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Overcoming weak entrepreneurial infrastructures for academic spin-off ventures

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ABSTRACT

We discuss the characteristics of academic "spin-off policies" in environments outside of high tech clusters and where technology transfer and entrepreneurship infrastructures have been weak. We explore whether the policies could explain the general lack of growth potential of spin-off ventures that have been repeatedly observed. We studied the case of Belgium, gathering data from nine sets of spin-off policies in the eight largest academic institutions and in forty-seven firms. We propose that spin-off policies in academic institutions significantly affect the growth potential of such ventures.

1. INTRODUCTION

In the 1990s spinning off new ventures from academic labs gained acceptance in Europe as a valid method of technology transfer. Entrepreneurship was also recognized as a key instrument of technology innovation (European Commission 1998, 2000). This was an important change in Europe, where academic

institutions have traditionally considered that technology transfer and commercialization were outside their mission (Owens-Smith et al., 2002) and entrepreneurship has not been as developed as in the USA (OECD, 1999).

Academic spin-off ventures in regions outside established high tech clusters tend to stay small (e.g. European Commission 1998, 2000). Explanations generally refer to macro-structural and cultural factors, but scholars have not extensively examined the spin-off policies that generate these ventures as a possible source of the problems of lack of growth and growth orientation. This is the focus of this paper.

2. LITERATURE REVIEW

Despite changes in policies and new public resources, a recent OECD survey shows that, outside the USA, spinning off new ventures from research institutions has remained a process of technology transfer with minimal impact (Callan, 2001). The conclusions of this survey are summarized below.

- Most OECD countries outside the USA witness the creation of no more than a couple dozen spin-off firms each year.
- The firms' size, growth rates, revenues, and product generation are modest, at least in the first decade of their existence. While a small percentage of spin-offs do blossom into large high-technology firms, a large proportion survive without growing considerably.
- Their failure rate is significantly below national averages.
- Not all academic disciplines equally generate new firms. Academic spin-off ventures are mainly in the biomedical and information technology fields.
- Spin-off firms tend to come from a small number of top research institutions. The support structures on which public spin-offs rely are expensive and not worth developing if an institution does not generate enough intellectual property to justify a professional technology commercialization staff.
- Academic spin-off firms cover a large variety of types of firms and there is not even a clear consensus on the definition of an academic spin-off firm

The OECD survey concludes that the impediments to spin-off formation are not yet well understood as data on financing, growth and life cycles are hard to come by. The characteristics highlighted by the survey are consistent with earlier findings from academic research and policy studies (e.g. Capron and Meeusen, 2000; Chiesa and Piccaluga, 2000; European Commission, 1998; Mustar, 1995; Roberts, 1991; Roberts and Malone, 1996; Segal Quince Wicksteed, 1990, 1999).

Of particular concern is the fact that academic spin-off ventures in regions outside established high tech clusters tend to stay small "boutiques" (e.g. European Commission 1998, 2000). They fail to grow to become global leaders in their market, in contrast to some of the spin-off firms that have emerged in established USA high tech clusters, such as Boston and Silicon Valley (Lee et al., 2000; Kenney, 2000; Roberts, 1991; Saxenian, 1994). This is a problem that has been observed among European new technology-based firms in general (Storey and Tether, 1998).

Various explanations have been posited. Some refer to institutional factors, or what policy makers label "structural deficiencies", such as tax disincentives or regulations representing ob-

stacles to entrepreneurship (Rowen, 2000). For instance, an important deficiency is the underdevelopment of capital markets in Europe, particularly the lack of early stage venture capital (Bannock Associates, 1999; European Commission, 1998; 2000)

Others point out to the divide between academia and industry (Howells and McKinley, 1999). Outside the USA, and indeed within many US institutions as well, academic institutions have until recently considered that technology transfer and commercialization were outside their mission (Owens-Smith et al., 2002).

