resources, induced by historical precedent and social context (Oliver, 1997). Based on these perspectives, we designed an empirical analyses typically focused towards better understanding the potential predictive capacity of institutional linkage on the founding resources and growth of science-based entrepreneurial firms. The research has shown that institutional linkage matters and therefore needs to be taken into account by technology transfer managers as well as potential, (academic) entrepreneurs when commercialising research results through setting up new ventures.

Our study also contribute to academic entrepreneurship research, in that this study is one of the very few attempts trying to better understand the intrinsic effect of institutional linkage on the resource endowments of science-based entrepreneurial firms. Traditionally, researchers have looked at broader environmental circumstances in understanding the resource constraints and opportunities for new ventures. For example, the availability of venture capital or public capital in a region and a network of entrepreneurs / experienced managers have traditionally been argued to be important for the successful establishment of the resource base of a firm (Roberts, 1991). In most studies to date, resources of new firms are evaluated in view of their
external environment and how the company succeeds in managing these interrelationships. This study substantially adds to these research endeavours by taking another lens: the parent organisation in general and the nature of the knowledge base, including varying emphases on respective transfer modalities seem to be equally important to take into account when assessing the founding resources and growth of science-based entrepreneurial firms. Interestingly, whether or not a company receives a formal transfer of technology and originates from a specific or a generic research organisation seems to be an issue that cannot be managed by an (academic) entrepreneur: it is intrinsic to the PRO from which the company emerges.

Although this study offers new insights in sources of explanation for the diversity of science-based entrepreneurial firms, it is not without its limitations. First, the data of the technology transfer related activities from the public research organisations is limited to one year. Although for the purposes of our study – empirically validating the difference between PROs with a generic and a specific research base – this is not necessarily a problem it misses out a number of research opportunities to be addressed. One issue that could be tackled with multi year data is whether or not PROs with a specific research base do set up more spin-offs as opposed to start-ups, for example during the last five years, in order to capture the broader institutional / environmental changes. Although our data show a spin-off / start-up ratio of 0,5 for the generic PROs and 0,17 for the specific PROs, data of one year is indicative at most. Testing this intuition with the company data was not possible given the range of the period in which the ventures are established. Nevertheless, temporal considerations are a potentially important issue regarding the time horizons involved in potential strategic changes in setting up different types if science-based entrepreneurial firms. The same is true for developing a technology, licensing it, and seeing it produce an income stream (Powers and McDougall, 2004). Second, this offer does not offer insight in the intrinsic quality of the technology transfer offices. The indicators are used to display the numeric variation across PROs and as signals of technology transfer related activities. Today, a lot of European PROs run their own technology transfer operations. Following Lambert (2003), this study opens up the question whether all these PROs have a strong enough research base to be able to build the high-quality offices of their own. Further research should shed light on whether or not the development of shared services in technology transfer on a regional
basis and/or technological specialisation basis should be encouraged. Third, since some companies in the sample are still relatively young (ranging from 1 – 13 years), it might be too early to rightfully assess the growth that these companies display. On the other hand, this is not necessarily a problem for our research purpose, which was specifically aimed at discerning the individual impact of the formal transfer of technology and start capital on the growth in employees and capital science-based entrepreneurial firms display.
APPENDIX: TESTS OF ASSUMPTIONS FOR MANOVA

Hypothesis 2 assesses the interaction and main effects of institutional linkage on the resources endowed to science-based entrepreneurial firms using a 2X2 factorial MANOVA.

Because two of the three dependent variables - start capital and number of employees - were not normally distributed (positively skewed), we transformed the variables by taking the natural logarithm. MANOVA is argued to be robust for small deviations from normality and the two most important assumptions for legitimately running a MANOVA are met (Hair et al., 1995). First, the assumption of homogeneity of variance-covariance matrices across groups. With most of the univariate tests showing non-significance, we can proceed to the multivariate test. Box’s M test has a significance level of 0,22, allowing us not to reject the null hypothesis of homogeneity of variance-covariance matrices stating that the groups show no significant differences. As a result, we are able to directly interpret the results without having to consider group sizes as potential impacts on the statistical tests of group differences. The second assumption is sufficient correlation of the dependent measures, which is assessed with the Bartlett’s test of sphericity. The significance level is 0,000, satisfying the necessary level of intercorrelation to justify MANOVA. Table 19 summarises this diagnostic information.

Table 19: Tests of assumptions for 2X2 factorial MANOVA: Homogeneity of variance-covariance matrix and Bartlett’s test of sphericity

<table>
<thead>
<tr>
<th></th>
<th>Start capital (log)</th>
<th>Productisation of technology</th>
<th>Employees (log)</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>P</td>
<td>Statistic</td>
<td>P</td>
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<tr>
<td><strong>Univariate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levene</td>
<td>1,99</td>
<td>0,12</td>
<td>0,85</td>
<td>0,47</td>
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<tr>
<td>Cochran</td>
<td>0,41</td>
<td>0,04</td>
<td>0,37</td>
<td>0,64</td>
</tr>
<tr>
<td><strong>Multivariate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box M</td>
<td>25,05</td>
<td>0,22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bartlett’s test of sphericity</td>
<td>55,03</td>
<td>0,00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although our research design is not strictly balanced, it is argued that more or less balanced designs are appropriate to enable MANOVA (Hair et al., 1995). In practice this means that the largest cell size divided by the smallest cell size of the groups that are created by the factorial design should be smaller than 3 (2,8 for our study).
REFERENCES


UNICO-NUBS. 2003. UNICO-NUBS Survey on Research Commercialisation, Numerical Data, Nottingham, UK.


LIST OF APPENDICES

Appendix 1: Cine: Spring 2004

Appendix 2: Three case studies of IMEC spin-offs: Vivactis, Sirius Communications and C-Cam Technologies

Appendix 3: The commercialisation process at selected Belgian interface services

Appendix 4: Survey instrument for science-based entrepreneurial ventures

Appendix 5: Guidelines for data input of survey science-based entrepreneurial firms

Appendix 6: Survey instrument for technology transfer offices
The strategy has evolved that today CINE builds, sells and supports secure middleware and distributed content protection solutions for audiovisual markets, mainly for the Digital Cinema and Broadband/Broadcast network applications. The current CEO of CINE has more than 20 years of experience in several successful start-ups in Europe and has significant sales and product marketing expertise. By 2002 - 2003, three of the founders left the company.

CINE targets the European marketplace to establish strong partnerships with market leaders and provide them added value through leading edge R&D. They focus on three high-growth markets: Digital Cinema, Professional Broadcast and Broadcast / Broadband applications. They plan to become a recognised technology provider in content protection for business and consumer applications. CINE approaches its markets in a four-steps process. They search for leading equipment providers, build relations and recognition through their expertise and positions itself on the market as a technology sub-contractor and a licensor of his middleware. Finally, they produce prototypes and products.

Since July 2002, the Company exploits its own IPR and middleware to carry out several paid developments projects that has confirmed the CINE business model and technology. The fiscal year 2003 showed a substantial increase in sales and a first year of profitable operation. The Company is seeking for a 2nd round of capital to penetrate more quickly its targeted markets by accelerating its R&D and the commercial development of its activities.

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APPENDIX 2: THREE CASE STUDIES OF IMEC SPIN-OFFS: VIVACTIS, SIRIUS COMMUNICATIONS AND C-CAM TECHNOLOGIES

A. VIVACTIS

Started in February 2002.
Technology situated on cross borders of MicroSystem technology and biology.

Core Technology\(^{49,50}\)
The research activities that lead to the creation of Vivactis were started early 1995 at IMEC. Vivactis is IMEC’s first spin-off in the emerging fields of microelectronics and biotechnology, known within IMEC as the Human++ program. Most of the early research was performed during the Ph.D. of one of the founders, resulting in the thesis “non-labelled techniques for physiometry”, Leuven (2000). During the Ph. D. work, a prototype sensor was fabricated (1998): Biological tests proved that the device could sense the activation of living cells by addition of an agonist. The work resulted in the creation of Vivactis, first incubating in IMEC (July 2001), and started in February 2002. Vivactis’ technology is situated on the cross borders of MicroSystem technology and biology. Vivactis is a biotechnology platform company primarily serving the life science industry. Also the food industry and the chemical seem to be promising markets. The researchers built a system (calorimeter) that allows the measurement of minimal temperature differences. Vivactis’ activities require a dynamic combination of several scientific disciplines: biochemistry, biology, drug discovery, electronics, MEMS engineering and computer science. Vivactis has a double mission statement: (1) Bring screening and assay-development of any target at the fingertips of any expert and non-expert scientist (2) Give the scientist information of the complete activity spectrum of any compound.

Vivactis' in-house synergy between microsystem technology and biology enables the company to bring its proprietary microcalorimetry technology as a general and universally applicable assay technology to the drug discovery market. The

\(^{49}\) Interviews and http://www.leuveninc.com/pooled/profiles/BF_COMP/view.asp?Q=BF_COMP_4174;
http://www.vivactis.be/; (most recent access: May 2003)

\(^{50}\) Interviews and Trends, 22-02-02 ‘IMEC baart spin-off’ and 28-02-02 ‘IMEC incubatiefonds investeert in eerste projecten’
microcalorimetry technology and a number of strategic applications are protected by patents.

**History**

1993  The department MicroSystems at IMEC (Belgium) was started (mechanisch bewerken van silicium)

1994  PVG (co-founder) starts working for IMEC in the department MicroSystems. His PhD focused on binding between molecules (and later specifically biomolecules).

1997 – 2000  PVG works for Heraeus. He defended his thesis successfully May 2000. The experience at Heraeus led PVG to have a quality focus and to gain business sense (‘It is important to take commercial issues into account during the research process’\textsuperscript{51}).

1995–2000  PhD of KV in the department Microsystem at IMEC: she developed a sensor, allowing to measure activity in cells. During this research, she worked for a while in Gasthuisberg (University Hospital of Katholieke Universiteit Leuven) and Janssen Pharmaceutica, since they delivered the cells needed to test how they would react on medical compounds.

Building credibility for the technology was key (‘people laughed at what I did’). After four years of intensive research, KV had a few invited papers and people started to ‘believe’ in the technology. Mid 2000, a decision had to be made: sell the technology or create value through a spin-off. She chose for the latter. Initially, she wanted to start small but IMEC did not agree; “you have to go international or you just don’t start”.

2000  IMEC proposes KV to ask PVG to come back to IMEC to contribute to the spin-off process\textsuperscript{52}.

\textsuperscript{51} Interview with PV, June 2001
\textsuperscript{52} KV and PVG were already good friends long before the plans for a spin-off emerged
PV joins IMEC in order to participate in the start-up effort KV and PV met about a year earlier at one of the invited paper sessions of KV)

02-2001

A Private Limited company (bvba) is created for IP reasons (with 3 partners: KV, PVG and PV\textsuperscript{53}). Patents: 2 pure technical patents and 3 applications. Goal is to incorporate this entity once the spin-off is formally established.

06-2001

**Technology:** Vivactis examines several applications in microelectronics. There is a Prototype but no proof of concept on biological material. There is a generic platform allowing the development of about 30 different services. Choices need to be made (which services will be started (first) and subcategories need to be identified). Building on industry needs, the firm needs to focus on 3 services (‘Developing a service portfolio takes 2 – 2.5 years’) 

**Plan:** attract about 400 000 € to overcome 4-6 months incubation from July 2001 onwards and establish legal entity by the end of 2001. The capital would come either from the Incubation Fund or together with a second partner (VC). However, the latter prefers a direct VC injection and KV only wants this if it’s no more than 650 000 € (dilution of equity). VC negotiations are ongoing.

**People:** 3 partners (KV, PVG and PW: no hierarchy) and 1 employee. Searching for an external CEO\textsuperscript{54}

Business development manager of IMEC argues that Vivactis is a ‘testcase’ for the Incubation Fund that will be established.

10-2001

IMEC Incubation Fund is established\textsuperscript{55}. The fund invests in IMEC research projects that have commercial potential but are not mature for

\textsuperscript{53} PV left / resigned from Vivactis the second half of 2001. He considered the progress too slow

\textsuperscript{54} At this time, this only happened 2 - 3 times in IMEC spin-offs.
the market. More specifically, projects in the stages between technological idea and the realisation of a prototype are eligible for funding. Next to IMEC, four investors participate in the fund: KBC Investeco, Fortis Private Equity, Software Holding and Finance (SHF) and VEM Chaudfontaine. The fund and the establishment of the division industrialisation and incubation within IMEC should enable closer contacts with corporate businesses. IMEC wants to adopt a market driven approach.

02-2002

Establishment of the Limited Liability Company with 600 000 EURO (IMEC and incubationfund), as a juridical vehicle. The Private Limited company (KV en PVG) is not yet incorporated.

KV and PVG are still on the pay roll of IMEC and PV left. As a result, Vivactis has a very low burn rate allowing IMEC to finance their activities for a couple more months.

Vivactis prepares first VC injection
Aim to have 30 employees by 02-03

09-2002

IMEC points to PW as an interesting contact to join KV and PVG. He comes from Fortis and has substantial financial expertise. His main responsibility is to search for and negotiate VC investment.

10-2002

Technology: ready to enter the chemical market. In this market, the feedback is much faster than in the Pharma industry and revenues can be generated earlier. For the moment, the chemical market is the ‘enabling’ market, although the main target remains Pharma. Once they are ready for this market, they will license out the activities for the chemical market.

Negotiations with a potential CEO for the new Ltd. Company

02-2003  Vivactis is in a process of offering ordinary shares to accredited investors.
7 employees
Aim: 20 employees in 18 months

08-2003  Vivactis opens new lab facilities
Vivactis moves its lab premises to Kapeldreef 60, 3001 Leuven, Belgium.

*Business strategy and positioning*\textsuperscript{57}

**Growth ambition**
When the private limited company was established in February 2001, the entrepreneurs had a business plan with huge expectations. Due to the Incubation Fund however, they had to minimize these ambitions. KV argues that the inertia that Vivactis experienced is due to the newness of the Incubation Fund and to the lack of bio expertise among the investors in the fund. During the fall 2002, having attracted external financial expertise (PW), the growth expectations have increased.

**Service model**
Initially, Vivactis wanted to sell services / information to the pharmaceutical industry, useful in their drug development process (For example: identify molecules to block proteins, testing possible side effects of drugs, … In this perspective, a huge lab would be build in Leuven. The ultimate longer term goal was to develop drugs.
In the meanwhile, Vivactis has adjusted its business plan, since it became clear that also the food industry and the chemical market can use their calorimeter. The food industry for example can use the system for quality control. When the founders presented the machine, it seems that it could perform the work of one year in exactly twelve minutes.

\textsuperscript{57} *Trends*, 13-02-2003, ‘CEO tegen wil en dank’, p. 24
Selling the system as a product
The entrepreneurs learned that some pharmaceutical companies do not want to outsource their screening. Therefore, they decided to also sell the calorimeter, so that they can design their own experimental designs and perform the experiments themselves.

Core business
Vivactis’ business is not geared towards consumer products and it inherently consists of the research of the pharmaceutical industries. Their ‘product’ is the delivery of tools that facilitate the research process in the pharmaceutical and biotech industries. Therefore, a clear-cut distinction between academia and research and development is rather artificial. In the drug development industry the research is both more innovative and more applied than in university laboratories. Thus, contacts and contracts in both settings are equally important to push the business forward. Obviously, a direct collaboration with an industrial partner will generate revenues more directly.

Partnerships / Network
Vivactis has an ongoing collaboration with IMEC, which allows access to integrated sensor fabrication facilities. Vivactis’ partnerships are geared towards the pharmaceutical and biotech industry for drug discovery and development, and with the food and (bio)chemical industry for enzyme/catalyst discovery and optimization, and physicochemical characterization.

In the drug discovery as well as in the food industry segment, Vivactis signed a collaboration deal with two multinational companies. These collaborations were set up after thorough screening by the founders / entrepreneurs. They wanted to get deals with large, well established and well known multinationals. They succeeded contacting the right people via telephone conversations and internet searches. It is still very much of their strategy to seek for the ‘right’ partners in such a way.

In the area of the chemical catalysts Vivactis acquired a K€ 387 subsidy from the Flemish government (IWT), for an Industrial Research Project in collaboration with a department from the Katholieke Universiteit Leuven (a Professor at the Agricultural
Sciences Department). This research collaboration is important since the professor brings in a wide network of contacts at multinational companies (Bayer, BASF, ...).

For the drug discovery and development process, Vivactis' technology allows testing all kinds of targets, even the so-called ‘tough targets’. It is their aim to revive orphan drugs, to expand the field of lead profiling and eventually to develop a proteome-wide screening, all this with only one technology and using only microliters of precious sample. For the food and (bio)chemical industry Vivactis’ technology revolutionizes high-throughput screening of enzymes and catalysts because it can be done in harsh environments, without the constraints associated with conventional labels. It can visualize the effect of physical, biological and chemical additives in real-time, and this is function of a large set of parameters, like temperature, pH, concentration, pressure, etc…

**Outsourcing of ‘non core’ technology / activities**

Vivactis explicitly chooses to keep the basic knowledge in house and to outsource as much as possible other activities. The idea to build a huge lab was abandoned although the firm still aims at developing new drugs. In order to do so, they can purchase a chemical library or license in molecules. For the IWT project for example, all activities that are related to the Calorimeter, are kept internal.

