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WORKING PAPER

Institutional Change and the Resource Flows going to Spin off Projects:

The case of IMEC.

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Institutional Change and the Resource Flows going to Spin Out Projects: The Case of IMEC

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 spin-outs at time of founding influenced by the way in which the overall technology transfer process 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 the academic ventures set up between 1987 – 2002. The basic argument of the research is that changes in the internal institutional environment -- and the spin out policy in particular -- co-evolve with a changing overall tendency in the amount of resources endowed to the academic ventures. More specifically, we identify three generations of academic ventures displaying the main organisational changes in technology transfer policies pertaining to spin off companies.

~~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 spin off companies. More specifically, we investigate the interplay between changes in the micro institutional technology transfer policies regarding spin off companies and the resources endowed to these firms. 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, In press; Clarysse and Moray, 2004), only few have looked into the 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 spin off firms.

IMEC, the Inter University Micro Electronics Centre (Leuven, Belgium), now more than 20 years old, 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. 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, nano-technology, 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 fundamental 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 attempts at bringing together these two realms in the context of creating research based spin offs. More specifically, we want to increase understanding as to how changes in institutional technology transfer policies co-shape the resources going to spin off projects.

To anchor the scope of our investigation, we frame questions from three perspectives, each representing a phase in addressing the problem of interest: How is the process of spinning off ventures organised within a large public research institute? How did this process change over time? Do the nature and the origin of resources going to the academic starters 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 research based spin offs 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 academic ventures can be distinguished according to different eras in the management of technology transfer.

2. Context: Research based spin offs from public research organizations

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 spin outs so far has been the lack of a clear definition to start from. In practice, academic spin outs 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[3]. 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 pure "academic spin outs', the co-called IP based spin outs. 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 out 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". These firms which 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

[3] 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).

the provision of capital. The start ups clearly use source learned (but often non protected and therefore 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 outs 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[4] in which they participate have repeatedly presented best practice examples of spin outs 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 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: spin-outs 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

[4] ASTP = Association of European science and technology transfer professionals. See http://www.astp.net

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 insitutional determinants with the spin out rate of universities and research organisations (Di Gregorio and Shane, 2002). 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 ventures 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, finally, if these institutional changes co-exist with changes in the resources endowed to the companies 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-out policy. It has been shown that new academic ventures are most often started in the proximity of or from within research institutes with an excellent research base. 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 academic 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 (Leanord-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[5]. 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 semi-conductor industry since 2001[6], 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 one third with Flemish Industrial Partners. The remaining 24% of the total budget comes as a subsidy from the Flemish Government. IMEC generates the remaining 20% from projects for the European Community, the European Space Agency and other government contracts. The remaining 24% comes as a subsidy from

[5] www.imec.be
[6] www.imec.be/wwwinter/mediacenter/en/generalassembly2002.shtml; accessed May 2003.

the Flemish government. Figure 1 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.

INSERT FIGURE 1 ABOUT HERE

From its inception in 1984, IMEC pursued being an internationally recognised centre of excellence in micro-electronics. 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 Flankers 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 world-wide 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 and spin-out policy. 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 out policies and the spin outs 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 spin out activity of other PROs in the region[7]. 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 contextualisation of 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 spin out activity, the extent to which start up versus spin outs are generated and the amount of start capital the ventures from these institutes attract at time of founding. Second, we have interviewed all senior managers involved in the spin out policy at IMEC. The interviews took place in 2002 and 2003 and the persons interviewed have significant

[7] 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.

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 academic starters 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 outs, 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[8]. 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 academic starters 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 1 provides a summary of the different sources and the respective methods.

INSERT TABLE 1 ABOUT HERE

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 spin outs and high tech starters in Flanders, in terms of start capital, founding team and technology

[8] 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.

development at time of founding. Fourth, we argue that three generations of IMEC starters can be distinguished, mirroring the way organisational technology transfer policies evolved.

~~4.1.~~ Context of academic starters 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[9] (1995). Moreover, since 1998 the PRO legally owns the IP generated from research[10] and government started subsidising the interface services. In this context, PROs set up seed capital funds to facilitate investments in academic starters 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, and the legal fees incurred to protect the university's IP. Table 2 gives an overview of these input indicators for all the Flemish PROs.