Some authors further point out that innovative high tech ventures seem to thrive especially in very particular ecologies of which Silicon Valley and the greater Boston area are the archetypes (Lee at al., 2000; Kenney, 2000; Saxenian, 1994). Such environments have, however, proved to be difficult to replicate.

Finally is the argument that certain cultures are less entrepreneurial than others (OECD, 1999). For instance, in some cultures the stigma of failure is higher. In Europe, entrepreneurship takes primarily the form of creating small businesses, known as small and medium size enterprises (SMEs). They are job-substitutes for their founders, or an instrument to pursue other

life style objectives, instead of incorporating growth targets (Timmons et al., 1990:9). The growth-oriented model of ventures only diffused internationally in the late 1990s, during the technology boom, from America's high tech clusters. So, the issue is not only a lack of growth that most ventures exhibit, it is also a lack of growth orientation of most entrepreneurs. For instance, academic institutions in our sample had to confront the issue of how to raise the interest of academics in spin-off initiatives.

All these macro-factors clearly play a role in why European new technology-based firms and academic spin-off ventures fail to grow, a question that has been addressed by policy makers, especially since the late 1990s (e.g. Cincera et al., 2001a; 2001b; OECD, 1999). For instance, at the Lisbon summit in 2000, the European Commission set a new ambitious strategic objective for the next decade "to become the most dynamic and competitive knowledge-based economy" (European Commission, 1999). However, the factors mentioned above represent structural and cultural obstacles that will need multi-year efforts to overcome.

Surprisingly, besides these macro-factors, few have examined the spin-off policies that generate these ventures as a possible

source of explanation for the problems of lack of growth and growth orientation, although it is likely that they have an impact. Indeed, new ventures are typically resource-poor and the academic institutions from which they originate, along with their sponsors, are major resource providers, whether it is early stage funding, space and facilities, intermediation with outside parties, or legitimacy. This dependence is particularly true in regions where there is a weak entrepreneurial community.

Our hypothesis that processes involved in the spin-off policies shape the ventures that they generate is consistent with Freeman's (1986: 33) conceptualization of entrepreneurship as an organizational product. He argues that the pieces necessary to create a new firm are generally outputs of other organizations and are provided by them. Academic spin-off firms are extreme examples of this "genetic" interpretation of organization formation and of entrepreneurship. From the point of view of the growth potential of spin-off ventures, it is important to focus on the spin-off process and on the early phase of firms because venture development is path dependant and initial stages strongly "imprint" future developments (Boeker 1989). It is thus likely, as Roberts (1991) suggests, that

early choices during the incubation phase impact the subsequent growth potential of ventures. If we want to improve the growth prospects of academic spin-off firms, perhaps is there a more *immediate* opportunity for leverage than addressing structural and cultural obstacles.

Thus our research question was formulated as follows. In an environment with a weak entrepreneurial structure and culture, what characteristics of academic spin-off policies could explain the lack of growth potential of spin-off ventures? We approached this question by examining nine sets of academic spin-off policies in eight academic institutions in Belgium, a country that is new to academic technology transfer and to entrepreneurship. Belgium shares a number of characteristics with other "old economy" regions that are trying to adjust to newer technologies and to new modes of technology innovation (Capron, 2000: 32). As in the rest of Europe, in the 1990s, federal and regional governments in Belgium expanded their science, technology and innovation (STI) policies (Cincera et al., 2001a; 2001b). Perhaps even more so than in other European regions, Belgium is characterized by a low entrepreneurial culture (Reynolds et al., 2001).