**Competitors**

Vivactis’s competitors consists of those firms that are also offering tools for steering the drug discovery / development process. Competition is not on technology but for the market (no companies have similar technology as Vivactis’). Since the drug development process easily takes 15 years, a ‘final’ judgment about which technology is most convincing / most appropriate will only be possible in a couple of years time. In the meanwhile, the different players are trying to convince the pharmaceutical industry of the superiority of their technology and / or tool(s).

**Financing**

**Rounds**

- Personal funds (bvba, 02-01, to protect IP)
- First capital injection: 600 000 € Incubation Fund (nv, 02-02)
- Second capital injection still in preparation. The incorporation of the company (NV en bvba into new NV) was planned for 11-02 VC negotiations have still not come to a closure.

**Public financing**

IWT project

GOM West Vlaanderen

**Criteria for investing**

All VC’s want that Vivactis uses commercially interesting cells for its research and testing. However, this means different things to different people: some specify the cell and the medicine, others (GIMV) are satisfied with any chemical reaction, as long it is ‘wet’, for the Incubation Fund dry measurement is enough ... This demonstrated that VC’s, in order to make informed decisions, should be very knowledgeable about the process (search reports).

June 2001: It was key to do as many as possible ‘commercially interesting tests’ (which meant different things to different people). However, testing on enzymes or cells implies different markets.

**People during the start-up process**

KV obtained her Master of Science in microelectronic engineering in 1995 at the "Katholieke Universiteit Leuven" (KUL). She also holds a degree in medicine studies at the same university. She obtained her Ph.D. on the topic of ‘non-labelled techniques for physiometry’ in the microsystem group at IMEC, Leuven in 2000. She invented the current design. More specifically, she developed a sensor that enables the measurement of living cells on silicium and similar materials. She is co-founder of VIVACTIS, where she is responsible for Microsystem Technology and Intellectual Property.

PVG obtained a Master of Science in electronic engineering at the Katholieke Universiteit Leuven and a Ph.D. on microsystems technology for biological applications at IMEC. In June 2003, he will finish a M.B.A. at the Vlerick Leuven Gent Management School. Professionally, he has been managing different R&D
projects for more than two years in a sensor technology start-up (Sensor-Nite) where he also gained experience in bringing a sensor to the market.

PV has a PhD in biology and has expertise in setting up biolabs. He worked for 2.5 years in US (post doc, close to Princeton / NY) and then in Lille Pasteur Institute (France). After that he decided to go industry because there were more jobs. He worked for 3 years for ORGANON (central France), a Dutch pharmaceutical SME. Then he worked for Glaxo Welcome Italy for 2 years and another 2 years for Devgen. He was director of screening, i.e. responsible for implementation of developments. He was part of part of core team that consisted of 15 persons. He left Devgen in November 2000 to join VIVACTIS when the incubation phase officially started (Dec 1st 2000). Over the course of 2002, Phil left the start-up as he found that the whole process took too much time.

F is a MD and has a Master in Computer Sciences. He has been working in the pharmaceutical industry for 10 years. He was KV’s mentor in Janssen Pharmaceuticals, when she was working on her PhD. They actually both had a business plan and went to the same VC: he brought them together to co-operate. In June 2001 KV and Felix were talking about whether or not Felix would join the company. He decided not to.

PW has obtained a Master of Law at the Rijksuniversiteit of Ghent in 1981 (RUG) and a master in Applied Economics at the Universitaire Faculteiten Sint-Ignatius, Antwerp 1983 (UFSIA). He has been working for several banks with a specialisation in corporate finance and investment banking activities such as IPO’s, private placements and the last three years specifically in merger and acquisitions.

**Board of directors (next to KV, PVG and PW)**

Vivactis has a Board of Directors, which supervises and advises the management. The articles of association provide that at least six board members must serve on our Board of Directors. Currently, the Board of Directors consists of seven members.

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58 [www.vivactis.be](http://www.vivactis.be)
JVH is director Strategic Development and Vice-President at IMEC. Mr VH has obtained a Master in Applied Economics at the Universitaire Faculteiten Sint-Igantius, Antwerp (1974). After several appointments in the industry he joined IMEC in 1986. At present Mr Van Helleputte is responsible for IMEC’s strategy.

LD is Director Business Development and Vice-President at IMEC. Mr D. has obtained a Master in electronic engineering and mechanics in 1982 and a Ph. D. in 1989 of the Katholieke Universiteit Leuven (KUL). Mr Deferm joined IMEC in 1985. He gained extensive experience in CMOS-based technologies by heading several departments as a director. Since 1999 Mr Deferm is Vice-President Business Development worldwide, for the legal and patent group and the IP policy.

HM is director of IMEC’s Invomec department and Vice-President at IMEC. Invomec gathers all IMEC’s spin-off activities. Mr. M. obtained a Master of Science in electronic engineering at the Katholieke Universiteit Leuven (KUL) in 1971 and a Ph.d. Applied Sciences in 1974.

AV is IMEC’s CFO and Vice-President at IMEC. After several appointments in the industry at Teves, Raychem (at present Tyco). Mr. V. joined IMEC in 1986 as CFO.

Table 20: Overview of data collection Vivactis

<table>
<thead>
<tr>
<th>Contacts / Source</th>
<th>Timing of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>KV</td>
<td>Interview 06-2001</td>
</tr>
<tr>
<td></td>
<td>Several e-mail and phone contacts 2001-2002</td>
</tr>
<tr>
<td></td>
<td>Interview 11-2002</td>
</tr>
<tr>
<td>PVG</td>
<td>Interview 06-2001</td>
</tr>
<tr>
<td></td>
<td>Several e-mail and phone contacts 2001-2002</td>
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<td></td>
<td>Interview 06-2002</td>
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<td>Standardized Survey 05-2003</td>
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<tr>
<td>PV</td>
<td>Interview 06-2001</td>
</tr>
<tr>
<td>PR (IMEC)</td>
<td>Interview 06-2001</td>
</tr>
</tbody>
</table>
B. SIRIUS COMMUNICATIONS

Started in 1996
Semi-conductor company (developing and commercializing CDMA chips)

Core Technology

Sirius, as a fabless semi-conductor company, is a leading developer of code division multiple access (CDMA) and W-CDMA baseband ASIC technology (application specific integrated circuits) for the 3G wireless and satellite communications market. The company focuses on developing high performance, low-power, and highly flexible standards-based CDMA and GPS physical modem layer silicon solutions, peripherals and development tools. It designs highly specialized software-programmable telecom chips for use in cellular, non-cellular and satellite communications.

History

1990 Start of research project in IMEC. The research was performed on request by a maritime communication company SAIT and in cooperation with the European Space Agency. It involved the development of a modulation-technique (chip) for satellite communication. More specifically, the researchers were expected to integrate three cards of a Code Division Multiple Access (CDMA) receiver into one chip. (‘This chip became the mother of all Sirius’s chips’)

1994 KM starts working for IMEC, in the VLSI Systems and Design Methodologies division (group of about 40 people). He was recruited to act as a broker between IMEC and industry, including ESA and the European Commission.

1995 The research reaches a stage of majority. An α-prototype of the chip, called CDMA was available and the idea of founding a company in order to bring this chip on the market existed. It was the researcher / inventor that primarily

recognized the market / technological opportunity. The most important driving force to valorize this opportunity in a spin-off was the parent institute by means of an internal business developer (KM). The inventor (LP) was willing to be involved in the start-up of a company.

1996 The company was founded with a capital of 750 000 € (first VC injection).

All founders were researchers at IMEC and had known each other for 7 years (expect KM, who only joined IMEC 1.5 years before start up of Sirius). Each founder owns 0.75% of the shares. There was a plan to increase this up to 19.8% after 5 years.

Four Founders: (1) KM (Industrial engineer, business development function at IMEC). He developed a business plan for Sirius and looked for capital). (2) LP (Civil engineer, researcher at IMEC who invented the chip concept; he accepted the function of CEO provided that KM would take care of these responsibilities in practice). (3) JVH (Civil engineer, researcher at IMEC, took care of the practical implementation of the chip. (4) MW (Civil engineer, researcher at IMEC, responsible for the design of the chip). No external management was attracted.

In year one, the company generated 250 000 € revenues. Only the first book year the company incurred a loss of less than 273 000 €.

1997 Marissa leaves company (shares are bought by other founders). She had underestimated the commitment to a start-up and returned to IMEC.

A β-prototype was developed and a product was available. It was sold to major companies such as Alcatel and Toshiba. From then on the CDMA chip was continuously adapted.

Recognition of the potential of CDMA developments for the 3G wireless market. At this time, there were about eight different modulation candidate
technologies for succession of the wireless phone. The IWT subsidized a part of the (174 000 000 € in 1998 and 275 000 € in 1999)

1998  Revenues amount 768 000 € (increase of 70%).

1999  JVH leaves company (shares are bought by the other founders). As the company grew to up to 16 people, the firm became too big for him. He had difficulty delegating responsibilities (wanted to stay in control) and was very perfectionist. He serves as an independent advisor / consultant for Septentrio

2000  Over the years, no capital increases were realized. The company generates 2 000 000 € revenues in 2000 and upon acquisition the capitalization of the company is 45 000 000 €.

2001  Sirius Communications is a company making profit.

February: Morgan Stanley is appointed as financial advisor to evaluate several candidates / possibilities for the acquisition of Sirius. Selling the company to one party seemed to be the best option because it provided the best perspective on selling the technology world-wide.

July, 21: Successful trade sale of Sirius Communication at 45 000 000 € to Agilent Technologies, a global technology leader in communications electronics, life sciences and health care. Sirius becomes part of Agilent’s Semiconductor Products Group. The spin-off however, remains on the premises in Rotselaar (near Brussels) and functions as an R&D center of Agilent (26 people in Sirius as compared to 40 000 of Agilent worldwide).

61 There is an overlap between Sirius and Septentrio’s activities. Septentrio received IP from IMEC, based on the same patents as Sirius’s activities (Sirius did not have exclusive license). It was only just before the acquisition of Sirius that they were able to enforce an exclusive license and rights on the basic patent. Currently, spetentrio has no exclusive license and will have to develop its own patents in the future.

The engineers from Sirius are part of a broader group of engineers within Agilent working on wireless technology. This is a business unit that is evaluated according to performance. Of the 1 000 000 000 $ that this group generates, Sirius contributes / will contribute about 600 000 000 $, because the chip they develop is integrated in products that will be responsible for 60% of the revenues.

*Technology transfer*
Sirius had a non-exclusive license from IMEC. When Sirius Communications was acquired by Agilent Technologies, not having an exclusive license formed a huge problem. After difficult negotiations the exclusive license was issued.

*Financing, including public financing*
At time of start-up, there were 13 shareholders. Besides the founders, friends and family, the following investors can be mentioned: IMEC: 25%, represented by capital; SAIT: 30%; Software Holding and Finance: 30%; ARM (Cambridge, UK): 3%, the CEO of this company functioned as a kind of mentor to KM.

When they wanted to exercise the plan to become the owner of 19,8% of the shares of Sirius Communications, IMEC always found a way not to let it happen. KM and LP succeeded to have the shares in their possession just before the take-over.

*Subsidies*
When Sirius Communications was started no R&D projects were going on. During the years it cooperated with IWT, ESA and the European Commission. At the time of take-over 4 R&D projects were running.

*Exit*
Most successful exit to date of IMEC spin-off
Business strategy and market positioning

Revenues
The first years, Sirius generated revenues from two sources: consulting to customers who wanted to develop CDMA chips and the sales of ‘test boards’ for those firms that wanted to build CDMA systems.
Later, Sirius started to license its CDMAx™ wideband transceiver intellectual property to foundries and telecommunications companies.

Customers / sales
At time of start-up, there was no network of direct business contacts. Establishing this over the years was a very intensive process and represented a major aspect in KM’s job. This was especially true, as the geographical scope of the market was worldwide / global right from the start and as a diversity of persons in the customers’ organization influences the buying process and it is hard to identify them in the organisation.
KM took care of sales in Europe and an important part of America. For Washington, Korea, Taiwan, Singapore, Japan and India a distributor was contacted. During the first year of operations the company targeted temporarily a niche market, focusing on a small specific group of customers but with the explicit intention to develop new applications and new market segments.

Initially, sales were focused on the US. It was only after two years that also Europe became a target. Contacts with the European customers s on a more frequent base (several times a week) then with the take place several times a week, whereas meetings with the US customers occur on a monthly basis.

In order to sell a completed product, Sirius is not dependent on other companies for complementary developments: all knowledge is available in house.

% of the different activities in the total turnover
33,3% of the turnover comes from the sale of a standardized product (card with integrated chip). This product can be adapted to the specific needs (for example a smaller card) of the customers, an activity responsible for another 33,3% of the turnover. The sale of the ‘rough’ chip accounted for the other 33,3%. The revenues
have ever since the start-up of Sirius Communications been divided in the way as mentioned above.

**Growth rate of the market**

Compound annual growth rate of 15-20%

The future market is argued to be a very large market. That is when also taking into account the market of the third generation GSM’s, a market Sirius Communications looks forward to enter. It concerns a market of 4-5 million pieces. It takes a long time until this market takes off, but when it will, it will be explosive. KM and LP pushed their research, the development of the CDMA chip in that direction for quite some time. A lot of players within the sector did not agree with this decision. Now, they must see how Sirius Communication is way ahead of them. There is a second market in which Sirius Communications has always been active: the telecommunication market. This is a market of only 10 000 pieces and knows a very slow but secure growth.

**Outsourcing**

Sirius focuses on its core business, all tasks that are not directly related were outsourced. After the take-over, sales, marketing, legal aspects, etc. are all taken care off by Agilent Technologies.

**Patents**

At the moment of the take-over, Sirius Communications was the owner of several patents (between 6 and 10), which represented an important added value to Agilent Technologies. In 2002, Sirius Communications is the owner of 20 patents.

**People and organisation of the activities**

Before working at Sirius Communications, KM worked one year and a half at IMEC, where he took care of the public relations with customers, political institutions, etc. After one year IMEC invited him to coach IMEC spin-offs, which he accepted. The first spin-off he guided was Sirius Communications.
LP – MW – JVH

Researchers / developers at IMEC since 1988. LP still is in the subsidiary today. MW and JVH left the company during the first two years of operations.

Board

There were 5 board members at time of start-up (representatives of SHF, SAIT, IMEC, ARM and KM). The contribution of the CEO of ARM to the company was, according to KM, extremely important (bringing reputation and expertise to the company, scanning the environment to connect to new sources of ideas, …). SHF (Billion) was useful as negotiator between IMEC/SAIT on one hand and the executive management on the other.

Company structure

At start-up, the tasks in the company were clearly delineated and could not be divided in the traditional divisions such as R&D, Production, Marketing, Sales,…. There were 4 persons each responsible for a different aspect of operations: Concept development, Chip development, Practical implementation, Other aspects.

Just before Agilent acquired the company there were 4 main task streams: System specifications, Chip development, Writing of the software, Sales and marketing.

External people

They had good contacts / specialized in each domain that was necessary for their operations: juridical, Financial, Accounting / auditing.

Table 21: Overview of data collection Sirius Communications

<table>
<thead>
<tr>
<th>Contact / Source</th>
<th>Timing of Data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>KM</td>
<td>Interview 03-2002</td>
</tr>
<tr>
<td>KM</td>
<td>Interview 10-2002</td>
</tr>
<tr>
<td>PG</td>
<td>Interview 03-2000</td>
</tr>
<tr>
<td>PG</td>
<td>Interview 11-2002</td>
</tr>
<tr>
<td>LP</td>
<td>Phone conversation Fall 2002</td>
</tr>
<tr>
<td>Mediargus® Search</td>
<td>05-2003 (Time period 01-1994 / 05-2003; Search terms: Sirius Communications)</td>
</tr>
</tbody>
</table>
C. C-CAM TECHNOLOGIES

Started in 1996
CMOS technology for image sensors

Core Technology

In the late 80's IMEC started the first experiments with CMOS image sensors. At that time they had already a lot of experience in designing CCD image sensors.

The FUGA technology was born in the early 90's. Some years later C-Cam Technologies was started as a first imaging spin-off company of IMEC with the aim to commercialise the FUGA sensors\(^{63}\).

C-Cam Technologies designed, produced and marketed CMOS Active Pixel Sensors & Cameras. The underlying FUGA technology of the sensors is initially developed by IMEC. Both image sensors & cameras have been sold for use in different markets: industrial, consumer, aerospace and others\(^{64}\).

History

1990 Start of the research project

1995 JA wrote a business plan based on a draft version he received from IMEC and some additional information regarding the technology and products. According to IMEC, the products were ready and ready for sales and there were first customers. So, the original business plans was based on product sales (without much technical development) and the main activities were approaching potential customers and building distribution channels.

The inventor / developers did not want to leave IMEC to commercialize the technology\(^{65}\). Therefore, IMEC and ICOS (who wanted to commercialize and further develop the products because they were useful to its business) searched


\(^{65}\) Three people were very important during the development of the technology, namely (1) LH made the first customer contacts; he is now the marketing manager at Fillfactory (a firm that commercializes the ‘image sensors’ technology after the bankruptcy of C-cam). (2) BD: currently works for Fillfactory. (3) Nico (works at ICOS).
for an external entrepreneur. At the same time, JA was actively pursuing a business opportunity.

1996 C-Cam was established. The founders were (1) ICOS (250 000 € for 49,5% of the shares), (2) IMEC who brought in the technology and received 49,5% of the share (the technology was valued at 250 000 €) and (3) JA (no personal money, 1% of the shares), who became the CEO.