INSERT TABLE 2 ABOUT HERE

The Katholieke University Leuven (KUL) and IMEC are the largest research organisations in terms of research expenditure, the size of the technology transfer office and the academic starters generated from their knowledge base. Together, they account for 54% of the academic starters 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 academic starters emerged from Flemish universities and research institutes from 1991 to 2002. The majority of these firms are spin outs (56% or 52 companies) but the start ups represent almost 41% of the total (N=38). Given IMEC's importance as a research institute in

[9] Decree of February, 22, 1995 (B.S. 19 juli 1995)
[10] University decree of August, 29, 1998, art 103 (B.S. 29 augustus 1998); Cfr. Bayh-Dole Act in the US in 1980

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.

The spin out process at IMEC: a centrally led technology push model

This section specifically sheds light on the spin out 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 out? Different activities of a proactive spin out 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 out company. (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 2 serves as a roadmap throughout this section.

INSERT FIGURE 2 ABOUT HERE

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 spin out ideas from a technological point of view. IMEC will establish 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. Ever 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 "spin out activities".
Since the responsibilities for potential spin out projects have shifted over different departments over the years, management of the 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 spin out opportunities. Compared to the Idea Board, this platform has a *commercial orientation*. An idea is considered appropriate for a spin out 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 deem an idea or project feasible for spin out 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 out 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 out. The result of this evaluation is a "Go / No Go" decision: If it is decided that an idea cannot be structured in a spin out (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 VP 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 outs established since 1999, this is always the case and also reflects an increasing structuring and visibility of the spin out process within IMEC.

The spin out 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 FTE). 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 VP and the Project Leader of I&I, the VP of the Financial Department, the VP Business Development and (one of) 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 spin outs are prepared by these project leaders 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 already late from the perspective of developing the business model. Despite IMEC's policy to attract experienced, external management, this has only happened in two companies within the year after founding.

The incubation phase usually takes 12-18 months[11] 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 out and that the incubation costs are discounted. The Enterprise Cell follows up the company after external capitalisation and provides feedback to the VP of the Financial Department.

[11] There is one particular company that, at the time of writing, entered the 24th month of incubation. Venture capitalists could not (yet) be convinced and IMEC decided the invest 1 million € in the company themselves.

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 out companies, the valuation of the IP traditionally happened at the start of the incubation phase through a licensing agreement. Since 1999-2000, IMEC stopped her non exclusive and exclusive "licensing for royalties" strategy towards spin outs 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 a integrated way, instead of only focusing of 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 loosing a complete research stream: a "cash" and "brain" drain IMEC exactly wants to prevent. Fillfactory, for example, a spin out 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[12].

[12] 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.

It is a huge challenge for IMEC to address two broad goals: establishing spin outs 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 mid nineties this model has worked very well with IMEC's corporate industrial partners, since it enables them to develop their own product line independently from each other, even in a environment where competition is fierce. IMEC wants to apply this model in the context of technology transfer to their spin out 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 out 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 out and for the developments, improvements made during this stage. To date, this model has not been applied yet for spin outs.

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 very immature in the early nineties, the "funding gap" (see Cressy, 2002) was a major challenge facing research-based spin-offs. 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 academic starters 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 out 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 1999-2000, 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[13] to stimulate new possible spin out 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 venture 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 bottle neck 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 up to 60% of the required capital[14]. Moreover, due to the small size of IMEC's Incubation Fund, they cannot secure (part of) the follow up financing for the incubated projects. Finding a lead investor for follow up financing is 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

[13] De financial partners are KBC Investco, Fortis Private Equity N.V., Software Holding & Finance N.V. and V.E.M. Chaudfontaine CVBA.

[14] 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)

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[15]. IMEC is actively planning to set up a seed Fund (60 million €), in which the Incubation Fund could be absorbed[16].

Resource Endowments to IMEC ventures

IMEC spun off its first venture in 1986 and up to 2002, 23 ventures were established. Table 3 provides an overview of the population of companies that originated from IMEC up to 2002[17].

INSERT TABLE 3 ABOUT HERE

The majority of these firms are spin outs (14). Table 3 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 in young firms and (high tech) spin out companies in particular (Barney, 1991; Heirman and Clarysse, 2003).

We compare the IMEC ventures to other Flemish academic starters (Moray, 2004) and other high tech start ups (Heirman and Clarysse, 2004) set up from 1991 up to 2002 (table 4).

INSERT TABLE 4 ABOUT HERE

The average IMEC starter 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 academic ventures and high tech start ups 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. Coware, established in 1996 is the only IMEC spin out 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

[15] In total, the Fund invested about 1.2 million € in 2 projects.

[16] The first closing of fund raising is planned during the third quarter of 2004.