A starting point of this research project was an isolated source in the literature that had examined academic spin-off policies. Roberts and Malone (1996) propose that two dimensions are key in analyzing spin-off policies: level of selectivity and level of support of academic institutions. They argue that only two academic spin-off strategies work in terms of selectivity and support: either high selectivity and high support strategies or low selectivity and low support strategies. First, the low support-low selectivity policy consists of spinning off many ventures, but with little support. It reduces the cost of spinning off, but seeks safety in numbers. "Choice is left to external agencies (such as venture capital funds) who are generally felt to have greater experience and expertise in 'picking winners' and less potential for conflicting objectives than the R&D organization" (Roberts and Malone, 1996: 41). Second, the high support-high selectivity strategy consists of the university spinning off a few well-supported ventures. It relies on picking potential winners and supporting them to increase their chance as much as possible.

On the other hand, the policy providing low support-high selectivity runs the risk of under-investment in a narrow portfolio.

The policy of high support-low selectivity is seen by the authors as the most risky because most of the investment risks are then made with low potential ventures.

Further, Roberts and Malone argue that low support-low selectivity policies are more fitted to entrepreneurially developed environments, while high support-high selectivity policies are more efficient in entrepreneurially underdeveloped environments. In entrepreneurially developed contexts, such as Boston or Silicon Valley, a strong entrepreneurial community has the capability to select the best entrepreneurial projects and allocate resources to them. Thus, research institutions can adopt a fairly passive strategy. In contrast, in underdeveloped entrepreneurial contexts that lack a strong entrepreneurial community, research institutions need to be more proactive by being selective and providing incubation capabilities to their spin-off projects.

(Insert Figure 1.)

3. RESEARCH DESIGN

Given the scarcity of the literature, we chose for our research a multiple case design susceptible of generating rich insights that could subsequently be tested on a larger scale. We adhered most closely to Eisenhardt's (1989) prescriptions for multiple case studiesWe collected primary, secondary, and archival data from government sources, academic institutions, and spin-of ventures on nine sets of spin-off policies in eight academic institutions.

Insert Figure 2

We interviewed twenty representatives of the eight largest academic institutions, the originating organizations of all but a few spin-off ventures in Belgium.

Insert Figure 3

In order to understand the *actual* practices of the academic institutions in terms of spin-off policies, ventures that had been spun-off were a major source of information. Of the identified population of 106 firms, we interviewed forty-one firms and gathered data on six firms via a questionnaire when interviews were not granted.

Insert Figure 4 and 5.

The representativeness of the academic institutions is strong, because they represent the largest such organizations in Belgium and they account for most of the 106 spin-off ventures. The representativeness of the firms is probably skewed in favor of ventures that adopted a growth orientation, as opposed to SMEs, because founders of the latter were generally less receptive to being interviewed, which is consistent with the SME culture of independence and suspicion of outsiders. However, this bias strengthens the argument developed in this work

With a few exceptions, two researchers were always present during interviews. One took notes during the interview and immediately wrote a report after each interview session. Each document includes both factual data reported by the interviewee and comments linking the specifics of the interview with references to other interviews in an attempt to identify trends.

The research process was recursive in that it included iterations of data collection and data analysis (Eisenhardt, 1989: 542). In this case, the process of data collection lasted over the course of

two years from early 1999 to December 2000 through four major iterations, which were punctuated by data analysis.

A detailed description of the research design and methodology is available in Degroof (2002).

4. ARCHETYPES OF SPIN-OFF POLICIES

In the 1990s, concerns emerged among policy makers that, compared to the USA, Europe was lagging in most technology sectors (Bannock, 1999). As a result, the importance of technology innovation increased in the eyes of European policy makers. The success stories of Boston and Silicon Valley suggested new ways of achieving technology innovation and economic growth (Saxenian, 1994; Lee et al., 2000). Entrepreneurship was at the core of this innovation process, in which academic institutions played a key role (BankBoston, 1997; Roberts, 1991). As a result, European, including Belgian, policy makers devised policies intended to stimulate technology innovation and entrepreneurship and put pressure on academic institutions to engage in technology transfer including by spinning off new ventures.