JA was the only employee. He had an office at the premises of ICOS (he could also use their secretary, meeting rooms and other facilities). His first task was to approach the already existing customers for this technology and broaden the customer base. However, very quickly it became clear that the product was not finished. There was an a-prototype and the different components could be sold separately, but each customer needed to adapt the technology before it could be used (‘The technology was fantastic and very promising. However, the existing software of potential customers needed to be adapted in order to read the signal of the image sensors and also the hardware needed some adaptations. Actually the technology was still in a laboratory phase’). Hence, milestones were not reached in the first years. There were some product sales in 1996, but much less than expected (‘pilot sales’ of separate components).

The business plan was adapted and additional capital was searched for.

1997 Early 1997: Capital increase (250 000 €) by VIV (27% of the shares). The shares of ICOS and IMEC diluted to 34% each. JA invested 5000 €. JA hired a salesman and technical person via a recruiting agency. The salesman had several years of sales experience, but neither experience nor affinity with the technology. The technical person was an engineer ‘pure sang’ and his task was to refine the software component of the ‘image sensors’.

Mid 1997: Roger Van Overstraeten (Director IMEC, H 1999?) announced that ‘IMEC had decided to commercialize the use of the CMOS technology in
image sensors’. The idea was to found a new company (Fillfactory) that would further develop and sell the CMOS technology. The new company would not only sell the ‘product’ or components of the product but actually further develop the technology and integrate it in the systems of customers. Actually, the new company be set up with the involvement of the researchers from IMEC.

**Late 1997:** By the end of 1997, C-cam needed a second capital increase. However, since Fillfactory was a spin-off in the pipeline of IMEC – working with the CMOS technology -- the original investors (VIV and ICOS) did not want to increase the capital. Although JA started to look for new external investors, this seemed impossible without the support and cooperation of VIV and ICOS. Moreover, IMEC offered to buy the shares of ICOS (for 250 000 €). Initially, JV turned down the offer, because he wanted to give C-Cam a chance to survive: if one of the investors left, attracting external capital would have become extremely problematic.

1998

JA did not succeed in persuading investors to inject new money in C-Cam. As a result, ICOS divested their participation in C-CAM Technologies. The official reason to divest was reported in the ‘We decided to divest our holding in this start-up as a result of the decision made by C-CAM Technologies’ Board of Directors to develop consumer applications. Given ICOS’ considerable experience with back-end semiconductor manufacturers and electronic assemblers, we believe that we should continue to focus our efforts on those markets.

VIV bought a part of the shares because otherwise they would have been minority shareholder without a ‘voice’. JA did not buy shares because JV advised him not to do so.

---

66 JA argues that in the sector of image sensors, it takes approximately 3 years to bring a prototype (lab-scale) to a market-ready product.

67 JA stated that JV (ICOS) ʻwas person with a clear vision. He was a real mentor.ʻ

IMEC was looking for someone who was able to raise external capital. IMEC screened several candidates but most of these people turned down the opportunity (after they were informed about the circumstances?) or IMEC did not approve of the candidates. JA contacted LDM (they knew each other from the MBA-program) and asked him for help. LDM was interested in the job. LdCe (VIV) contacted Van Overstraeten (IMEC) and told him he had found the right man for the job (JA could not do this because IMEC would never approve a contactperson of him). But also LDM was not able to find capital for C-cam.

In a final phase, the idea was to found Fillfactory and to bring in the activities of C-cam in this new company. However, the whole process took too long and eventually C-cam went bankrupt (23-11-1999).

IMEC hired LDM to write the BP for Fillfactory and to raise the capital. The company was formally established in December 1999. Currently, L is still the CEO of Fillfactory.

People and organisation of the activities
JA is an engineer, graduated in 1978. He worked one year in product development. Since 1979 he had technical/commercial jobs. He also has an MBA (Antwerp). He met Luc De Meyer during this training. In 1995 Jos was looking for a new job opportunity and he contacted KVIV, a network of academic engineers to screen interesting opportunities. KVIV brought him contact with JVs from ICOS. JV was looking for someone that could write a business plan for a new technology developed at IMEC and which was useful for the business of ICOS. ICOS could not commercialize the technology (not their core business) and JV wanted a new independent company to do it.

Composition of Board of directors
At start-up: 2 persons from ICOS, 2 persons from IMEC and JA
After capital increase: 1 from ICOS, 1 from VIV, 1 from IMEC (Van Overstraeten stepped out) and JA.
Table 22: Overview of data collection C-Cam Technologies

<table>
<thead>
<tr>
<th>Contact / Source</th>
<th>Timing of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>JV</td>
<td>Interview 01-2000</td>
</tr>
<tr>
<td>JA</td>
<td>Interview 03-2002</td>
</tr>
<tr>
<td></td>
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<tr>
<td>LH</td>
<td>Interview 11-2002</td>
</tr>
<tr>
<td>BD</td>
<td>Interview 12-2002</td>
</tr>
<tr>
<td>Mediargus® Search</td>
<td>05-2003 (time period 01-1994 / 05-2003; search terms: C-Cam technologies)</td>
</tr>
</tbody>
</table>
Leuven R&D (LRD) is the oldest and most developed university interface service (Debackere & De Bondt, 2002). Debackere en Van Dun (2002: p. 64) point out that the organisation chart of the LRD (central management) consists of four core departments (see Figure 2): (1) contract research, (2) management of intellectual property, (3) innovation and spin-offs, and (4) finance and administration.

**Leuven R&D (LRD): Structure and organisation of the commercialisation process**

**Structure**

At the KUL, Leuven R&D (LRD) is the organization that is responsible for managing contract research carried out for companies, for taking out and following up patents, and for establishing science-based entrepreneurial firms and following them up. In addition, there is also the Contract Research Department (DOC), which manages the contract research for the government. The activities of LRD include: a) contract research; b) management of intellectual property; c) innovation and science-based entrepreneurial firms and d) finance and administration.

**Innovation process**

*Identification of opportunities*

Leuven R&D has the advantage of a long tradition, a tradition upon which its good reputation at the university is based. For this reason we need not spend a lot of time on proactively identifying the opportunities. The interface service has been in existence for thirty years, during which time it has made a significant cultural impact on the university.

*IP*

The interface service has built up its own area of competence in the field of patents, the writing of claims, etc., and it is because of this expertise that it can follow a selective patent policy. The licensing of IP is an important activity in the overall responsibilities of LRD. The contractual aspects, the negotiations and the choice between the exclusive and the nonexclusive granting of licenses is supported by LRD.

*Strategic Choice between science-based entrepreneurial firm, royalty and contract research*

The interface service attaches much importance to the presence of an enterprising researcher, the potential of the technology, the market and the transition from business plan to business model. Emphasis is being put on the search for complementary
income as a source of financing. The aim is to realise between two and four science-based entrepreneurial firms per year.

**Financing**

Most science-based entrepreneurial firms are financed by the Gemma Frisius Fund. This is a university seed capital fund that can serve as a driving force for the formation of consortiums with the financial partners and external VCs; it also enables the university to bring in extra financial returns (see Table 2).

**Support for start-up**

LRD provides help in drawing up the business plan, concluding contracts (including IP), converting from business plan to business model, and attracting capital.

**Follow-up after start-up**

LRD plays a role in the board of directors in individual start-ups in which it has taken an equity participation. It also works actively with other agents of innovation.

**General innovation support**

Cuyvers & Zimmerman (2002) describe LRD as the ‘network incubator’, which means that LRD is an actor in the Leuven ‘innovation network’. In addition to LRD, there are various other actors who play a role in the innovative landscape of the Leuven region. Examples include the incubation center, Leuven INC., which is a training and network organization, and Capricorn, a committed private investor. In collaboration with the other actors, LRD is devoting a substantial amount of time and attention to energizing the innovation climate in the region.

B. VUB

As for its structure and operation, the VUB Interface Service is probably the one that most resembles LRD. Just like LRD, the VUB Interface Service manages the contract research and it disposes of a portion of the income from this contract research via a fixed overhead (pre-deduction). (This fixed overhead, however, is not used solely for interface financing or tech transfer, but also takes care of doubtful debtors, disputes and pre-financing.) Thus the contracting research financing mechanism is very similar to the financing of LRD.

Just as with LRD, this contract research includes all kinds of activities, such as stimulating and organizing contacts via company visits, employee participation in the business centers/science parks, internal awareness creation actions relating to contract research, the dissemination of information about all sorts of calls for proposals, the promotion of the services on offer, financial and legal assistance in drawing up contracts, the organization of events, etc. In contrast to LRD, the Interface Service at
the VUB in its current form is only a couple years old, which means that the service is less well known among the academics than LRD. The interface service will therefore continue seeking out the more proactive academics and promoting itself among them. Logically speaking, therefore, the cultural conversion of researchers within the university has progressed less than at the KUL.

Another important difference from LRD is the fact that the financial-administrative support for this contract research still comes through the central financial administration of the university. This means that the divisions also cannot be set up as LRD does, but the contract research takes place rather in the traditional manner within the university structure.

The VUB is pursuing a 'selective' patent policy and is supervising the patent procedures itself (1.5 FTEs). The interface service actively supports the making of business plans. It has a budget available for pre-financing any feasibility studies, market studies, patent applications, etc. that may be required. By means of intense collaboration with the Board of Directors of the BI³ Fund, a potential start-up is being coached for the purpose of attracting capital. The interface service is still too young to have already developed a number of different tracks, though in collaboration with the VIB it has recently produced an exit-oriented science-based entrepreneurial firm with external venture capital in biotechnology. Thus it appears that this dynamic interface service is seeking to develop a highly diversified portfolio.

VUB is also devoting a great deal of attention to the availability of incubation facilities. Currently, it is establishing a second VUB incubator (in addition to the I&I at Zellik, nearby the Jette campus) on the Arsenaal site, near the Oefenplein Campus.

### VUB: Structure and organisation of the commercialisation process

#### Structure

At the VUB there is an 'Interface Service' that is responsible for the administrative management of the contract research and for the commercialization of technology through the granting of licenses or the establishment of science-based entrepreneurial firms. This service is also responsible for obtaining patents. In addition, there is the Central Financial Administration, which provides financial-administrative support for the contract research (both with companies and government).
Commercialisation process

Identification of opportunities
On a regular basis, the relatively young Interface Service organizes a series of 'starter seminars' intended to promote entrepreneurship. In addition, it carries on a great deal of internal promotion in support of contract research, as well as undertaking awareness creation actions dealing with the commercialization of research and other themes at the departmental/research group level.

IP
IP support is an important activity. The service has developed its own competence in this field, which is supplemented by intensive collaboration with external patent attorneys. The licensing of IP is an important activity within the overall responsibilities of the Interface Service. Other aspects that it also supports include contractual matters, negotiations and the choice between the exclusive and the non-exclusive granting of licenses.

Strategic choice: science-based entrepreneurial firm, royalty or contract research
The university endeavors to produce an average of one science-based entrepreneurial firm per year.

Financing
The BI³ fund was established in 2002 to provide financing for science-based entrepreneurial firm projects. The logical route to take, then, is to present such projects to this seed capital fund.

Project support before start-up
The interface service recently invested in the development of sufficient competence to help projects with drawing up a business plan and to direct the development of the science-based entrepreneurial firm. This is done in collaboration with the BI³ Fund.

Follow-up after start-up
Usually – and certainly in the recently established science-based entrepreneurial firms – either the VUB or the BI³ Fund has a representative in the Board of Directors.

General innovation support
The Interface Cell at the VUB devotes much attention to the availability of incubation facilities. It is currently busy setting up a second VUB incubator. It also participates in the different study groups and regional platforms.

C. GHENT UNIVERSITY

The technology transfer office manages interface activities at Ghent University. Contract research is still managed in part by the Research Coordination Office, although the aim is to achieve close collaboration and integration. Both sections are part of the Research Affairs Directorate, which is under the leadership of the Research...
Director. The Directorate is a department within the university, in conformity with the internal regulations of this institution. Financial and HR support for contract research remains within the respective departments of the university. The Technology Transfer Office therefore has an indirect overview of contract research, but is not able to intervene directly in these affairs, as is the case in LRD.

In contrast to LRD and the VUB Interface Service, the financing of the Technology Transfer Office is not related to the volume of contract research. The financing is largely dependent on the subsidies that are made available to the interface services by the Flemish Community.

Just like at the KUL and the VUB, the Technology Transfer Office devotes much attention to managing the IP in the broadest sense of the word. IP affairs occupy a central place in departmental operations. In its awareness-creating role, the Office endeavors to convince the members of the tenured academic staff to have their inventions protected. The primary mechanisms used to achieve these ends are: (1) maintaining a very favorable remuneration system (see below) and (2) the performance of great amounts of field-work by the people in the Technology Transfer Office. Seminars and workshops are organized on a regular basis dealing with the creation of intellectual property and the marketing of that property via licenses or science-based entrepreneurial firms. At the same time, the Technology Transfer Office is responsible for managing the intellectual property in the contract research (contract negotiations, legal support, etc.).

In view of the limited size of the budget, a very strict patent policy is currently being pursued. When a potentially interesting technology is signaled, an evaluation of its innovativeness is first carried out, and then a study of its economic feasibility. With the in-house knowledge available, this can be done in a cost-efficient manner. During the priority year, the technology is intensively marketed in collaboration with the inventors. If during the priority year it turns out that there is interest on the part of industry, or if it turns out that the researchers involved are interested in creating a science-based entrepreneurial firm, then the protective measures are continued.

There is also close collaboration with the Baekeland Fund. This fund – just as the other university funds – invests at an early stage in start-ups.
**Ghent University: Structure and organisation of the commercialisation process**

**Structure**

The Research Coordination Office manages the university's contract research (both with the government and with companies). The Technology Transfer Office is responsible for (1) creating and managing intellectual property, (2) marketing the research results via licenses and science-based entrepreneurial firms, and (3) managing the intellectual property associated with contract research.

**Commercialization process**

**Identification of opportunities**

The opportunities are detected mainly via the management of intellectual property (via invention disclosures and via the management of contract research). The Technology Transfer Office informs the different departments ad hoc about the various possibilities for commercialization.

**IP**

The Technology Transfer Office is responsible for managing university IP. To this end, it pursues a selective patent policy. It has developed competence in a number of different fields to enable it to pursue this policy.

**Strategic choice: science-based entrepreneurial firm, royalty or contract research**

The most important elements in this choice are the wishes of the researchers involved (and their availability for collaborating in the commercialization process), the strength of the technology, the structure of the market and the availability (or unavailability) of surrogate entrepreneurs.

**Financing of science-based entrepreneurial firms**

Just like the VUB and the KUL, Ghent University is participating in a university seed capital fund. The Baekeland Fund has the first right of refusal with science-based entrepreneurial firms that are starting up. Typically, science-based entrepreneurial firms that are ready to start up are presented to this fund.

**Assistance with projects before start-up**

The Technology Transfer Office assists with the writing of their business plan, with IP management, with the contractual aspects and with finding financing. It also may actively assist in finding financing and possibly obtaining capital from the Baekeland Fund.

**Follow-up after start-up**

Through participation in the Board of Directors.

**General innovation-support**

The Technology Transfer Department is devoting much attention to developing the regional innovation network (incubation centers, science parks, network activities with innovation agents in the region, etc.)
Within the Limburg University Center the Interface Service is part of the Research Coordination Office. Since Limburg is a university of limited size and with a limited number of fields of study (see below), its Research Coordination Office is staffed with 1.4 FTE, 0.5 FTE of which is dedicated to IP management and science-based entrepreneurial firm support. An average of one patent is taken out per year. A number of science-based entrepreneurial firms have been created in the past, though the university owns shares in only one of them. The university seed capital fund (*Wendelenfonds*) was disbanded in 2002. Just like the other university funds, private Venture Capitalists formed this fund. There was a failure, however, to generate enough projects meeting the requirements set by the fund.

### LUC: Structure and organisation of the commercialisation process

#### Structure
The Research Coordination Office manages the university contract research (both with government and companies). The Interface Service is part of the Research Coordination Office.

#### Commercialization process

**Identification of opportunities**
One person (0.4 FTE) is responsible for the search for opportunities (e.g. via business plan competition).

**IP**
0.1 FTE takes care of the IP (approximately one patent per year).

**Strategic choice: science-based entrepreneurial firm, royalty or contract research**
Potential science-based entrepreneurial firms can count on the support of the Interface Service.

**Financing of science-based entrepreneurial firms**
Is done by the research departments, possibly supplemented by public support in the region (EFRD or European Fund for Regional Development).

**Assistance with projects before start-up**
Assistance is given in developing the business plan.

**Follow-up after start-up**
Via participation in the Board of Directors

**General innovation support**
Similar activities as in the other universities.

REFERENCES


APPENDIX 4: SURVEY INSTRUMENT FOR SCIENCE-BASED ENTREPRENEURIAL FIRMS

1. GENERAL INFORMATION

1.1. Formal legislation

a. Legal founding date (e.g. creation of a legal entity/partnership)
   Year  
   Month  
   Who  
   Juridical form type  

b. First injection of money
   Year  
   Month  
   Who  

c. Start of activities
   Year  
   Month  

1.2. What type of institutional link did the company have at TIME OF FOUNDING?

1. None, this is an independent start-up. The company emerged from the ideas and knowledge of one or more independent entrepreneurs.
2. Corporate spin out: the start-up emerged from the business activities of another private corporation. The transfer of knowledge can be formal (through equity participation) or informal (e.g. when employee leaves firm to start company based on skills acquired at the parent).
3. Academic spin out: the company spun out from a university or public research institute (irrespective of whether there was a formal transfer of knowledge). The key technological knowledge or idea was at least in part developed while working at the university / the research institute.