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 a legal entity 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 clearly sets out that IMEC ventures are rather unique when we compare them to other academic ventures and high tech start ups established in the same region and time frame. We are particularly interested in how the institutional spin off policies possibly account for this. Since IMEC has developed its spin out policies 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 academic starters.

The interconnectedness of institutional context and resource flows: Three generations of IMEC starters

Following the evolution within IMEC regarding the transfer of IP and the investment policy, we distinguish "three generations" of academic starters 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 and source of capital at time of founding, the mode in which technology was transferred (start up vs spin out), the maturity of the technology at time of founding and some characteristics of the human resources. Investigating the evolution of resource endowment to the companies as the spin out policy changes, we add some more detail to measuring the financial, technology and human resources. For the financial resources, we both look at the founding capital and the capital the ventures were able to attract with 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.

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

[17] 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).

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 complementes with professional business developers. Therefore, we also looked at the extent IMEC researchers were involved in the academic starter and the number of external managers attracted in the venture within 12 months after founding.

For measuring the maturity of technology we adopted Roberts' scale (1991) from basic research (1) becoming increasingly developmental (8) until alpha prototype (9). 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.

Table 5 provides an overview of the resources at time of founding of the three generations of academic starters.

INSERT TABLE 5 HERE

a. First Generation: 1986 – 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. 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 micro-electronics 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 = 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 academic starters were set up), only 1 is still in operation as an independent entity (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.

b. Second Generation: 1996-1998

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 outs (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 life time 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 project" at time of start up[18].

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 outs whereas during the first era only start ups could be noted and the second generation showed a balanced mix of start ups and spin outs. Additionally, these firms seem to start buisness 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 IMEC spin outs 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 seed capital fund). This should enable the spin outs 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 out 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[19]. 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 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 way IMEC transfers research to academic ventures seem to co-evolve with the resources these ventures are endowed during the first year after formal incorporation. But why should be interested in these issues? How do the IMEC ventures perform in terms of multiplying investment value and ensuring employment? These questions are important, since IMEC devotes a lot of time, energy and thus financial resources in setting up these companies. The next section sheds some light on this.

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[18] ITP did invest in 2 third generation IMEC ventures at time of start up: Fillfactory and Septentrio

[19] 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.

Financial-economic added value of IMEC starters

Over the years IMEC strongly developed and professionalized 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? In the next section, we discuss a number of financial – economic performance indicators of these academic starters. Table 6 summarises some performance indicators.

INSERT TABLE 6 HERE

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)[20]. 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[21]. Next to the estimated multiple, we also calculated the realized 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 done, we also calculated the internal rate of return per year for each company and averaged it per generation of starters. 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 IMEC starters set up between 1986 and 1995 generate a little over twice their investment value. A multiple of 2.88 for the first generation starters reflects an estimated gross return of 11,1 % per year on seed and follow up investments[22].

[20] See EVCA Yearbook, 2003.

[21] This is not necessarily the multiple realised by IMEC: this depends on the capital investment of IMEC and their equity position.

[22] Before dedcution of the costs incurred to set up the companies, to incubate them and to participate in different boards of directors.

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 will still be too 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 actually realised investments an average multiple of 3,9 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 (1996-1998) shows a multiple of 1.5[23]. 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 equivalence for the second generation but much lower than the expectation of a professional VC.

b. Exits and employment

From the 23 academic starters that were set up, 14 are 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 25 000 € 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 2500 € public money invested. This is a high contribution to society.

[23] 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.

~~5.~~Conclusion and Discussion

In this study, we offer an integrative perspective on how the spin out process is organised in a public research organisation, which is recognised as being a world-wide centre of excellence in the field of micro-electronics. We also show how the spin-out policy adopted has an impact on the resource flows going to (potential) academic starters.

Spinning out ventures has clearly become an alternative way of commercialising technology in many public research organisations, including IMEC. However, setting up an organisation to implement such a spin-out coaching model 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 over time a structure to enable setting up new ventures.

This strategic choice to stimulate spin-offs had major implications. First, IMEC has been confronted with the need to finance these start-ups. 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. IMEC learned that it had to finance the pre-seed phase itself *or* it had to find public forms of capital.

But 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 for the potential spin-off and to put enough proprietary technology in the spin-off to attract financial investors in this spin-off 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 outs and will have to prove its merit in the years to come.

The third set of resources, next to technology and finance, in which IMEC has invested, are the human resources. Gradually, it has set up a coaching organisation to assist the spin-outs 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 incubation phase.