In analyzing academic spin-off policies, we found it useful to distinguish among three phases in the process of proactive spin-off that we identified inductively: the origination phase, the concept testing phase, and the start up support phase. The origination phase includes the genesis of the spin-off process. This phase highlights, for instance, how the opportunity was identified (by the individual initiative of an entrepreneurial scientist, or by a pro-active search for a technology opportunity within the research institution). At this point a first selection occurs. This is followed by the concept-testing phase, during which the opportunity is tested from a technical, an intellectual property, and a business point of view. This phase stops when there is a confirmation of the business opportunity that is often materialized by a new round of funding. At this point, the start-up support phase starts and the business opportunity is exploited.

(Insert Figure 6.)

Summary data on the spin-off policies that we observed are presented in appendix 1. The detailed analysis of nine spin-off

policies in eight academic institutions suggests that some of them share characteristics: a few archetypes of spin-off policies emerge.

In starting from the less developed to the more developed process, we distinguish four archetypes of spin-off policies. *(Insert Figure 7).*

4.1 First archetype: Absence of proactive spin-off policy

This archetype characterized all but one of the academic institutions prior to 1996 and three out of eight academic institutions in the period 1996 to 2000.

Origination phase. In the absence of pro-active technology transfer policy in an academic institution, the spin-off process was driven only by entrepreneurial scientists. The creation of a spin-off project resulted from the work experience of one or a few scientists, who perceived a commercial opportunity derived from their research work. The opportunity was commonly identified by industry participants in the research project or clients for whom the scientist(s) performed R&D or technical consulting work from within their lab. The venture creation typically happened following an in-

crease in demand for the service that could no longer be handled within the research lab.

Concept testing phase. The business project was, however, generally modest and often took the form of a direct extension of the contract-based work performed by the lab.

Ventures that emerged from such process generally represented a substitute for a job for their founders or a vehicle to pursue lifestyle objectives rather than entrepreneurial objectives incorporating growth.

(Insert Figure 8.)

4.2 Second archetype: Minimalist support and selectivity

Universities that initiated a technology transfer policy, in the late 1990s began developing a proactive spin-off process with minimum support and selectivity. This was the case of three universities in our sample and of two other smaller ones outside the sample that we did not study in detail.

Origination phase. The new technology transfer policy did not include proactive technology opportunity search: the identification

of a potential spin-off opportunity relied on individual scientists. In the absence of this search capability, these universities relied more on internal public relations campaigns encouraging researchers to submit entrepreneurial projects and advertising the resources available, mainly in the form of newly available seed funding. In this early phase of implementation of a spin-off policy, the academic institutions more likely encouraged spin-off policy initiatives than acted selectively in choosing projects to support. Indeed at best no more than a couple entrepreneurial initiatives began each year. Consistent with a weak entrepreneurial environment, academics generally showed little interest in commercializing the findings of their research. Policies of these academic institutions and of government agencies consisted of encouraging scientists to become entrepreneurs, instead of attracting people from the business world to exploit the commercialization of technology.

Intellectual property assessment slowly emerged as an intrinsic part of the process, in part because academic institutions obtained ownership in 1999 of the intellectual property of publicly funded research. This followed the much earlier lead of the United States Bayh-Dole legislation (Owens-Smith, 2002). Thus, in the

late 1990s Belgian universities were just beginning to acquire some intellectual property expertise. This generally translated into hiring one person with some background in that area or in subcontracting to an outside firm. Business assessment and selectivity of the opportunity by the academic institution was limited because of a lack of internal capabilities; the primary concern of universities during these initial years of support for spin-off initiatives was to generate projects rather than being selective.

Concept testing phase. Academic institutions supported little concept testing before the ventures were founded. Assistance in writing a business plan was limited, sometimes consisting only of providing the potential founders with a template for a business plan. Resources for product development and market test were not available. Rarely did the academic institutions attempt to expand the founding team beyond the original scientists and the board beyond the founders and a representative of the university or its investment fund. The main form of support was the provision of seed funding.