1.3. a. Which research project(s) (or invention(s)), event(s) or ‘business experience (s)’ triggered the idea to found the company?
   ............................................................................................................................
   ............................................................................................................................
   ............................................................................................................................

   b. Start of research project in parent institute(s)?
   (= time at which the project, forming the base of the eventual applied technology within the company, started within the parent organization; when the project is the result of several projects one should consider the time and/or project that added most value to the eventual commercialization of the technology)
Year                      ..............
Month                     ..............

C. Involvement of the 'intellectual carrier' of the idea / the inventor in the company?

Circle the number that corresponds to your answer

1. Researcher / inventor was not aware of the technology being transferred into a spin-off
2. Researcher stayed in research position at research institute
   How was inventor involvement maintained?
   ...........................................................................................................................
   ... 
   Did the inventor get shares?
   ...........................................................................................................................
   ... 
3. Shareholder with formal participation limited to employee (no C** function)
4. Shareholder with participation limited to Board of Directors or SAB
5. Shareholder with formal participation in a C** function

2. CAPITALIZATION / OWNERSHIP

Please indicate the evolution in the type(s) of financing the firm received, by filling out each change in the capital structure of the company.

The tables allow you to fill out the different types of financing the company received at different time intervals; the purpose of these questions is to get an overview of the evolution of the financial structure of the company. We ask for financial information at time of founding and three subsequent financing rounds, because we believe these changes are relevant for the overall / technological development of the company.

<table>
<thead>
<tr>
<th>Type of financing (indicate names of the investors)</th>
<th>Moment in time: legal founding date:</th>
<th>Total Capital:</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>INCLUDE ALL CAPITAL THAT WAS INJECTED WITHIN 12 MONTHS AFTER LEGAL FOUNDING</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Shares in return for CAPITAL²</td>
</tr>
<tr>
<td>Total Capital:</td>
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<td>% Shares in return for CAPITAL²</td>
</tr>
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<td>Personal capital¹</td>
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<td>% Shares in return for CAPITAL²</td>
</tr>
<tr>
<td>External capital4</td>
<td></td>
<td>% Shares in return for CAPITAL²</td>
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<tr>
<td>- Fund from parent institute</td>
<td></td>
<td>% Shares in return for CAPITAL²</td>
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<tr>
<td>NAME:</td>
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<td>% Shares in return for CAPITAL²</td>
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<td></td>
<td>% Shares in return for CAPITAL²</td>
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<td>- Venture capitalist(s)</td>
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<td>NAMES:</td>
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<td>- Corporate</td>
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investor(s)  
NAMES:  

……………………  
……………………  
- Business Angel(s)  
/3F  
- Other  

Loans

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<thead>
<tr>
<th></th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidies</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

1~ the founders (=inventors)  
2~percentage of shares that the financing party got in return for the injection of money  
3~sometimes no money is injected in a company, but certain parties do receive shares for example in return for the transfer of knowledge or technology  
4~external money being any amount and type (i.e. injected by fund from parent institute, VC funds, corporate investors, Bas, 3Fs or other parties) of investment that increases the capital of the company.

Are there any option plans present at time of founding?  
Yes/No  
If Yes, describe their nature:  
 ..........................................................................................................................  
 ..........................................................................................................................  
 ..........................................................................................................................

<table>
<thead>
<tr>
<th>Type of financing (indicate names of the investors)</th>
<th>Moment in time: first capital increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount (€)</td>
</tr>
</tbody>
</table>
| Total Capital: Personal capital1  
Exteral capital4  
- Fund from parent institute  
NAME:  

……………………  
- Venture capitalist(s)  
NAMES:  

……………………  
- Corporate investor(s)  
NAMES:  

……………………  
- Business Angel(s)  
/3F  

……………………
- Other  

<table>
<thead>
<tr>
<th>Loans</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidies</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reserved profits</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

1. the founders (=inventors)  
2. percentage of shares that the financing party go in return for the injection of money  
3. sometimes no money is injected in a company, but certain parties do receive shares for example in return for the transfer of knowledge or technology  
4. external money being any amount and type (i.e. injected by fund from parent institute, VC funds, corporate investors, Bas, 3Fs or other parties) of investment that increases the capital of the company.

Were there option plans created at this moment in time?  
Yes/No

If Yes, describe their nature:

…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………………

<table>
<thead>
<tr>
<th>Type of financing (indicate names of the investors)</th>
<th>CAPITAL TODAY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YEAR: ..........</td>
</tr>
<tr>
<td>Amount (€) capital</td>
<td>% Shares in return for</td>
</tr>
<tr>
<td>Total Capital:</td>
<td></td>
</tr>
<tr>
<td>Personal capital ¹</td>
<td></td>
</tr>
<tr>
<td>External capital ⁴</td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td>XXXXXXXXXXXXXXXXXX</td>
</tr>
</tbody>
</table>

3. TECHNOLOGY TRANSFER

3.1.a. In what stage was the ‘New Product Development Cycle’ at founding?

☐ Idea phase
☐ Proof of Concept, i.e. α-prototype
☐ Prototype that works in a real-life environment, i.e. β-prototype
☐ Concrete market-ready product
☐ Not applicable, the company works accordingly a service business model

3.1.b. If the company did NOT have an α-prototype at time of founding, please indicate the maturity of the technology.

Scale from basic research, becoming increasingly developmental to prototype development Please circle the number that corresponds with the degree of development that is most applicable to the company’s initial technology base at time of technology transfer:
1. Investigations in pure and applied theoretical studies  
2. Experimental validation of theory and accumulation of data  
3. Combined theoretical and experimental studies of new or unexplored fields of technologies.  
4. Conception and/or demonstration of the capability of performing a specific and elementary function, using new or untried concepts, principles, techniques, and/or materials.  
5. Theoretical analysis and/or experimental measurement of the characteristics of behavior of materials and/or equipment, as required for design.  
7. First demonstration of the capability of performing a specific and elementary function, using established concepts, principles and/or materials.  

3.2. *At this time, which phase of technology development has been reached? Since when?*  

<table>
<thead>
<tr>
<th>Phase Description</th>
<th>Since when? M/Yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>α prototype(^1)</td>
<td>YES/NO</td>
</tr>
<tr>
<td>β prototype(^2)</td>
<td>YES/NO</td>
</tr>
<tr>
<td>Product / standardised service(^3)</td>
<td>YES/NO</td>
</tr>
<tr>
<td>Not applicable, the company still applies/changed to a service model</td>
<td>YES/NO</td>
</tr>
</tbody>
</table>

\(^1\)α-prototype: a first attempt;  
\(^2\)β-prototype: final version of the product;  
\(^3\)Product: market-ready  

3.3. *Indicate the degree of importance of technology transferred from the source organization on the formation of the spin-off.*  

In the first three categories, learned technology is unquestionably important in order for the company to be established; the difference is only in degree. Please circle the number that corresponds to your answer.  

**Direct:** The company would not have been started without the formal transfer of Intellectual Property rights.  

**Partial:** The company was founded based upon the formal transfer of Intellectual Property rights; however, this know-how needed to be expanded with some other source of know-how (i.e. IP coming from another institute then the parent institute).  

**Vague:** No formal transfer of Intellectual Property rights took place. The company was founded based upon know-how and skills acquired by the initial founders (coming from the parent institute).  

**None:** the link with the parent institute is not quite clear; for some reason the company was indicated as a spin-off company (a lot of parent institutes like to have as many as spin-offs as they can on their track record)
3.4. a. How would you describe the link with your ‘parent institute(s)’ at THIS TIME?

- Independent start-up
- No link: there is no informal ongoing relationship nor formal transfer of technology or equity participation
- Informal link: There is an ongoing relationship between spin-off and parent, e.g. through people (employees / managers of the parent serving on the board or advising the spin-off), through scientific collaboration, the parent is a customer or supplier or partner to the spin-off. There is no equity participation, nor formal IP transfer from the parent to the spin-off.
- Formal link: the ‘parent institute’ does have an equity participation as a consequence of the injection of money and/or the transfer of technology (through patenting/licensing)

3.4.b. Did this ‘link’ change over time?

Yes/No

If yes: What was the cause of this change?

............................................................................................................................... ........................
............................................................................................................................... ........................
............................................................................................................................... ........................
............................................................................................................................... ........................

3.5. a. Did the firm use office space and laboratory equipment from the parent during tech transfer and early start-up?

<table>
<thead>
<tr>
<th></th>
<th>Year one</th>
<th>Today</th>
<th>If change over time: indicate date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office space</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>………………</td>
</tr>
<tr>
<td>Laboratory and equipment</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>………………</td>
</tr>
</tbody>
</table>

3.5.b. Was the company in one way or another subsidized?

<table>
<thead>
<tr>
<th></th>
<th>Year one</th>
<th>Today</th>
<th>If change over time: indicate date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans below market prices</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>………………</td>
</tr>
<tr>
<td>Others?</td>
<td>……………</td>
<td>……….</td>
<td>………………</td>
</tr>
<tr>
<td>Indicate the nature?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. FOUNDERS, KEY PEOPLE AND EMPLOYEES

1.1. Founding Team

Founding team members: need to have (1) a function (hands-on management function or regular employee) within the company AND (2) ownership of an equity stake

a. Number of founders ……..

b. Evolution in the composition of the founding team?

Check the applicable boxes for each of the founders (F1, F2, F3, …)

<table>
<thead>
<tr>
<th>Original Founding team</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical degree (bio-science, physics, electronics, mechanics, robotics, telecom, …) (0=no; 1=yes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-technical degree (economics, law school,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Additions to the team

<table>
<thead>
<tr>
<th>Name</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of joining the firm (mm/yy)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function at moment of joining the firm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function today</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical degree (bio-science, physics, electronics, mechanics, robotics, telecom, …): (0=no; 1=yes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-technical degree (economics, law school, psychology, …) (0=no; 1=yes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of years of experience in the sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of years of experience in the same function</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% shares at moment of joining the firm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% shares today</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Exits from team

<table>
<thead>
<tr>
<th>Name</th>
<th>E1</th>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of leaving the firm (mm/yy)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial function within the company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function at moment of leaving the company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% shares when initially joining up the company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% shares at moment of leaving the company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 For example:

- CEO (Chief Executive Officer) = Business development, General management
- CFO (Chief Financial Officer) = Financing
- COO (Chief Operation Officer) = Operations management
- CMO (Chief Marketing Officer) = Marketing, Business development
- CTO (Chief Technical Officer) = R&D, Technical Management
- CF = Commercial function, sales man
- R = Researcher
- SH = Shareholder, not actively involved in daily operations
- None = Has left the company
- SAB=Scientific advisory board
- Other: ...........

To what extent was the entrepreneurial team expanded, since founding of the company. Please indicate carefully when management joined or founders left the team and what their function is / was.
2. working experience
3. a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company
4. a person has management experience if that person performed already a CEO/CTO/CSO/CMO/CFO/COO function during his career
5. (1): low, when less then 3 years/ (2): average, between 3 & 6 years of experience/ (3): high, higher then 6 years

**c. Number of founders that worked with each other before founding**

\[ N = \ldots \ldots \ldots \ldots \]

**d. Number of years of joint working experience of the founders**

\[ N = \ldots \ldots \ldots \ldots \]

**e. Entrepreneurial motivation: to what extent were following criteria important when taking the decision to (co)-found the company?** (5 = very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = very unimportant)

<table>
<thead>
<tr>
<th>Push Factors (Smilor et al., 1990)</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for additional money</td>
<td></td>
</tr>
<tr>
<td>Ideas are rejected within the university</td>
<td></td>
</tr>
<tr>
<td>Dislike of research responsibilities and requirements</td>
<td></td>
</tr>
<tr>
<td>Dismissed</td>
<td></td>
</tr>
<tr>
<td>Difficulties in dealing with university bureaucracy</td>
<td></td>
</tr>
<tr>
<td>Lack of excitement with university career</td>
<td></td>
</tr>
<tr>
<td>No tenure</td>
<td></td>
</tr>
<tr>
<td>Forced retirement</td>
<td></td>
</tr>
<tr>
<td>General frustration in dealing with the university</td>
<td></td>
</tr>
<tr>
<td>Dislike teaching</td>
<td></td>
</tr>
<tr>
<td>Concern for future</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pull factors (Smilor et al., 1990)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognition of a market opportunity</td>
<td></td>
</tr>
<tr>
<td>Desire to put theory into practice</td>
<td></td>
</tr>
<tr>
<td>Desire to try something new</td>
<td></td>
</tr>
<tr>
<td>Desire to work independently (self-employment)</td>
<td></td>
</tr>
<tr>
<td>Desire to have fun with an entrepreneurial venture</td>
<td></td>
</tr>
<tr>
<td>The prospect of business contracts</td>
<td></td>
</tr>
<tr>
<td>Desire for wealth</td>
<td></td>
</tr>
<tr>
<td>Govern contracts</td>
<td></td>
</tr>
<tr>
<td>Research support</td>
<td></td>
</tr>
<tr>
<td>Now or never</td>
<td></td>
</tr>
<tr>
<td>Make world better</td>
<td></td>
</tr>
<tr>
<td>Outside financing</td>
<td></td>
</tr>
</tbody>
</table>

**4.2. Employees**

a. What was the number of employees at time of founding and today?
At founding | Today
--- | ---
Total number of FTE employees | 1 | 1
Employees (FTE) in R&D | 1 | 1
Employees (FTE) in marketing and sales | 1 | 1
Employees (FTE) in consulting and engineering | 1 | 1

Active founders are included

b. Next to the members of the founding team, what is the number of people that left the parent institution to join the start-up (e.g. technicians, software developers, … that were knowledgable about the technology)?

N = …….

5. CORPORATE GOVERNANCE

Following questions only apply to firms that are public limited companies.

Board of Directors

a. Number of Board members at start-up:

In total …………
Number that are members of the founding team …………
Number of external members that represent their interests within the company (i.e. venture capitalists) …………
Number of external but independent members …………

b. Number of external board members that were known by members of the founding team before the founding of the company: 

………………

c. How important are different roles of the Board for the company at time of start-up?

Rate 1 (very unimportant) – 5 (very important)

|---|---|---|---|---|---|
i. Bring their reputation to the company | 1 | 2 | 3 | 4 | 5 |
| Ii. Bring their expertise to the company, assessing internal progress | 1 | 2 | 3 | 4 | 5 |
| Iii. Scanning the environment to connect to new sources of ideas | 1 | 2 | 3 | 4 | 5 |
| Iv. Manage regulatory process | 1 | 2 | 3 | 4 | 5 |

d. Number of board meetings in the first year after start-up …………………
Investors
Please answer the following questions regarding your LEAD Venture Capital Investor:

i) Which of the following roles has the LEAD VC investor provided to your company?
ii) How important was it to you that the lead VC investor carried out this role?
iii) How effective did you find your lead VC investor in carrying out this role?

<table>
<thead>
<tr>
<th>ROLES</th>
<th>i) Has the Lead VC investor carried out this role? Yes - No</th>
<th>ii) Importance 1=not important – 5=very important</th>
<th>iii) Effectiveness 1=very low effectiveness – 5=very high effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Find additional financing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Impose milestones to the entrepreneurs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Open doors (network)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Meet the entrepreneurs regularly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Negotiate important contracts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Restrictions on changes in ownership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Hire the head of marketing &amp; sales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Daily management (operational tasks)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Negotiate intellectual property rights</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Determine the composition of the Board of Directors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Form an Advisory Board</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Hire a CFO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Hire a CEO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Restrictions on the CEO’s remuneration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Hire the R&amp;D head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Hire new employees</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Restrictions on additional borrowings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Contact potential customers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Assist with strategic planning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Have a seat on the Board of Directors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Regularly check sales figures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Have a look at the financial overview regularly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Serve as a sounding board for new ideas</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Parent Institute

f. Which of the following descriptions describes your ‘parent institute’?

1. **Low selective model**
   
   *Socially attractive spin-outs:*
   
   the TTO’s objective is to create employment and enhance development in a depressed region. The TTO’s mission is to create many (>7) spin-outs each year. Most of those spin-out companies are consulting or service oriented, and most target a local market.

2. **Supportive model**
   
   *Economically attractive spin-out:*
   
   the TTO’s objective is to create economically profitable businesses. The TTO’s mission is to create 3 to 7 spin-outs a year. Most spin-outs are based upon a proprietary technology developed at the research institutes. Half of the spin-outs are product-oriented spin-outs. Most spin-outs receive money from a public/private capital fund, set up by the TTO.

3. **Incubator model**
   
   *Financially attractive spin-outs:*
   
   the TTO’s objective is to create businesses that will generate financial returns to investors. The TTO’s mission is to create only 1 to 3 spin-outs a year. Those spin-outs target a global market, they all receive private VC money and all are based upon a proprietary technology developed at the research institutes.


a. To what extent is the company dependent on other companies for complementary developments in order to sell their complete first product?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The spin-off needs to lobby with several (high level) parties in different organizations in order to further develop and commercialize its technology.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>The company does not have all knowledge and technology to bring a complete product to market and needs to rely on co-development with one other company.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>All knowledge is available in house</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Other market players seem to pull the spin-off into the market. Thus, they have a positive effect on (the growth) of the business activities of the spin-off</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Overall, how would you characterize the complexity of the ‘buying decision’ of your main customers?