The main question that emerges is whether IMEC's initiatives have an impact on the type of spin-outs 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 academic start ups and spin outs emerge is often implicitly neglected by lumping together firms from diverse institutional parents, without controlling for these differences. Overall, IMEC spin-offs start at a significantly larger scale than spin-offs from other public research institutes or universities and other high tech start-ups. The differences are the largest for the financial resources (nearly 2 mio € vs 650K vs 250K Euro). Because the population of IMEC spin-offs is biased towards the IT based and – to a lesser extent – micro electronic spin-offs, technology might be a main explanatory variable. However, the lacking group are biotech spin-offs which are normally considered to start at a larger scale (Heirman and Clarysse, 2003). Since IMEC has undertaken most efforts to set up a sound investment system and to attract venture capital, it is not surprising that the IMEC spin-offs start up with a significantly larger capital base. It only indicates the impact of the institutional choices made but does not necessarily indicate that the spin-offs really *need* this amount of money.

Next to the financial resources, we also find that IMEC spin-offs have significantly more founder-entrepreneurs than the other high tech start-ups, but not more than the spin-offs from other public research organisations and universities. Founding teams of 3 people on average seem to be characteristic for spin-offs. 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 researchers are coached by the spin-off team from the technology transfer office for starting a company. The cost benefit question only comes later. As aforementioned, we even observe a lack of heterogeneity in the start-up teams. This is totally different for other high tech start-ups, including corporate spin offs. The latter category usually have two complementary founders, driven by the spirit to start a lean and mean company and become breakeven as soon as possible.

Also in terms of technology, a difference is found although not significant. There is some indication that the IMEC spin-offs like the other spin-offs are started with a less mature technology than the other high tech start-ups. Although the cross sectional comparison of the population of IMEC spin-offs with other spin-offs 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 academic ventures over time.

We have described that IMEC has three generations of academic starters, each reflecting a particular shift in IMEC's IP policy and the investment mechanisms for the projects. Although IMEC's VC fund was not a straightforward success in itself, it raised the interest of other local VCs and baby VCs for the IMEC spin-offs. This is clearly reflected in higher capital levels these ventures were able to attract during the first 12 months of operations (less than 600K Euro for the first generation up to over 3 million Euro for the third generation).

Its change in technology 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 these start-ups and even the number of researchers recruited in the new venture. Whereas the first generation spin-offs were started by researcher-entrepreneurs, who envisaged a nearby market opportunity, the last generation 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 upon a technology that is far from market ready, but seems to be too marginal as a basis for contract research. Instead of having a couple of individuals that want to start a company, the whole research team is transferred to the venture. Of course, the background knowledge stays in the larger research group within IMEC. The transfer of the research team is reflected in a larger number of founders and employees coming from IMEC.

At the human resource site, the changes are too recent to see any reflections in the population of spin outs. We expect these changes to become prevalent in a "next" generation of companies spinning out of IMEC.

Overall, we can conclude that the decisions taken at IMEC to change its spin-off policy *do* have an effect on the type of spin-offs created. The starting configuration of spin-outs has changed as a result of these changes in spin-offs policy. Spin-offs have become larger, start up with more employees and a less mature technology. 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 outs per year. The underlying rationale of IMEC is that in fact the opportunities are there but that an increasing pro active role need to played in recognising these technological and market opportunities in the labs.

Finally, we asked the question whether it really matters. We calculated the multiple (and related IRR) realised by the IMEC spin off population (first generation) and compared it to the multiples found in the venture capital literature. The IRR of 11,8% for the first generation of spin-offs is double the IRR of 5,2% (Murray and Mariott, 1998) which was found to be an average for seed investments in high tech. Still, these financial performances are far 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: yes, 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 which is expected by VCs. As a result, IMEC has major difficulties to convince institutional investors to invest in its own fund.

Further, we observe that from a socio-economic perspective the IMEC spin-offs create a total employment of about 450 full time equivalents. This is significant, but the total employment of a much less time consuming initiative such as the TOP programme at the university of Twente to stimulate spin-offs was about 1200 people in 2001[24]. Total employment created by small

[24] In about 180 companies; see http://people.mech.kuleuven.ac.be/~kgadeyne/marjan/node6.html

start-ups might be higher than employment created by a few large spin off companies. This conclusion opens the floor to set out some policy implications.