Ventures were financed with the help of a seed fund set up by academic institutions, generally with public and sometimes pri-

vate financial partners. In one region the government also subsidized a two-year leave of absence for researchers to conduct a feasibility study of spin-off projects. Besides the provision of seed funding, founders were largely left on their own, in spite of their lack of business experience. Ventures were founded at a very early stage when the entrepreneurial project of the founders was still vague and its main asset consisted of scientific knowledge. Thus, the concept-testing phase happened, for the most part, after founding without the involvement of universities.

Universities that initiated spin-off process with minimal selectivity and support typically had a view of entrepreneurship that was much more infused with the SME model of ventures than with the growth-oriented mode of ventures. They also exhibited a conservative approach to venturing and typically compelled founders to submit business plans showing rapid positive cash flow. In so doing, they pushed founders even more to adopt a contract-based business model, often consulting. Universities were understandably not very well equipped to provide support to spin–off ventures, but they also pressured founders not to seek support outside the

university and thus contributed to their isolation and the fragmentation of a potential nascent entrepreneurial community.

Insert Figure 9.

4.3 The third archetype: Intermediate support and selectivity.

This process involves more selectivity and support. It appeared in one university after 1999, after it had experimented for a few years with little success with the prior model of a spin-off process of minimal support and selectivity. The new policy, initiated around 2000 – 2001, involved a more proactive technology transfer policy consisting of building up internal capabilities in intellectual property and in business opportunity assessment and testing. It also involved efforts at structuring the nascent local entrepreneurial community into a support network and at building bridges with a more advanced entrepreneurial cluster overseas.

Origination phase. The origination process is based on an original organization of research, which separates the organization and the budget of contract-based research under the responsibility of an office of technology transfer, apart from the organization and

the budget of the university. This gave more independence and resources to the office of technology transfer than in other universities. The university experimented with two systems of proactive technology opportunity search but with mixed success. By the end of 2001, it still largely relied on individual initiatives. This example may point to the difficulty of conducting proactive opportunity search in a university setting. By 2001, its technology transfer unit included five professionals involved in intellectual property management and business assessment. Its capability to assess business opportunities relied in part on this internal capability and on structuring the nascent local entrepreneurial community and seeking its support. This represented a departure from other universities, which did not benefit from a nascent entrepreneurial community, but did not reach out to local business either.

Concept testing phase. The major change in the spin-off process followed at this university after 1999 is that more support was provided for the concept-testing phase before ventures were founded. This appears to be due to lessons drawn in the prior years from disappointing spin-off experiences with firms spun off after too little concept testing of their business idea and the uni-

versity's realization of the importance of the concept-testing phase in terms of support and selection. It also seems to be due to the need felt by this university to push founders to target more ambitious opportunities than the small businesses they were usually tempted to create. Finally, as the global internet – telecom technology bubble collapsed, the financial partners in the university's investment fund required more proof of concept from spin-off projects seeking funding. The change thus translated not only into more support, but also in higher selectivity. It materialized into small financial support of EURO 30,000 to 50,000 from the university's technology transfer office for business concept testing, such as product development or market testing, while potential founders were still on the university's payroll.

Start-up support phase. The university indirectly got involved in providing support for the start-up support phase, primarily by creating, along with another local research institutions, a network among the nascent high tech community, including about thirty of its own spin-off ventures founded over two decades. It also initiated links of this network with Cambridge Network, a similar entrepreneurship forum in Cambridge (UK), which was used as a

template to create the Belgian forum. This nascent community further benefited from the proactive development by the university of a science park, soon to be complemented by two others.

Insert Figure 10.

This spin-off model is the first among Belgian universities to exhibit a wider range of support mechanisms and to exercise selectivity. It is also the first that opened up to outside supportive communities, both locally and internationally.