*Be aware that the customer as indicated in the following description, not necessarily needs to be the end consumer as such; it applies to the main targeted customer of YOUR company*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The economic buyer(^1), the technical buyer(^2) and user buyer(^3) are represented by the same person in the customer’s organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Different buyer roles are scattered along different people in the customers’ organization. However, identifying the key decision makers is rather easy.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 3. | A diversity of persons influences the buying process and it is hard to identify them in the organization (e.g. the spin-off may not have access to user buyers) or the key
decision makers are located very high in the organization (e.g. corporate headquarters).

1Economic buyer = this buyer as the authority to sign the contract; present at the top end of the company hierarchy;
2Technical buyer = this buyer judges the quantifiable aspects of the offered product; he will communicate his opinion about the usefulness of the product to the user and economic buyer;
3User buyer = this buyer particularly assesses the impact of the product on his own job; will it make his job easier?; present at the lower end of the company hierarchy.

7. CHARACTERISTICS OF THE MARKET

a. Were / Are there competitors that develop similar technologies / products?

<table>
<thead>
<tr>
<th>At time of start-up</th>
<th>N(^1)</th>
<th>Size(^2)</th>
<th>Present</th>
<th>N(^1)</th>
<th>Size(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No</td>
<td>0</td>
<td>No</td>
<td>0</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>Yes, at local level</td>
<td>1</td>
<td>Yes, at local level</td>
<td>1</td>
<td>Yes, at local level</td>
</tr>
<tr>
<td>2</td>
<td>Yes, at national level</td>
<td>2</td>
<td>Yes, at national level</td>
<td>2</td>
<td>Yes, at national level</td>
</tr>
<tr>
<td>3</td>
<td>Yes, at global level</td>
<td>3</td>
<td>Yes, at global level</td>
<td>3</td>
<td>Yes, at global level</td>
</tr>
</tbody>
</table>

\(^1\)N= number of competitors that develop rival products
\(^2\)Size= size in terms of employees of these organizations: 1=small; 2=medium; 3=large

b. What is the geographical scope of the market of the firm?
Circle the number that corresponds to your answer

<table>
<thead>
<tr>
<th>At founding</th>
<th>%(^1)</th>
<th>Present</th>
<th>%(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. National / local</td>
<td>1. National / local</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. European</td>
<td>2. European</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)% = if relevant, the percentage of the overall revenue coming from customers at national/local, European and worldwide/global level respectively

c. During the first year of operations, to what extent did your company target a niche or mainstream market?

1. The company targeted a niche market: a small market, mostly based on one application for a small, specific group of customers; often this implies that services rather than final product are offered to a small, specific group of customers
2. The company targeted temporarily a niche market: the first applications targeted a small specific group of customers but there was an explicit intention to develop new applications and penetrate new market segments.
3. The company targeted a mainstream market: a large (mio $) market served by other, probably larger and older companies, often characterized by heavy competition or it implies that the company has evolved towards a ‘product-company’

8. SUCCESS / GROWTH

a. Revenues

<table>
<thead>
<tr>
<th>Were there any revenues?</th>
<th>Year one</th>
<th>Last year</th>
</tr>
</thead>
<tbody>
<tr>
<td>If so: How much?</td>
<td>Yes / No</td>
<td>Yes / No</td>
</tr>
<tr>
<td></td>
<td>.......... (Euro)</td>
<td>.......... (Euro)</td>
</tr>
</tbody>
</table>
b. Is the company break-even in its operations?

Break-even = returns – expenses = 0; as from the moment the company has positive operational cash flow, we say that company is break-even.

- Yes
- No

If Yes: Since when (month/year): ……………..

c. What is the total ‘burn rate’ or ‘expenditure’ of the company?

<table>
<thead>
<tr>
<th>Total expenditure or ‘burn rate’/ month</th>
<th>Year one</th>
<th>Last year</th>
</tr>
</thead>
</table>


d. [GrowthExp_Rev]: How would you evaluate the growth of the company in terms of revenues in comparison with your expectations at start-up?

<table>
<thead>
<tr>
<th></th>
<th>Below expectations</th>
<th>Equal expectations</th>
<th>Little above expectations</th>
<th>Above expectations</th>
<th>Much above expectations</th>
</tr>
</thead>
</table>


e. [GrowthExp_Emp]: How would you evaluate the growth of the company in terms of employees in comparison with your expectations at start-up?

<table>
<thead>
<tr>
<th></th>
<th>Below expectations</th>
<th>Equal expectations</th>
<th>Little above expectations</th>
<th>Above expectations</th>
<th>Much above expectations</th>
</tr>
</thead>
</table>


f. [SuccesExp]: How would you evaluate the overall success of the company in comparison with your expectations at start-up?

<table>
<thead>
<tr>
<th></th>
<th>Below expectations</th>
<th>Equal expectations</th>
<th>Little above expectations</th>
<th>Above expectations</th>
<th>Much above expectations</th>
</tr>
</thead>
</table>

The early growth phase of high tech start-ups is often full of obstacles. The technology did not reach maturity yet; concrete, tangible products are often lacking or the products show bugs. Additionally, there is a lot of market uncertainty. After a difficult start-up period, spin-offs can experience ‘take off’, i.e.: sales cycles become shorter, the customer base expands rapidly and the sales grow exponentially.

g. Has your company reached ‘take off’ yet?

- Yes, since…..
- No
- Don’t know

If not:
Do you expect ‘take off’ (i.e. increase in the growth rate)?

- Yes, in the short run (in a few weeks or a few months)
- Yes, in the middle-long term (about one year)
- Yes, in the long run (one year to a few years)
- No, the firm will grow slowly
- No, the firm will stay small

Please explain
# Appendix 5: Guidelines for Data Input of Company Survey

## Company Passport

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Company Name</td>
</tr>
<tr>
<td>Name</td>
<td>Company Name</td>
</tr>
<tr>
<td>Address: Street and Nr</td>
<td></td>
</tr>
<tr>
<td>Address: ZIP and Town</td>
<td></td>
</tr>
<tr>
<td>Address: Country</td>
<td></td>
</tr>
<tr>
<td>Phone Nr</td>
<td></td>
</tr>
<tr>
<td>e-mail</td>
<td></td>
</tr>
<tr>
<td>Respondent</td>
<td>Who did you talk to?</td>
</tr>
<tr>
<td>Function of the respondent</td>
<td>CEO, CTO, COO,…employee?</td>
</tr>
<tr>
<td>Date</td>
<td>Date of the interview</td>
</tr>
<tr>
<td>VAT Nr</td>
<td>Only for Belgian companies</td>
</tr>
<tr>
<td>Population</td>
<td>1 = Steunpunt; 2=Indicom; 3=Both</td>
</tr>
</tbody>
</table>

## General Info

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TechDomain</td>
<td>Mainly Biotech (1) – Mainly hardware/micro-electronics (2) – Mainly IT (3) – Other (4)</td>
</tr>
<tr>
<td>NACE code</td>
<td>3 numbers and up to 3 different Nace codes per firm</td>
</tr>
<tr>
<td>LegalFound_MMMYYYY</td>
<td><strong>Date (mm/yyyy)</strong> at which a legal entity/juridical form was created.</td>
</tr>
<tr>
<td>LegalFound_YYYY</td>
<td>Type of legal entity that was created</td>
</tr>
<tr>
<td>Form</td>
<td></td>
</tr>
</tbody>
</table>
| End Date | **Last data point available: mm/yyyy**  
- For firms that still exist as an independent entity this is the date of the interview  
- For firms that failed / merged / were acquired, this is the date of bankruptcy or acquisition (time they stopped operating as independent entity) |
| Age | Number of months since founding until month of the interview or until failure or acquisition (N) |
| MMYYYY_FirstMoney | **Date (mm/yyyy)** at which a first injection of money took place.  
In some countries one can found a company without depositing an amount of start capital; the deposit of the start capital is in those cases only necessary in a later stage i.e. when the company actually starts its activities. |
| MMYYYY_StartAct | **Date (mm/yyyy)** at which the company really started its activities; date at which the company
### Type of institutional link
1. None, this is an **independent start-up**. The company emerged from the ideas and knowledge of one or more independent entrepreneurs.
2. **Corporate spin out**: the start-up emerged from the business activities of another private corporation. The transfer of knowledge can be formal (through equity participation) or informal (e.g., when employee leaves firm to start company based on skills acquired at the parent)
3. **Academic spin out**: the company spun out from a university or public research institute (irrespective of whether there was a formal transfer of knowledge). The key technological knowledge or idea was at least in part developed while working at the university or research institute.

### DetOrigin
Name of the parent institute

<table>
<thead>
<tr>
<th>Origin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: University</td>
<td></td>
</tr>
<tr>
<td>2: Research Institute</td>
<td></td>
</tr>
<tr>
<td>3: Other company</td>
<td></td>
</tr>
<tr>
<td>4: Current company that changed its mission</td>
<td></td>
</tr>
<tr>
<td>5: Independent entrepreneur</td>
<td></td>
</tr>
<tr>
<td>6: Other</td>
<td></td>
</tr>
</tbody>
</table>

### RP_StartYear
Start year of research project within the parent institute (s) on which the company’s activities are based (yyyy)

Start of research project = time at which the project, forming the base of the eventual applied technology within the company, started within the parent organization; whenever the project is the result of several projects then one should consider the time and/or project that added most value to the eventual commercialization of the technology.

### INV_INV
**Inventor involvement in the company**

<table>
<thead>
<tr>
<th>Inventor involvement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Researcher / inventor was not aware of the technology being transferred into a spin-off</td>
<td></td>
</tr>
<tr>
<td>2. Researcher stayed in research position at research institute</td>
<td></td>
</tr>
<tr>
<td>3. Shareholder with formal participation limited to employee (no C** function)</td>
<td></td>
</tr>
<tr>
<td>4. Shareholder with participation limited to Board of Directors or SAB</td>
<td></td>
</tr>
<tr>
<td>5. Shareholder with formal participation in a C** function</td>
<td></td>
</tr>
</tbody>
</table>

### CAPITALIZATION/OWNERSHIP

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TotalCap0</strong></td>
<td>Total capital at founding (Amount in Euro): ALL MONEY THAT IS INJECTED WITHIN 12 MONTHS AFTER FOUNDING! (since often financing rounds can take a while before they are actually closed)</td>
</tr>
<tr>
<td><strong>Personal0</strong></td>
<td>Personal (= injected by the founders/inventors) capital at founding: Amount in Euro</td>
</tr>
<tr>
<td><strong>%CapShares_Pers</strong></td>
<td>% capital shares: percentage of shares that the financing party got in return for the injection of money or for the transfer of knowledge/ intellectual property.</td>
</tr>
</tbody>
</table>

---

**Table1: moment in time = legal founding date**

All questions relate to the **FIRST YEAR OF OPERATIONS!**
<table>
<thead>
<tr>
<th>%FoundShares_Pers</th>
<th>% founder shares: percentage of shares that the party got in return for the transfer of knowledge/ intellectual property.</th>
</tr>
</thead>
<tbody>
<tr>
<td>External0</td>
<td>External (= by fund from parent institute, VC, corporate investor, BA, 3F or other parties) capital at founding</td>
</tr>
<tr>
<td></td>
<td>1. Amount in Euro</td>
</tr>
<tr>
<td></td>
<td>2. % shares: percentage of shares that the financing party got in return for the injection of money or for the transfer of knowledge/ intellectual property.</td>
</tr>
<tr>
<td></td>
<td>3. % founder shares: percentage of shares that the party got in return for the transfer of knowledge/ intellectual property.</td>
</tr>
<tr>
<td>%CapShares_Ext</td>
<td>% capital shares: percentage of shares that the financing party got in return for the injection of money or for the transfer of knowledge/ intellectual property.</td>
</tr>
<tr>
<td>%FoundShares_Ext</td>
<td>% founder shares: percentage of shares that the party got in return for the transfer of knowledge/ intellectual property.</td>
</tr>
<tr>
<td>VC0</td>
<td>Did the company receive financing from an institutional venture capital investor during the first year?</td>
</tr>
<tr>
<td></td>
<td>0 = no</td>
</tr>
<tr>
<td></td>
<td>1 = yes (3F are excluded, as well as parent institutes)</td>
</tr>
<tr>
<td>Workloans0</td>
<td>(Based on BELFIRST data) = Financial debts +1y (other debts) + Financial debts_max1y ('handelsschulden'+'belanstingen/bezoldigingen/sociale lasten'+'overige schulden'): using data from the founding year</td>
</tr>
<tr>
<td>BankLoans0</td>
<td>(Based on BELFIRST data) = Financial debts +1y (Fin debts) + Financial debts_max1y (debts+1y,verv-1y + fin debt): using data from the founding year</td>
</tr>
<tr>
<td>Subsidies0</td>
<td>Did the company receive any kind of subsidies? (Amount of Euro) Subsidies = grants obtained from government; public money in order to support the development of the technology into a product. It does not include public loans or public equity.</td>
</tr>
<tr>
<td>OptPlans0</td>
<td>Are particular arrangements made at time of legal founding with one of parties that specify the ownership of shares as time/performance of the company evolves? 1=yes; 0=no. If yes, describe these specifications.</td>
</tr>
<tr>
<td>Table2: moment in time = first capital increase</td>
<td></td>
</tr>
<tr>
<td>TotalCap1</td>
<td>Amount of capital increase (Amount in Euro)</td>
</tr>
<tr>
<td>Personal1</td>
<td>Personal (= injected by the founders/inventors) capital: Amount in Euro</td>
</tr>
<tr>
<td>External1</td>
<td>External (= by fund from parent institute, VC, corporate investor, BA, 3F or other parties) capital: Amount in Euro</td>
</tr>
<tr>
<td>VC1</td>
<td>For the first capital increase, did the company receive financing from an institutional venture capital investor?</td>
</tr>
<tr>
<td></td>
<td>0 = no</td>
</tr>
<tr>
<td></td>
<td>1 = yes (3F are excluded, as well as parent institutes)</td>
</tr>
</tbody>
</table>
| Subsidies1        | Did the company receive any kind of subsidies? (Amount in Euro) Subsidies = grants obtained from government; public money in order to support the development of the technology into a product.
product. It does not include public loans or public equity.

<table>
<thead>
<tr>
<th>ResPro1</th>
<th>Reserved Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>OptPlans1</td>
<td>Are particular arrangements made at this moment in time with one of parties that specify the ownership of shares as time/performance of the company evolves? 1=yes; 0=no. If yes, describe these specifications.</td>
</tr>
</tbody>
</table>

**Table 3: moment in time = second capital increase**

<table>
<thead>
<tr>
<th>TotalCap2</th>
<th>Amount of capital increase (Amount in Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal2</td>
<td>Personal (= injected by the founders/inventors) capital: Amount in Euro</td>
</tr>
<tr>
<td>External2</td>
<td>External (= by fund from parent institute, VC, corporate investor, BA, 3F or other parties) capital: Amount in Euro</td>
</tr>
<tr>
<td>VC2</td>
<td>For the second capital increase, did the company receive financing from an institutional venture capital investor? 0 = no; 1 = yes. (3F are excluded, as well as parent institutes)</td>
</tr>
<tr>
<td>Subsidies2</td>
<td>Did the company receive any kind of subsidies? (Amount in Euro)</td>
</tr>
<tr>
<td></td>
<td>Subsidies = grants obtained from government; public money in order to support the development of the technology into a product. It does not include public loans or public equity.</td>
</tr>
<tr>
<td>ResPro2</td>
<td>Reserved Profits</td>
</tr>
<tr>
<td>OptPlans2</td>
<td>Are particular arrangements made at this moment in time with one of parties that specify the ownership of shares as time/performance of the company evolves? 1=yes; 0=no. If yes, describe these specifications.</td>
</tr>
</tbody>
</table>

**Table 4: moment in time = third capital increase**

<table>
<thead>
<tr>
<th>TotalCap3</th>
<th>Amount of capital increase (Amount in Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal3</td>
<td>Personal (= injected by the founders/inventors) capital: Amount in Euro</td>
</tr>
<tr>
<td>External3</td>
<td>External (= by fund from parent institute, VC, corporate investor, BA, 3F or other parties) capital: Amount in Euro</td>
</tr>
<tr>
<td>VC3</td>
<td>For the third capital increase, did the company receive financing from an institutional venture capital investor? 0 = no; 1 = yes. (3F are excluded, as well as parent institutes)</td>
</tr>
<tr>
<td>Subsidies3</td>
<td>Did the company receive any kind of subsidies? (Amount of Euro)</td>
</tr>
<tr>
<td></td>
<td>Subsidies = grants obtained from government; public money in order to support the development of the technology into a product. It does not include public loans or public equity.</td>
</tr>
<tr>
<td>ResPro3</td>
<td>Reserved Profits; the amount (EURO) of profit or loss that the companies transfers to the next book year.</td>
</tr>
<tr>
<td>OptPlans3</td>
<td>Are particular arrangements made at this moment in time with one of parties that specify the ownership of shares as time/performance of the company evolves? 1=yes; 0=no. If yes, describe these specifications.</td>
</tr>
</tbody>
</table>

**Table 5: Moment in time = TIME OF INTERVIEW**

<table>
<thead>
<tr>
<th>CapToday</th>
<th>Total capital today (Amount in €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExtCapToday</td>
<td>External capital today (in €)</td>
</tr>
<tr>
<td>PersCapToday</td>
<td>Personal capital today (in €)</td>
</tr>
<tr>
<td>VC_Today</td>
<td>At time of the interview, do one or more institutional venture</td>
</tr>
<tr>
<td>capital investor(s) have equity in the company?</td>
<td>0=no 1=yes</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>WorkLoansToday</strong> (Based on BELFIRST data) = Financial debts_{+1y} (other debts) + Financial debts_{max1y} ('handelsschulden'+'belastingen/bezoldigingen/sociale lasten'+'overige schulden'): using data from the year in which the interview took place</td>
<td></td>
</tr>
<tr>
<td><strong>BankLoansToday</strong> (Based on BELFIRST data) = Financial debts_{+1y} (Fin debts) + Financial debts_{max1y} (debts_{+1y},verv_{-1y} + fin debt): using data from the year in which the interview took place</td>
<td></td>
</tr>
</tbody>
</table>

**TECHNOLOGY: TECH TRANSFER AND TECHNOLOGY DEVELOPMENT**

<table>
<thead>
<tr>
<th>Tech transfer</th>
<th>StageNPD0</th>
</tr>
</thead>
</table>
| **a. StageNPD0** | Stage in New Product Development Cycle at founding.  
1. The company has a service business model  
2. Idea Phase for product development process  
3. Proof of concept, i.e. α-prototype;  
4. Prototype that works in realistic environment, i.e. β-prototype;  
5. Concrete market-ready product; |
| **b. Maturity0** | Maturity of technology if no alpha prototype at founding  
Scale from basic research (1), becoming increasingly developmental(8)  
1. Investigations in pure and applied theoretical studies  
2. Experimental validation of theory and accumulation of data  
3. Combined theoretical and experimental studies of new or unexplored fields of technologies.  
4. Conception and/or demonstration of the capability of performing a specific and elementary function, using new or untried concepts, principles, techniques, and / or materials.  
5. Theoretical analysis and/or experimental measurement of the characteristics of behavior of materials and/or equipment, as required for design.  
7. First demonstration of the capability of performing a specific and elementary function, using established concepts, principles and /or materials.  