6. Policy implications

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 academic starter 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 spin-off 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 decision made, even by the VCs in which the organisation participated as a shareholder, to invest in its spin-offs. 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 universities or public research organisations have to spin-out 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 spin-offs. Usually these people are recruited very late in the process, once most decisions are already made about the concrete market opportunity. Even more important, at the moment of opportunity seeking, no persons with experience in different industries are involved. This is because 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, the most important asset of a start-up – its human resources – has to originate in the organisation's core business. But most universities and public research institutes 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. However, if the government wants to stimulate this, 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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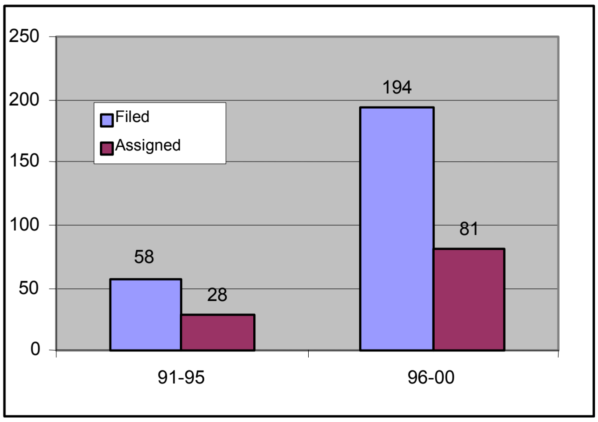
FIGURES AND TABLES

Figure 1: Patent activity at IMEC



Source: Van Helleputte and Robeyns (2003)

Figure 2: The spin off process at IMEC

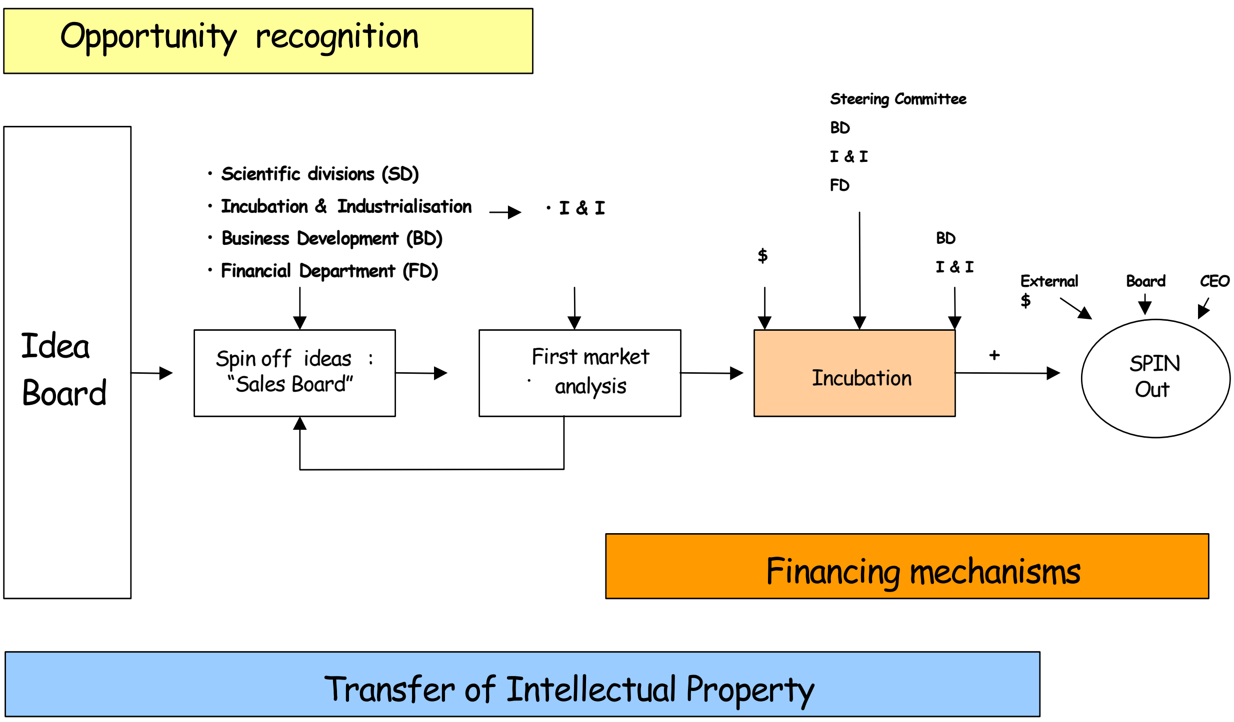


Table 1: Overview of Data Collection

	Face to Face Interviews (N = 40)	Standardized Survey (N=20)	Secondary sources
PRO IMEC Management	**9**	UNICO/NUBS TTO survey **(1)**	Press releases, Year reports, IMEC website
Academic starters (20 since 1991)	**Total: 31**	**Total: 20**	**Longitudinal database of financial data of 23 companies**
2 spin outs set up in 1996	8	Standardized survey	Press releases, Year reports, company website
1 spin out set up in 2002	6	Standardized survey	Press releases, Company website
17 remaining companies	17	Brief phone survey and standardized survey	Press releases, Company websites, Year reports