4.4 Fourth archetype: High support and selectivity

A fourth model of proactive spin-off process was implemented outside universities by two specialized research institutes. In contrast to universities that were all at least one hundred years old, these institutes were established respectively in 1984 and 1995 by a regional government as part of its Science Technology and Innovation (STI) policy with a strong mandate for technology transfer. These research institutes are umbrella organizations for research in microelectronics and biotechnology. The older of the

two was the first academic institution to attempt to spin-off ventures proactively in the late 1980s and early 1990s, but had little success given its lack of experience and the absence of risk capital. A more systematic policy appeared in 1996, when risk capital became more available.

The origination phase. Both institutes put in place a particular organization of research with a strong emphasis on technology transfer. They developed procedures for a proactive technology opportunity search of research findings with commercial potential. This task turned out to be more effective than in universities, probably in part because the specialized research institutes were dealing in one scientific area in contrast with universities whose research spanned a large number of sectors.

With their strong endowment, the two research institutes could put in place strong intellectual property capabilities to evaluate the technical potential of opportunities. One had a staff of twenty people in its technology transfer unit by 1999, while the second had a team of seven intellectual property professionals. Thus their capability to assess the potential of a technology early

on in terms of intellectual property was strong, in contrast to the universities.

Their ability to assess the business potential of the technology was more difficult to evaluate. It probably relied in part on their extensive local and international network, which extended beyond academia to industry and the venture capital community. The teams in charge of technology transfer concluded this origination phase of the spin-off process by selecting technologies that they believed had great business potential worth testing. If there was no existing local firm able to exploit the opportunity through licensing, they considered transferring the technology by creating a spin-off venture, but only if the potential was high enough to be able to attract venture capital from the outset.

The concept-testing phase. The concept-testing phase translated into incubating the spin-off project during a period of twelve to eighteen months. It involved work on the defense of intellectual property by the institutes' technology transfer teams. The business side of the concept-testing phase was generally delegated to one or two persons with industry or policy experience, who were hired in a consultant capacity with the prospect of becoming part of man-

agement of the future venture. It included, for instance, business plan development, product development, and market research, as well as assembling a potential management team and board. The concept-testing phase also relied on the institutes' extensive international network in academia and industry.

The objective pursued in the concept-testing phase was to create enough proof of concept for the project that it would be eligible for newly available venture capital. Ventures were only founded at the end of this concept testing phase when they had a technology that was intellectually protected, a business plan that demonstrated its strong market potential, a convincing business model to exploit it, and, finally, a management team able to carry out this project. Because the institutes targeted venture capital as funding sources, the selection was very severe. Not only do venture capitalists invest only in the most promising firms, but also the spin-off ventures of the institutes needed to compete internationally with others for the funding. Thus, in contrast to a university setting, funding was much more competitive. In 2001, after venture capitalists became more conservative, one of the institutes formed a seed stage fund with financial partners from the banking

sector to overcome this new financial gap and bring ventures to the higher level of proof of concept required by venture capitalists.

The start-up support phase. The start-up support phase was primarily carried over by the management team put in place with the help of its financial backers, as well as the firms' board members and advisers. The institutes also contributed, however, primarily through their local and international network in academia and industry. After 2000, when the venture capitalists became more conservative, one of institutes created a seed fund, in partnership with two local financial partners, to help its spin-off ventures reach the stage of proof of concept required by venture capitalists. It also created an industry specific network involving large and small firms and it joined a local entrepreneurship forum, along with another academic institution.

Insert Figure 11.

Using Roberts and Malone's (1996) view of spin-off policies in terms of selectivity and support, we could represent the observed spin-off policies as follows.

Insert Figure 12.

5. IMPLICATIONS OF SPIN-OFF POLICIES ON GROWTH POTENTIAL OF VENTURES

What are the implications of these academic spin-off policies on the growth potential of ventures?

In this type of environment with weak entrepreneurial culture and infrastructure, policies providing no or minimal selectivity and support, which represent the majority of cases in Belgium and probably in Europe (see Figure 12) have significant impact on the growth potential of spin-off ventures.