<table>
<thead>
<tr>
<th>Phase of technology development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aproto</td>
</tr>
<tr>
<td>DateAproto</td>
</tr>
<tr>
<td>Bproto</td>
</tr>
<tr>
<td>DateBproto</td>
</tr>
<tr>
<td>Product</td>
</tr>
<tr>
<td>DateProduct</td>
</tr>
</tbody>
</table>
| Not applicable | Because the company still applies a service business model or no longer has the ambition to develop a product and therefore changed its business model to one focusing on services (0: No;
If the business model of the company changed over the years indicate when this change took place (Mm/yy)

IMPORT_TT
Importance of tech transfer for the spin-off company, representing the degree of dependence on source technologies.
1 = Direct; 2 = Partial; 3 = Vague; 4 = None

Months_pro
Number of months from founding until the moment the company has a product ready (calculate)

a. LINK_PI
The formality of the link between the spin-off and the parent.
0: Independent Start-up
1: No link: the firm spun-off from another organization but there is no formal transfer of technology or equity link nor an ongoing (informal) relationship with the parent;
2: Informal link: the parent institute does not have an equity participation in the company, but another link does exist. For example: the entrepreneur has started up his company based upon the knowledge he acquired while working for the ‘parent institute’; or the technology was developed within the ‘parent institute’ but was never officially transferred (through patenting/licensing. Another possibility could be that there is an (informal) ongoing relationship between spin-off and parent, e.g. through people (employees/managers of the parent sit in the board or advise the spin-off informally), through scientific collaboration, the parent is a customer or supplier or partner to the spin-off;
3: Formal link: formal link between spin-off and parent through equity participation (parent owns shares in the spin-off because the parent invested in the company and/ or transfer of technology).

b. ChangeLINK_PI
Did the ‘link (as described in 3.4.a. change over time)? (0: No; 1: Yes);

Physical incubation
Office Space
Use of office space
OS_0
OS_TODAY
1. Year one: at founding (0 = No; 1 = Yes)
2. Today: moment of interview (0 = No; 1 = Yes)

Labs and equipment
Use of labs and equipment at founding
LE_0
LE_Today
1. Year one: at founding (0 = No; 1 = Yes)
2. Today: moment of interview (0 = No; 1 = Yes)

FOUNDERS, KEY MANAGEMENT AND EMPLOYEES

Founders
Founding team members: need to have (1) a function (hands-on management function or regular employee) within the company AND (2) ownership of an equity stake

a. N_Founders
Number of founders (N)

b. Evolution of the composition of the founders’ team?
Table 1: Original founding team

<table>
<thead>
<tr>
<th>EDO1;…;EDO5</th>
<th>Education of first,…, fifth founder (1 = technical; 2 = non-technical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience</td>
<td>Should be interpreted in terms of working experience</td>
</tr>
<tr>
<td>ExpR&amp;DO1;…; ExpR&amp;DO5</td>
<td>Number of years of experience of the first,…, fifth founder in R&amp;D (N)</td>
</tr>
<tr>
<td>ExpPO1;…; ExpPO5</td>
<td>Number of years of experience of the first,…, fifth founder in production (N)</td>
</tr>
<tr>
<td>ExpCO1;…;ExpCO5</td>
<td>Number of years of experience of the first,…, fifth founder in a commercial function (N)</td>
</tr>
<tr>
<td>ExpFO1;…;ExpFO5</td>
<td>Number of years of experience of the first,…, fifth founder in a financial function (N)</td>
</tr>
<tr>
<td>ExpLO1;…;ExpLO5</td>
<td>Number of years of experience of the first,…, fifth founder in a legal function (N)</td>
</tr>
<tr>
<td>ExpCE1;…;ExpCE5</td>
<td>Number of years of experience of the first,…, fifth founder in a consulting and engineering (N)</td>
</tr>
<tr>
<td>ExpFo1; …; ExpFo5</td>
<td>Does one of the founders has previous experience with the founding of a company (0: no; 1:yes)</td>
</tr>
<tr>
<td>SectorExpTeam</td>
<td>Cumulative sector experience of the initial founding team (=a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company) (1): low, when less then 3 years/ (2): average, between 3 &amp; 6 years of experience/ (3): high, higher then 6 years</td>
</tr>
<tr>
<td>MgtExpTeam</td>
<td>Cumulative management experience of the initial founding team (=a person has management experience if that person performed already a CEO/CTO/COO/CMO/CFO/COO function during his career) (1): low, when less then 3 years/ (2): average, between 3 &amp; 6 years of experience/ (3): high, higher then 6 years</td>
</tr>
<tr>
<td>F1O1; …; F1O5</td>
<td>Function at founding of the first,…, fifth founder (CEO; CFO; COO; CMO; CTO; CF; R (researcher); B (board member); 0 (none))</td>
</tr>
<tr>
<td>F2O1;…; F2O5</td>
<td>Function today of the first, …, fifth founder (CEO; CFO; COO; CMO; CTO; CF; R (researcher); B (board member); 0 (none))</td>
</tr>
<tr>
<td>Shares1O1; …; Shares1O5</td>
<td>Number of shares at founding of the first,…, fifth founder (N)</td>
</tr>
<tr>
<td>Shares2O1; …; Shares2O5</td>
<td>Number of shares today of the first,…, fifth founder (N)</td>
</tr>
</tbody>
</table>

Table 2: Additions to the team

<table>
<thead>
<tr>
<th>tDate</th>
<th>Month/year at which a first additional person joined the founding/management team</th>
</tr>
</thead>
<tbody>
<tr>
<td>tFunct_Join</td>
<td>Function of that person at moment of joining the team (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1Funct_Today</td>
<td>Function of that person today (moment of interview) (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>1Educ</td>
<td>Education of additional founder/manager (1 = technical; 2 = non-technical)</td>
</tr>
<tr>
<td>1SectorExp</td>
<td>Number of years of sector experience (=a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company)</td>
</tr>
<tr>
<td>1FunctExp</td>
<td>Number of years of experience the additional person has in a similar function</td>
</tr>
<tr>
<td>1Shares_Join</td>
<td>% shares at time of joining the firm of the additional founder/manager (0,00)</td>
</tr>
<tr>
<td>1Shares_Today</td>
<td>% shares today of the additional founder/manager (0,00)</td>
</tr>
<tr>
<td>2Date</td>
<td>Month/year at which a second person joined the founding/management team</td>
</tr>
<tr>
<td>2Funct_Join</td>
<td>Function of that person at moment of joining the team (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>2Funct_Today</td>
<td>Function of that person today (moment of interview) (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>2Educ</td>
<td>Education of additional founder/manager (1 = technical; 2 = non-technical)</td>
</tr>
<tr>
<td>2SectorExp</td>
<td>Number of years of sector experience (=a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company)</td>
</tr>
<tr>
<td>2FunctExp</td>
<td>Number of years of experience the additional person has in a similar function</td>
</tr>
<tr>
<td>2Shares_Join</td>
<td>% shares at time of joining the firm of the second additional founder/manager (0,00)</td>
</tr>
<tr>
<td>2Shares_Today</td>
<td>% shares today of the second additional founder/manager (0,00)</td>
</tr>
<tr>
<td>3Date</td>
<td>Month/year at which a third person joined the founding/management team</td>
</tr>
<tr>
<td>3Funct_Join</td>
<td>Function of that person at moment of joining the team (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>3Funct_Today</td>
<td>Function of that person today (moment of interview) (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>3Educ</td>
<td>Education of additional founder/manager (1 = technical; 2 = non-technical)</td>
</tr>
<tr>
<td>3SectorExp</td>
<td>Number of years of sector experience (=a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company)</td>
</tr>
<tr>
<td>3FunctExp</td>
<td>Number of years of experience the additional person has in a similar function</td>
</tr>
<tr>
<td>3Shares_Join</td>
<td>Number of shares at time of joining the firm of the third additional founder/manager (N)</td>
</tr>
<tr>
<td>3Shares_Today</td>
<td>% shares today of the third additional founder/manager (0,00)</td>
</tr>
<tr>
<td>4Date</td>
<td>Month/year at which a fourth person joined the founding/management team</td>
</tr>
<tr>
<td>4Funct_Join</td>
<td>Function of that person at moment of joining the team (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>4Funct_Today</td>
<td>Function of that person today (moment of interview) (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>4Educ</td>
<td>Education of additional founder/manager (1 = technical; 2 = non-technical)</td>
</tr>
<tr>
<td>4SectorExp</td>
<td>Number of years of sector experience (=a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company)</td>
</tr>
<tr>
<td>4FunctExp</td>
<td>Number of years of experience the additional person has in a similar function</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4Shares_Join</td>
<td>% shares at time of joining the firm of the additional founder/manager (0,00)</td>
</tr>
<tr>
<td>4Shares_Today</td>
<td>% shares today of the fourth additional founder/manager (0,00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5Date</th>
<th>Month/year at which a fifth person joined the founding/management team</th>
</tr>
</thead>
<tbody>
<tr>
<td>5Funct_Join</td>
<td>Function of that person at moment of joining the team (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>5Funct_Today</td>
<td>Function of that person today (moment of interview) (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>5Educ</td>
<td>Education of additional founder/manager (1 = technical; 2 = non-technical)</td>
</tr>
<tr>
<td>5SectorExp</td>
<td>Number of years of sector experience (a person has sector experience if he did already work in the same sector as the interrogated company is active in before joining the company)</td>
</tr>
<tr>
<td>5FunctExp</td>
<td>Number of years of experience the additional person has in a similar function</td>
</tr>
<tr>
<td>5Shares_Join</td>
<td>% shares at time of joining the firm of the second additional founder/manager (0,00)</td>
</tr>
<tr>
<td>5Shares_Today</td>
<td>% shares today of the fifth additional founder/manager (0,00)</td>
</tr>
</tbody>
</table>

**Table 3: Exits from team**

<table>
<thead>
<tr>
<th>1Date_Exit</th>
<th>Month/year at which a person left the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>1Funct_Join</td>
<td>Initial function within the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>1Funct_Exit</td>
<td>Function of that person at moment of leaving the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>1Shares_Join</td>
<td>% shares at founding of the founder/manager leaving the firm (0,00)</td>
</tr>
<tr>
<td>1Shares_Exit</td>
<td>% shares today of the founder that left the firm (0,00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2Date_Exit</th>
<th>Month/year at which a person left the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>2Funct_Join</td>
<td>Initial function within the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>2Funct_Exit</td>
<td>Function of that person at moment of leaving the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>2Shares_Join</td>
<td>% shares at founding of the founder/manager leaving the firm (0,00)</td>
</tr>
<tr>
<td>2Shares_Exit</td>
<td>% shares today of the founder that left the firm (0,00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3Date_Exit</th>
<th>Month/year at which a person left the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Funct_Join</td>
<td>Initial function within the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>3Funct_Exit</td>
<td>Function of that person at moment of leaving the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>3Shares_Join</td>
<td>% shares at founding of the founder/manager leaving the firm (0,00)</td>
</tr>
<tr>
<td>3Shares_Exit</td>
<td>% shares today of the founder that left the firm (0,00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4Date_Exit</th>
<th>Month/year at which a person left the team</th>
</tr>
</thead>
<tbody>
<tr>
<td>4Funct_Join</td>
<td>Initial function within the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>4Funct_Exit</td>
<td>Function of that person at moment of leaving the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>4Shares_Join</td>
<td>% shares at founding of the founder/manager leaving the firm (0,00)</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4Shares Exit</td>
<td>% shares today of the founder that left the firm (0,00)</td>
</tr>
<tr>
<td>5Date Exit</td>
<td>Month/year at which a person left the team</td>
</tr>
<tr>
<td>5Funct Join</td>
<td>Initial function within the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>5Funct Exit</td>
<td>Function of that person at moment of leaving the company (CEO, CTO, COO, CSO, …)</td>
</tr>
<tr>
<td>5Shares Join</td>
<td>% shares at founding of the founder/manager leaving the firm (0,00)</td>
</tr>
<tr>
<td>5Shares Exit</td>
<td>% shares today of the founder that left the firm (0,00)</td>
</tr>
<tr>
<td>c. PriorKnowlF</td>
<td>Fraction of founders that worked with each other before founding (e.g. 3 out of 4 = 0.75)</td>
</tr>
<tr>
<td>d. Ycoop</td>
<td>Number of years the founders worked together before joining the firm</td>
</tr>
<tr>
<td>e. Nature relationship</td>
<td><strong>Context of joint-working experience of the founders (all that apply)</strong></td>
</tr>
</tbody>
</table>
| Nature_Rel        | 1. Person to person academic interaction  
e.g.: PhD student and advisor, researchers in same department / institute, personal connections through conferences …  
2. Academic interaction by means of institutional research collaboration, i.e. Research project performed jointly by 2 universities  
3. Person to person industry – academic relation  
e.g.: Someone from academia knows a corporate employee as part of his personal network  
4. Industry – academic research collaboration, i.e.: Research project performed jointly by a commercial firm and academic department  
5. Person to person industry – industry relation, e.g.: Colleagues in corporate R&D department, personal contacts in other firms (e.g. through trade associations)  
6. Formal industry – industry (research) collaboration, e.g.: 2 firms contractually collaborating on research project and / or different phases in business development |
| Employees         |                                                                                                                                            |
| a. N employees    |                                                                                                                                            |
| FTE1              | Total Number of employees at founding in full-time-equivalents (N)                                                                      |
| FTE2              | Total Number of employees today in full-time-equivalents (N)                                                                              |
| FTERD1            | Number of employees in R&D at founding in full-time-equivalents (N)                                                                       |
| FTERD2            | Number of employees in R&D today in full-time-equivalents (N)                                                                             |
| FTECF1            | Number of employees in a commercial function/marketing&sales at founding in full-time-equivalents (N)                                     |
| FTECF2            | Number of employees in a commercial function/marketing&sales today in full-time-equivalents (N)                                         |
| FTECE1            | Number of employees in a consulting & engineering function at founding in full-time-equivalents (N)                                       |
| FTECE2            | Number of employees in a consulting & engineering function today in full-time-equivalents (N)                                           |
ENTREPRENEURIAL MOTIVATION: PUSH/PULL

<table>
<thead>
<tr>
<th>Push1 – Push11</th>
<th>Entrepreneurial Motivation: to what extent were following criteria important when taking the decision to (co)-found the company?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull1-Pull12</td>
<td>(5 = very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = very unimportant) (Smilor et al., 1990)</td>
</tr>
</tbody>
</table>

CORPORATE GOVERNANCE

<table>
<thead>
<tr>
<th>Corporate Governance_Board</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. N_Board</td>
<td>Number of board members at time of start-up of the company</td>
</tr>
<tr>
<td>b. PriorKnowl_Board</td>
<td>Number of external board members that were known by members of the founding team before founding of the company</td>
</tr>
<tr>
<td>c. Roles_Board</td>
<td>Reput 1 = Very unimportant; 2 = Unimportant; 3 = Neutral; 4 = Important; 5 = Very important</td>
</tr>
<tr>
<td></td>
<td>Expertise 1 = Very unimportant; 2 = Unimportant; 3 = Neutral; 4 = Important; 5 = Very important</td>
</tr>
<tr>
<td></td>
<td>ScanEnv 1 = Very unimportant; 2 = Unimportant; 3 = Neutral; 4 = Important; 5 = Very important</td>
</tr>
<tr>
<td></td>
<td>RegProcess 1 = Very unimportant; 2 = Unimportant; 3 = Neutral; 4 = Important; 5 = Very important</td>
</tr>
<tr>
<td>d. Board meetings</td>
<td>RvB1 Number of board meetings in the first year (X/year)</td>
</tr>
<tr>
<td></td>
<td>RvB2 Number of board meetings last year (X/year)</td>
</tr>
</tbody>
</table>

Corporate Governance_Investors

The following questions are related to the service provided by the LEAD venture capital investor to the portfolio company.

e.i. VC services – Carried out role? (23 collums) Which of the following services has the LEAD VC investor provided in your company? 1 = yes; 0 = no

e.ii. VC services – Importance carrying out role? (23 collums) How important was it to you that the lead VC carried out this role? 5 = very important, 4 = important, 3 = moderately important, 2 = slightly important, 1 = irrelevant

e.iii. VC services – Effectiveness? (23 collums) How effective did you find your lead VC in carrying out this role? 1 = very low effectiveness, 5 = very high effectiveness

Corporate Governance_Parent Institute

f. RoleParent Which of the following description describes best “your parent institute”?
1. Low selective model  
*Socially attractive spin-outs:*  
the TTO’s objective is to create employment and enhance development in a depressed region. The TTO’s mission is to create many (>7) spin-outs each year. Most of those spin-out companies are consulting or service oriented, and most target a local market.