Table 2: Characteristics of University Industry Technology Transfer in Flemish Universities

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

Table 3: Academic starters from IMEC

Start ups	**Spin outs**
Matrix (1987) (A: Cobrain)	1. C-Cam Technologies (1996) (B)
LCI SmartPen (1992) (B)	2. Target Compiler Technologies (1996)
Soltech (1989)	3. Sirius communications (1996) (A: Agilent Technologies)
JSR Electronics (1989)	4. Coware (1996)
Easics (1991) (A: TransWitch)	5. Frontier Design (1997) (MBO and A: Adelante Technologies)
Destin (1992) (B)	6. Oligosense (1998)
Alphabit (1992) (A: HP)	7. Q-star test (1999)
Ansem (1998, with KUL)	8. Fillfactory (1999)
3E (1999)	9. Septentrio (2000)
	10. Xenics (2000)
	11. Photovoltech (2001)
	12. Vivactis (2002)
	13. Loranet (2002) (B, as incubation company)
	14. Acunia / SmartMove (1996) (B)

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

Table 4: Resource endowments of IMEC starters at time of founding compared to other spin offs and high tech starters in Flanders[25]

		IMEC SPIN OFFS		OTHER ACADEMIC STARTERS		OTHER HIGH TECH START UPS	
CHARACTERISTICS	MEASURES	DATA	N	DATA	N	DATA	N
Capital after 12-18 months (K €) (*)	Mean Median St.dev. Min-max	**1957,2 671,8 2585,8 75 – 9940**	**20**	**688,5 198,3 1362,4 3 – 6000**	**57**	**234,1 61,5 713 0,1 – 5000**	**120**
Number of founders[26] **(*)**	Mean Median Min-Max	**3 3 0-11**	**19**	**2,6 3 1 – 7**	**56**	**1,8 1,5 0 – 6**	**120**
NUMBER OF EMPLOYEES AT TIME OF FOUNDING	Mean Median St.dev. Min-Max	**5 3,5 6 0 – 25**	**19**	**3,3 3 3 0 – 16**	**55**	**4 2 10 0 – 101**	**121**
Maturity of technology (0-3)[27]	Median Min-Max	**1 0 - 3**	**20**	**1 0 – 3**	**55**	**0 0 – 3**	**121**

** Differences between groups significant at p < 0,01(Kruskall Wallis and F test)*

[25] In Flanders, we know the full population of academic starters: 93 ventures were established from 1991 up to 2002. We have detailed data on 77 of these companies. For the "other high tech starters", we use the definition of research based start ups as conceptualised and sampled by Heirman and Clarysse (2004).

[26] Founders are the persons who have a hands-on function in the company AND/OR who have equity at time of formal incorporation.

[27] 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).

Table 5: Resource endowments of three generations of IMEC starters at time of founding

		1987-1995 (N=7)	1996-1998 (N=8)	1999-2002 (N=8)
Financials (mean, K€)	Founding capital	457	293	1621
	Capital after 12-18 months *	594	1163	3026
Technology (median)	Maturity	9	7	5
	Involvement inventor	3	5	5
People (median)	N founders	3	4	4
	Mean experience founders (years)	17,5	35,8	41
	FTE employees	2	3	4,5
	N External management	0	0	0
	N IMEC researchers in company	1,5	1,5	4

*

Difference between groups significant at p< 0,05 (Kruskall Wallis test)

Table 6: Performance indicators of three generations IMEC starters (12/2003)

	1987-1995 (N=7)	1996-1998 (N=8)	1999-2002 (N=8)
Realised multiple (Actual exits)	2,54	0,69	0
Estimated multiple, incl. TS	2.88	1,47	1.9
Estimated IRR	11.10%	8.75%	42.97%
Employment Q3 2003 (N FTE)	48	271	126
Total invested capital, Q3 2003, K €	9,915.40	81,897.90	29,293.65

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