2. Supportive model  
*Economically attractive spin-out:*  
the TTO’s objective is to create economically profitable businesses. The TTO’s mission is to create 3 to 7 spin-outs a year. Most spin-outs are based upon a proprietary technology developed at the research institutes. Half of the spin-outs are product-oriented spin-outs. Most spin-outs receive money from a public/private capital fund, set up by the TTO.

3. Incubator model  
*Financially attractive spin-outs:*  
the TTO’s objective is to create businesses that will generate financial returns to investors. The TTO’s mission is to create only 1 to 3 spin-outs a year. Those spin-outs target a global market, they all receive private VC money and all are based upon a proprietary technology developed at the research institutes.

<table>
<thead>
<tr>
<th><strong>BUSINESS COMPLEXITY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
</tbody>
</table>
| VAC_1stPro | **This question applies to the first product that is/was developed by the company.**  
1 = the value chain is very complex: The company needs to lobby with several (high level) parties in order to further develop and commercialize its technology.  
2 = the value chain is complex: The company does not have all knowledge and technology to bring a complete product to market and needs to rely on co-development with one other company.  
3 = Neutral; All knowledge is available in house.  
4 = the company is pulled into a market. In some cases, there can be a positive effect of other market players on the growth of the business activities of the focal firm. |
| b. SalesProcess | **The customer is not necessarily the end consumer as such; it applies to the main targeted customer for the particular interrogated company.**  
1 = one person is economic, technical and user buyer.  
2 = different buyer roles are covered by different people in the customers’ organization. However, the key decision-makers are straightforward and are found rather easy.  
3 = Very difficult sales cycles: different people play different buying roles and difficult to identify all people that influence decision making or decision makers are spread over different hierarchical levels and key decision makers (i.e. economic buyers) are located high in the organization (e.g. in corporate headquarters). |
# CHARACTERISTICS OF THE MARKET

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Competitors</td>
<td></td>
</tr>
</tbody>
</table>
| Comp_SU     | Competitors that develop similar products at time of start-up.  

0 = No, 1 = local, 2 = national, 3 = global                                                                 |
| Ncomp_SU    | N: number of competitors that develop rival products                                                                                       |
| SizeComp_SU | Size: the size of these organizations in terms of number of employees: 1 = small; 2 = medium; 3 = large.                                       |
| Comp_Pres   | Competitors that CURRENTLY develop similar products  

0 = No, 1 = local, 2 = national, 3 = global                                                                 |
| Ncomp_Pres  | N: number of competitors that develop rival products                                                                                       |
| SizeComp_Pres | Size: the size of these organizations in terms of number of employees: 1 = small; 2 = medium; 3 = large.                                       |
| b. Geographical scope                                |                                                                                                                                              |
| Geog_SU     | 1 = National / local, 2 = European, 3 = Worldwide / global                                                                                  |
| LocalRev_Su | % = the percentage of the overall revenue coming from customers at national/local level (0,00)                                             |
| EuroRev_Su  | % = the percentage of the overall revenue coming from customers European level (0,00)                                                       |
| GlobalRev_Su| % = the percentage of the overall revenue coming from customers at worldwide/global level (0,00)                                             |
| Geog_Pres   | 1 = National / local, 2 = European, 3 = Worldwide / global                                                                                  |
| LocalRev_Pres | % = the percentage of the overall revenue coming from customers at national/local global level (0,00)                                      |
| EuroRev_Pres| % = the percentage of the overall revenue coming from customers European level (0,00)                                                       |
| GlobalRev_Pres | % = the percentage of the overall revenue coming from customers at worldwide/global level (0,00)                                         |
| c. Market size and targeted market                   |                                                                                                                                              |
| TargetMarket | 1 = Niche market, 2 = Temporarily a niche market, intention to penetrate new market segments, 3 = Mainstream market                      |
| ‘Calc_Msize0’| Did you calculate, at time of founding, the potential size of the total market that company aims to target?  

Yes (1): No (0)                                                                 |
| MarketSize0 | The calculated or estimated market size in MILLION €                                                                                     |
| Mshare0_Calc| Did you calculate, at time of founding, the market share that the company targets?  

Yes (1): No (0)                                                                 |
| Mshare0     | The calculated or estimated market share in ‘%’ (0,00)                                                                                   |
**Fulfill_Mshare**

Could the company fulfill these calculations? (Today)
- Yes (1)
- No (0)

**MsizeToday**

What is the size of the market you are CURRENTLY operating in?
- (in €) This can be the same as marketSize0, but not necessarily!

**Mshare_Today**

What is the current market share of the company: in €

**Calc_Growth**

Did you calculate, at time of founding, the annual growth rate of the targeted market?
- Yes (1)
- No (0)

**Growth**

Indicate the calculated or estimated growth in %/year (0,00)

**Effective_Growth**

What is the effective annual growth rate? Indicate the growth in ‘%/year’ (0,00)

**d. Sales strategy**

1 = yes; 0 = No

---

### SUCCESS/GROWTH

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. Revenues</strong></td>
<td></td>
</tr>
<tr>
<td>DRev1</td>
<td>Revenues generated first year (0: No; 1: yes)</td>
</tr>
<tr>
<td>DRev2</td>
<td>Revenues generated last year (0: No; 1: yes)</td>
</tr>
<tr>
<td>Rev1</td>
<td>Amount of revenues in first year (Amount in Euro) Equivalent for 12m</td>
</tr>
<tr>
<td>Rev2</td>
<td>Amount of revenues in last year (Amount in Euro) Equivalent for 12m</td>
</tr>
<tr>
<td>CrinRev1</td>
<td>Share of contract research for industry in first years’ revenues (%)</td>
</tr>
<tr>
<td>CrinRev2</td>
<td>Share of contract research for industry in last years’ revenues (%)</td>
</tr>
<tr>
<td>SubinRev1</td>
<td>Share of subsidies in first years’ revenues (%)</td>
</tr>
<tr>
<td>SubinRev2</td>
<td>Share of subsidies in last years’ revenues (%)</td>
</tr>
<tr>
<td>LicinRev1</td>
<td>Share of licensing in first years’ revenues (%)</td>
</tr>
<tr>
<td>LicinRev2</td>
<td>Share of licensing in last years’ revenues (%)</td>
</tr>
<tr>
<td>C&amp;EinRev1</td>
<td>Share of consulting and engineering services in first years’ revenues (%)</td>
</tr>
<tr>
<td>C&amp;EinRev2</td>
<td>Share of consulting and engineering services in last years’ revenues (%)</td>
</tr>
<tr>
<td>M&amp;SinRev1</td>
<td>Share of maintenance and support services in first years’ revenues (%)</td>
</tr>
<tr>
<td>M&amp;SinRev2</td>
<td>Share of maintenance and support services in last years’ revenues (%)</td>
</tr>
<tr>
<td>CustSinRev1</td>
<td>Share of customized product sales in first years’ revenues (%)</td>
</tr>
<tr>
<td>CustSinRev2</td>
<td>Share of customized product sales in last years’ revenues (%)</td>
</tr>
<tr>
<td>StSinRev1</td>
<td>Share of standardized product sales in first years’ revenues (%)</td>
</tr>
<tr>
<td>StSinRev2</td>
<td>Share of standardized product sales in last years’ revenues (%)</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>OtherinRev1</td>
<td>Share of other activities in first years’ revenues (%)</td>
</tr>
<tr>
<td>OtherinRev2</td>
<td>Share of other activities in last years’ revenues (%)</td>
</tr>
<tr>
<td><strong>b. Break even</strong></td>
<td></td>
</tr>
<tr>
<td>BreakEven</td>
<td>Is the company break-even (0: No; 1: Yes) \nBreak-even =\text{returns} – \text{expenses} = 0; as from the moment the company has positive operational cash flow, we say that company is break-even.</td>
</tr>
<tr>
<td>DateBreakEven</td>
<td>Since when is the company break-even (month/year)</td>
</tr>
<tr>
<td><strong>c. Burn rate</strong></td>
<td></td>
</tr>
<tr>
<td>TotBR1</td>
<td>Total burn-rate at founding (Amount in Euro/month)</td>
</tr>
<tr>
<td>TotBR2</td>
<td>Total burn-rate today (Amount in Euro/month)</td>
</tr>
<tr>
<td><strong>d. Perceived Success/Growth</strong></td>
<td></td>
</tr>
<tr>
<td>GrowthExp_Rev</td>
<td>Growth of the company compared to the expectations (of the entrepreneurs) at founding in terms of revenues (1 = below expectations; 2 = as expected; 3 = little above expectations; 4 = above expectations; 5 = much above expectations)</td>
</tr>
<tr>
<td>GrowthExp_Emp</td>
<td>Growth of the company compared to the expectations (of the entrepreneurs) at founding in terms of employees (1 = below expectations; 2 = as expected; 3 = little above expectations; 4 = above expectations; 5 = much above expectations)</td>
</tr>
<tr>
<td>SuccessExp</td>
<td>Global success of the company compared to expectations (of the entrepreneurs) at founding (1 = below expectations; 2 = as expected; 3 = little above expectations; 4 = above expectations; 5 = much above expectations)</td>
</tr>
<tr>
<td><strong>f. TakeOff</strong></td>
<td></td>
</tr>
<tr>
<td>TakeOff</td>
<td>Take-off reached (0: No; 1: Yes)</td>
</tr>
<tr>
<td>DateTakeOff</td>
<td>Date of take-off (mm/yyyy)</td>
</tr>
<tr>
<td>ExpTakeOff</td>
<td>If NOT: \n\textbf{Expected date of take-off} (1 = short term, i.e. within a few week to a few months; 2 = middle-long term, i.e. within about one year; 3 = long term, i.e. over more than a year; 4 = slow growth is expected; 5 = staying a small company is expected)</td>
</tr>
<tr>
<td>Bankrupt</td>
<td>0: not bankrupt; 1: bankrupt</td>
</tr>
<tr>
<td>Exit</td>
<td>0: no exit; 1: exit (tradesale or IPO)</td>
</tr>
<tr>
<td>Tradesale</td>
<td>0: no tradesale (or merger); 1: acquired by other firm/ tradesale</td>
</tr>
<tr>
<td>IPO</td>
<td>0: privately held; 1: Publicly held (IPO)</td>
</tr>
<tr>
<td>Bankrupt</td>
<td>0=No; 1=Yes</td>
</tr>
<tr>
<td>Exit</td>
<td>0=No; 1=Yes</td>
</tr>
</tbody>
</table>
APPENDIX 6: SURVEY INSTRUMENT FOR TECHNOLOGY TRANSFER OFFICES FROM PUBLIC RESEARCH ORGANISATIONS

SURVEY ON UNIVERSITY TECHNOLOGY TRANSFER ACTIVITIES: FINANCIAL YEAR 2002

General instructions

We have endeavored to make the questionnaire as simple as possible to complete. However, there are a small number of instructions that we would like to bring to your attention:

- Words in CAPITALS in the questions are defined in the DEFINITIONS section at the end of the questionnaire.
- The financial year may vary by institution so please use your own financial year. The survey covers the financial year ending during 2002.
- Please note that the data you provide should be for the whole of your institution’s TECHNOLOGY TRANSFER activities.

1. Please state the period of your institution’s financial year for 2002: ___/___/01 to ___/___/02

SECTION 1: RESOURCES

2.a) Does your institution include a MEDICAL SCHOOL? □ Yes □ No

Note: The institution must own all or part of the MEDICAL SCHOOL and have direct formal and operational links.

2.b) Does your institution include a BUSINESS INCUBATOR? □ Yes □ No

Note: The institution must own all or part of the BUSINESS INCUBATOR and have direct formal and operational links.

2.c) Does your institution include a SCIENCE PARK? □ Yes □ No

Note: The institution must own all or part of the SCIENCE PARK and have direct formal and operational links.

3. In what year did your institution dedicate at least 0.5 PROFESSIONAL FULL-TIME EQUIVALENTS (FTEs) toward TECHNOLOGY TRANSFER ACTIVITIES?

69 Adapted from UNICO / NUBS (2003)
4. TECHNOLOGY TRANSFER AND OTHER FTEs:

Note: Please use either a full or fractional level of FTEs when allocating the number of FTEs employed in TECHNOLOGY TRANSFER ACTIVITIES below.

4.a) What was the total number of FTEs that were employed in your TECHNOLOGY TRANSFER ACTIVITIES in total during financial year 2002?

________

Note: 4.a) Covers FTEs whose duties and responsibilities include licensing, patenting and SPIN-OUT Company creation processes, as well as FTEs providing administrative, secretarial, accounting, contract management and professional support.

OF THIS NUMBER:

4.b) How many LICENSING FTEs were employed in TECHNOLOGY TRANSFER ACTIVITIES in financial year 2002?

________

Note: LICENSING FTEs refers only to the number of full time executives whose duties are specifically involved with the licensing and patenting process.

4.c) How many SPIN-OUT FTEs were employed in TECHNOLOGY TRANSFER activities in financial year 2002?

________

Note: SPIN-OUT FTEs refers only to the number of full time executives whose duties are specifically involved with the process of creating new SPIN-OUT COMPANIES.

4. RESEARCH EXPENDITURES

<table>
<thead>
<tr>
<th>TOTAL RESEARCH EXPENDITURE</th>
<th>NATIONAL GOVERNMENT SOURCES</th>
<th>EUROPEAN GOV. SOURCES</th>
<th>INDUSTRY SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2002</td>
<td>€</td>
<td>€</td>
<td>€</td>
</tr>
</tbody>
</table>

Note: The sum of Research Expenditures funded by Government, EU, and Industrial sources may not equal Total Research Expenditures.

SECTION 2: LICENCES/OPTION AGREEMENTS/ASSIGNMENTS

6.a) LICENCES/OPTION AGREEMENTS/ASSIGNMENTS:

6.a.i) How many of LICENCES/OPTIONS/ASSIGNMENTS did your institution execute in financial year 2002? (Excluding research contracts)
6.a.ii) In total, how many LICENCES/ OPTIONS were ACTIVE as of the last day in financial year 2002?

<table>
<thead>
<tr>
<th></th>
<th>Total number of ASSIGNMENT S/ LICENCES/OPTIONS Executed (6.a.i)</th>
<th>Total Number of ACTIVE LICENCES / OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Year 2002</td>
<td>........</td>
<td>........</td>
</tr>
<tr>
<td>Cumulative through end of Financial Year 2002</td>
<td>........</td>
<td>........</td>
</tr>
</tbody>
</table>

6.b) How many of the LICENCES / OPTIONS / ASSIGNMENTS executed in financial year 2002 were licences to NEW SPIN-OUT COMPANIES?

<table>
<thead>
<tr>
<th>Total (Same as 6.a.i)</th>
<th>To NEW SPIN-OUT COMPANIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UK</td>
</tr>
<tr>
<td>........</td>
<td>........</td>
</tr>
</tbody>
</table>

SECTION 3: LICENSING INCOME

7. LICENCE INCOME: Excludes software and biological material end user licences under € 1500

These questions want to shed some light as to what extent the research institution generates ‘big’ licenses. If an exact figure cannot be given, please include an estimate.

7.a) How many licences generated between €72 205.90 and €359 585.40 for your institution in financial year 2002?

N = __________

7.b) How many licences generated €360 995.97 or more for your institution in financial year 2002?

N = __________

7.c) What was the amount of LICENCE INCOME RECEIVED at your institution during financial year 2002?

Note: Number of licences here should exclude software and biological material end-user licences under € 1500.

€ __________
SECTION 4: INTELLECTUAL PROPERTY PROTECTION AND PATENTING

8. IP PROTECTION EXPENDITURES:

How much did your institution spend in external legal fees, patent costs, and specialist IP consultancy advice in financial year 2002? Please give an estimate if actual figures are not available.

€__________________

PATENT-RELATED ACTIVITY

9.a) How many INVENTION DISCLOSURES were received and NEW PATENT APPLICATIONS FILED by your institution in financial year 2002?

<table>
<thead>
<tr>
<th>INVENTION DISCLOSURES received</th>
<th>TOTAL PATENTAPPLICATIONS FILED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Domestic</td>
</tr>
</tbody>
</table>

10. INCENTIVES AND REWARDS

10.a) Does your institution have an agreed policy on how income from EXECUTED LICENCES is distributed amongst the (academic) Inventor, Department and Institution?

☐ Yes  ☐ No

10.b) How is income from EXECUTED LICENCES distributed amongst the (academic) Inventor, Department and Institution for licence revenue in excess of €100k, or at the highest tier.

<table>
<thead>
<tr>
<th>Percentage of net revenues</th>
<th>Inventor receives</th>
<th>Department receives</th>
<th>Institution receives</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
</tbody>
</table>

SECTION 5: SPIN-OUT and START-UP COMPANIES

Note: SPIN-OUT COMPANIES and START-UP COMPANIES are not equivalent. To avoid double counting, please refer to the Survey Terms and Definitions provided.

11. NEW SPIN-OUT AND NEW START-UP COMPANIES:

Note: Questions refer to SPIN-OUT COMPANIES and START-UP COMPANIES created during financial year 2002.

11.a) How many NEW SPIN-OUT COMPANIES were formed during financial year 2002 (that is companies that depended on LICENSING or ASSIGNMENT of intellectual property generated at your institution for initiation)?
11.b) How many new START-UP COMPANIES were formed during financial year 2002 (that is companies that did not depend on LICENSING or ASSIGNMENT of intellectual property generated at your institution for initiation)?

11.c) Of the NEW SPIN-OUT COMPANIES in question 11.a) in how many does your institution hold EQUITY?

11.d) How many of the NEW SPIN-OUT COMPANIES established from your institution during financial year 2002 were done so using EXTERNAL EQUITY FINANCE?

11.e) How many of the NEW SPIN-OUT COMPANIES established during financial year 2002 were done so using the following specific forms of finance?

<table>
<thead>
<tr>
<th>Venture Capitalist finance</th>
<th>Business Angel finance</th>
<th>Industrial Partner finance</th>
<th>University Challenge Fund (UCF) finance or equivalent</th>
<th>Other External Finance (e.g. repayable loans)</th>
<th>Internal Finance (e.g. repayable loans)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Multiple sources of external finance for each SPIN-OUT COMPANY may be possible.

Note: Proof of Concept Funding (Scotland) Spinout Wales Funding (Wales) and University Challenge Funds (England) are equivalent.

11.f) How many of the NEW SPIN-OUT COMPANIES established during financial year 2002 have their primary place of business in your home region?

11.g) How many NEW SPIN-IN COMPANIES, (i.e. firms that have been established from your institution based on technology generated outside your institution), were formed during financial year 2002?

12. EXISTING SPIN-OUT AND EXISTING START-UP COMPANIES:

Note: Questions refer to SPIN-OUT COMPANIES and START-UP COMPANIES created before financial year 2002. Note: SPIN-OUT COMPANIES and START-UP COMPANIES are not equivalent. Please refer to the Survey Terms and Definitions provided.
12.a) How many *EXISTING SPIN-OUT COMPANIES* became *NON-OPERATIONAL* as of the last day in financial year 2002?

______________

12.b) How many *EXISTING START-UP COMPANIES* became *NON-OPERATIONAL* as of the last day in financial year 2002?

______________

12.c) In how many *EXISTING SPIN-OUT COMPANIES* did your institution still hold *EQUITY* as of the last day in financial year 2002?

______________

12.d) Please indicate if you use any of the methods listed below to arrive at estimates of portfolio values for *OPERATIONAL SPIN-OUT COMPANIES*.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost (less provision)</td>
<td>☐</td>
</tr>
<tr>
<td>Earnings Multiple</td>
<td>☐</td>
</tr>
<tr>
<td>Discounted Future Cash Flows</td>
<td>☐</td>
</tr>
<tr>
<td>Third Party Valuation</td>
<td>☐</td>
</tr>
<tr>
<td>Net Assets</td>
<td>☐</td>
</tr>
<tr>
<td>Other</td>
<td>☐</td>
</tr>
</tbody>
</table>

12.g) How many *SPIN-OUT COMPANIES* have exited your investment portfolio during financial year 2002? How much value was realised through sale of all or part your shareholdings in these *SPIN-OUT COMPANIES* through both *FULL EXITS* and *PARTIAL EXITS*?

<table>
<thead>
<tr>
<th>Total number of Exits (11.g.i)</th>
<th>Exits via Trade sale / Acquisition / Merger</th>
<th>Exits via IPO / Stock Market Floatation</th>
<th>Exits via Management Buy-Out</th>
<th>Exits via Failure / Liquidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Exits in FY2002</td>
<td>Full Partial</td>
<td>Full Partial</td>
<td>Full Partial</td>
<td>Full Partial</td>
</tr>
<tr>
<td>Value realized in FY2002</td>
<td>€ € € €</td>
<td>€ € €</td>
<td>€ €</td>
<td>€ €</td>
</tr>
</tbody>
</table>

*Note:* The Number of FULL EXITS and PARTIAL EXITS for each sub-category should add up to the Total Number of FULL EXITS and PARTIAL EXITS in (11.g.i).

**SURVEY TERMS AND DEFINITIONS**

<table>
<thead>
<tr>
<th>0.5 PROFESSIONAL FULL-TIME EQUIVALENT</th>
<th>0.5 PROFESSIONAL FTE means a professional position whose duties included support of TECHNOLOGY TRANSFER ACTIVITIES (as defined in this Survey) at least 50% of the time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>ACTIVE LICENCES / OPTIONS</td>
<td>The cumulative number of Licences/ Options over all years that had not terminated by the end of the Survey’s financial year requested.</td>
</tr>
<tr>
<td>ASSIGNMENT / LICENCE/OPTION AGREEMENT WITH EQUITY</td>
<td>The number of ASSIGNMENTS/LICENCES/OPTIONS that were executed in the year requested that included equity, where equity is defined as an institution acquiring an ownership interest in a company.</td>
</tr>
<tr>
<td>BUSINESS INCUBATOR</td>
<td>BUSINESS INCUBATOR also refers to Technology Incubators, Innovation Centres and similar property units that provide an instructive and supportive environment to entrepreneurs at start-up and during the early stages of businesses. The institution must own all or part of the BUSINESS INCUBATOR and must also have direct formal and operational links.</td>
</tr>
<tr>
<td>EQUITY</td>
<td>Equity, for the purposes of this Survey, is defined as an institution acquiring an ownership interest in a company (e.g. stock and rights to receiving stock).</td>
</tr>
<tr>
<td>EXECUTED LICENCE</td>
<td>The signed grant of rights that does not amount to an assignment by the licensor (e.g. your institution) to the licensee (e.g. a biotech company) in the form of a contract that permits the licensee to exploit IP according to the contractual terms and conditions.</td>
</tr>
<tr>
<td>EXISTING SPIN-OUT COMPANIES</td>
<td>EXISTING SPIN-OUT COMPANIES refers to SPIN-OUT COMPANIES that were created before the start of financial year 2002. EXISTING SPIN-OUT COMPANIES does not refer to those SPIN-OUT COMPANIES created during financial year 2002, which should only be referred to as NEW SPIN-OUT COMPANIES. Please refer to the definition provided for what constitutes a SPIN-OUT COMPANY.</td>
</tr>
<tr>
<td>EXTERNAL EQUITY FINANCE</td>
<td>Finance provided in return for an external institution acquiring an ownership interest in a company (e.g., stock) or an option to acquire an ownership interest in a company (e.g. the right to receive stock at some future point in time).</td>
</tr>
<tr>
<td>FOREIGN</td>
<td>FOREIGN for the purposes of this Survey refers to countries or territories outside the United Kingdom, where the United Kingdom includes England, Scotland, Wales and Northern Ireland.</td>
</tr>
<tr>
<td>FULL EXIT</td>
<td>FULL EXIT refers to an instance when your institution has sold all of its EQUITY in a SPIN-OUT COMPANY to another institution or to the SPIN-OUT COMPANY itself, and no longer retains any EQUITY within the SPIN-OUT COMPANY.</td>
</tr>
<tr>
<td>INVENTION DISCLOSURES</td>
<td>INVENTION DISCLOSURES include the number of disclosures, no matter how comprehensive, that are made in the year requested and are counted by the institution.</td>
</tr>
<tr>
<td>TECHNOLOGY TRANSFER ACTIVITIES</td>
<td>Includes those activities associated with the identification, documentation, evaluation, protection, marketing and licensing of technology (including trademarks but not university’s insignia) and intellectual property management, in general. It encompasses all other activities also associated with the day-to-day operations of a technology transfer office, including assisting with the negotiation of research agreements, material transfer agreements, reporting on inventions to sponsors, and all other duties performed by the office.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LICENSING FTE</td>
<td>Person(s) employed in the TECHNOLOGY TRANSFER Office whose duties are specifically involved with the licensing and patenting process in either full or fractional FTE allocation. Licensing examples include licensee solicitation, technology valuation, marketing of technology, license agreement drafting and negotiation.</td>
</tr>
<tr>
<td>MEDICAL SCHOOL</td>
<td>MEDICAL SCHOOL refers to a research and teaching department that the institutions must own all or part of. The institutions must also have direct formal and operational links with the MEDICAL SCHOOL.</td>
</tr>
<tr>
<td>LICENCE/OPTION AGREEMENT</td>
<td>A LICENCE is where the Licensor (e.g. your institution) grants rights to use the technology under LICENCE in a defined Field of Use and Territory. An OPTION AGREEMENT grants the potential licensee a time period during which it may evaluate the technology and negotiate the terms of a LICENCE agreement.</td>
</tr>
<tr>
<td>LARGE COMPANIES</td>
<td>Companies that had more than 500 employees at the time the LICENCE/OPTION/ASSIGNMENT was signed.</td>
</tr>
<tr>
<td>LICENCE INCOME RECEIVED</td>
<td>Includes LICENCE issue fees, payments under options, lump sum payments in consideration of an assignment, annual minimums, running royalties, termination payments, the amount of equity received when cashed-in. Does not include research funding, patent expense reimbursement, a valuation of equity not cashed-in, trademark licensing royalties from university insignia or income received in support of costs incurred under Material Transfer Agreements.</td>
</tr>
<tr>
<td>LICENCE INCOME PAID TO OTHER INSTITUTIONS</td>
<td>A subset of LICENCE income received and should not be subtracted from the total. This number will be used to better define the double-count of LICENCE income reported under this survey. It includes the amounts paid to other institutions under inter-institutional agreements.</td>
</tr>
<tr>
<td>NEW PATENT APPLICATIONS FILED</td>
<td>Relates to first filing of a patent irrespective of territory. Does not include continuations, divisionals, or reissues and typically does not include applications for continuation in parts (CIPs).</td>
</tr>
<tr>
<td>NEW SPIN-OUT COMPANY</td>
<td>NEW SPIN-OUT COMPANIES refers to those SPIN-OUT COMPANIES that were created during financial year 2002. NEW SPIN-OUT COMPANIES does not refer to those SPIN-OUT COMPANIES created before financial year 2002, which should be referred to as EXISTING SPIN-OUT COMPANIES. Please refer to the definition provided for what constitutes a SPIN-OUT COMPANY.</td>
</tr>
<tr>
<td>OPERATIONAL</td>
<td>A company that possesses sufficient financial resources and expends these resources to make progress toward stated business goals.</td>
</tr>
<tr>
<td>NEW PATENT APPLICATIONS FILED</td>
<td>NEW PATENT APPLICATIONS FILED is a subset of TOTAL PATENT APPLICATIONS FILED. It does not include continuations, divisionals, or reissues, and does not include Continuations In Parts (CIPs). A provisional application filed in financial year 2002 may be counted as new. If a provisional application is converted in financial year 2002 to a regular application, then that corresponding regular application filed in financial year 2002 should not be counted as new.</td>
</tr>
<tr>
<td>PARTIAL EXIT</td>
<td>PARTIAL EXIT refers to an instance when your institution has sold part of its EQUITY in a SPIN-OUT COMPANY to another institution.</td>
</tr>
<tr>
<td><strong>institution or to the SPIN-OUT COMPANY itself, but still retains some EQUITY within the SPIN-OUT COMPANY.</strong></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>PATENTS ISSUED</strong></td>
<td>PATENTS ISSUED includes the number of patents (for the region / territory asked for in the Survey) that have been issued or reissued to your institution in the year requested. Plant breeders rights may also be included.</td>
</tr>
<tr>
<td><strong>NON-OPERATIONAL</strong></td>
<td>A company that does not possess sufficient financial resources and cannot progress towards stated business goals. The company is not diligent in its efforts to achieve these goals.</td>
</tr>
<tr>
<td><strong>RESEARCH EXPENDITURES: EUROPEAN GOVERNMENT SOURCES</strong></td>
<td>RESEARCH EXPENDITURES: EUROPEAN GOVERNMENT SOURCES include expenditures made by the institution in financial year 2002 in support of its research activities that are funded by the European Commission or other central European Funds e.g. Framework Five.</td>
</tr>
<tr>
<td><strong>RESEARCH EXPENDITURES: GOVERNMENT SOURCES</strong></td>
<td>RESEARCH EXPENDITURES: GOVERNMENT SOURCES include expenditures made by the institution in financial year 2002 in support of its research activities that are funded by the national government.</td>
</tr>
<tr>
<td><strong>RESEARCH EXPENDITURES: INDUSTRY SOURCES</strong></td>
<td>RESEARCH EXPENDITURES: INDUSTRY SOURCES include expenditures made by the institution in financial year 2002 in support of its research activities that are funded by <em>for-profit</em> corporations, but <em>not</em> expenditures supported by other sources such as foundations and other nonprofit organisations.</td>
</tr>
<tr>
<td><strong>RUNNING ROYALTIES</strong></td>
<td>RUNNING ROYALTIES refers to Royalties earned on sale of products. RUNNING ROYALTIES excludes LICENCE issue fees, payments under options, termination payments, annual minimums not supported by sales, and equity realised from Spin-Out Companies, which should be reported separately.</td>
</tr>
<tr>
<td><strong>SCIENCE PARK</strong></td>
<td>SCIENCE PARK refers to a business support and technology transfer initiative that encourages and supports the start-up, incubation and development of innovation led, high growth, and knowledge based businesses. The institution MUST own all or part of the Science Park and MUST also have direct formal and operational links.</td>
</tr>
<tr>
<td><strong>SME (SMALL AND MEDIUM Sized) COMPANIES</strong></td>
<td>SMALL AND MEDIUM SIZED COMPANIES that had 500 or fewer employees at the time the LICENCE/OPTION/ASSIGNMENT was signed. For the purposes of this Survey, this does not including <em>NEW</em> SPIN-OUT Companies initiated by your institution during financial year 2002. However it does include <em>EXISTING</em> SPIN-OUT COMPANIES AND <em>EXISTING</em> START-UP COMPANIES established before to financial year 2002.</td>
</tr>
<tr>
<td><strong>SPIN-OUT COMPANIES</strong></td>
<td>As used in this Survey, SPIN-OUT COMPANIES are companies or traders as persons engaged in businesses that were dependent upon LICENSING or ASSIGNMENT of the institution's technology for initiation. If a technology was licensed to an EXISTING SPIN-OUT COMPANY, and not to a NEW SPIN-OUT COMPANY, this company should be counted as an SME COMPANY as opposed to a SPIN-OUT COMPANY.</td>
</tr>
<tr>
<td><strong>SPIN-OUT FTE</strong></td>
<td>SPIN-OUT COMPANIES as used in this Survey, will continue to refer only to those companies that were dependent upon your institution's technology for initiation in the form of a LICENCE or ASSIGNMENT. Person(s) employed in the TECHNOLOGY TRANSFER Office whose duties are specifically involved with the creation of SPIN-OUT COMPANIES in either full or fractional FTE allocation. Examples include business plan development, conducting market research, searching for and securing finance from investors, searching for and securing a management team.</td>
</tr>
<tr>
<td><strong>START-UP COMPANIES</strong></td>
<td>As used in this Survey, START-UP COMPANIES are companies or traders as persons engaged in businesses that were not dependent upon LICENSING or ASSIGNMENT of the institution's technology for initiation. If a technology was licensed to an existing START-UP COMPANY, but not to a newly initiated SPIN-OUT COMPANY, this company should be counted as an SME COMPANY as opposed to a SPIN-OUT COMPANY. START-UP COMPANIES as used in this Survey, will continue to refer only to those companies that were not dependent upon your institution's technology for initiation in the form of a LICENCE or ASSIGNMENT.</td>
</tr>
<tr>
<td><strong>SPIN-IN COMPANIES</strong></td>
<td>Companies originating from your institution, which were predominantly based on a LICENSED or ASSIGNED technology that was generated from outside your institution.</td>
</tr>
<tr>
<td><strong>TOTAL PATENT APPLICATIONS FILED</strong></td>
<td>TOTAL PATENT APPLICATIONS FILED including any filing made during the financial year requested, including provisional applications, provisional applications that are converted to regular applications, new filings, and if applicable Continuations In Parts (CIPs), continuations, divisionals, reissues, and plant patents. Applications for certificates of plant variety protection may also be included.</td>
</tr>
<tr>
<td><strong>TOTAL RESEARCH EXPENDITURES</strong></td>
<td>TOTAL RESEARCH EXPENDITURES include expenditures made by the institution in financial year 2002 in support of its research activities that are funded by all sources including the national government, local government, industry, foundations, voluntary organisations and other non-profit organizations.</td>
</tr>
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