First, Roberts and Malone (1996) suggest that low selectivity implies a low average potential quality of the ventures being spun-off. This paper also proposes that low support implies that academic institutions spun off ventures at a very early stage of development, when their main asset was some form of scientific knowledge, but when founders had little concrete idea on how to commercialize it and turn it into a viable business model. As a result, the only option for founders was to adopt a very simple business model consisting of performing contract-based work, often in the

form of consulting, which was a close extension of the work they had performed in their lab. Prior to the early 1950s a similar pattern was followed by most spin-off ventures from M.I.T.

Thirty-two out of forty-three firms classified in our sample indeed never performed concept testing beyond the stage of contract-based work and tried to develop a more scalable business model. We ranked these ventures as traditional SMEs (see appendix 2). Streamco illustrates such a case (see appendix 3)

We also saw a small number of firms, which departed from the SME model. There were only seven such firms in our sample, all founded after 1995 (see appendix 2). A few founders pushed concept testing further in order to find an opportunity with greater potential. Spin-off policies that involve little support push most of the burden of the concept-testing phase to after the founding of the venture. So, these founders needed to complement their scientific expertise with market knowledge by experimenting through their contract-based work as there were so few models or templates available locally, due to the weak entrepreneurial community and the weak incubating capabilities of their originating academic institutions. The founders needed to experiment by themselves, for

instance, with refining their product, selecting a market niche, and finding a viable business model in general. It was a learning process that was characterized mainly by experimentation, which was thus slow.

In other words, these ventures needed to go through a "gestation period" of experimentation. Such a period could sometimes last several years. Although founders of these ventures hoped to build a firm that would grow beyond the SME model, growth was not an immediate opportunity. Instead, their focus was on learning basic business skills and figuring out a viable business model. This is why we propose to label these ventures "growth oriented ventures in gestation." This observation is similar to the "soft start" described by Segal Quince Wicksteed (1990) in their description of ventures in the high tech cluster of Cambridge, England in the 1980s. The main challenge of such ventures in their early stage was to succeed in their concept-testing phase while operating as a business. Magnes illustrates such a case (see appendix 3).

The main implication in terms of lack of growth potential of spin-off policies involving no or minimal selectivity and support can be summarized as follows.

(Insert Figure 13)

In contrast to the above university cases, the four ventures spun-off by the two specialized research institutes, following a spin-off policy involving the highest selectivity and support, reflected at founding the most growth oriented model. They had the highest capitalization, the most complete and experienced founding team, the most experienced investors and board members, and pursued opportunities with the most potential, the model of technology ventures that is common in USA high tech clusters. They organized their comprehensive spin-off process to make their spin-off ventures eligible for venture capital from the outset. Fullsoft illustrates this case (see appendix 3).

6. IMPLICATIONS FOR FUTURE ACADEMIC SPIN-OFF POLICIES

Our data provide some evidence that support Roberts and Malone's (1996) prediction that environments with weak entrepreneurial infrastructure and culture require academic spin-off policies involving high selectivity and high support in order to generate

growth oriented ventures. The data provide further evidence that spin-off policies of weak selectivity and weak support are not likely in such environments to produce growth-oriented ventures.

However, in the cases that we studied, and probably in many instances of weak entrepreneurial regions, at least in Europe, Roberts and Malone's (1996) recommendation to use high selectivity and high support spin-off policies represent an ideal to achieve rather than an immediately accessible policy. The detailed examination of the processes required by such spin-off policies, indeed, highlights that such a policy requires considerable resources to which individual academic institutions seldom have access, as the present cases illustrate. The three-stage framework proposed above to represent a proactive spin-off process highlights this argument. *(Insert Figure 14)*

This suggests that, at the minimum, academic institutions consider alternative strategies, such as partnerships with other actors in certain phases of the process. For instance, it seems that scale is a problem for a number of universities. Putting in place an infrastructure supporting technology transfer and spin-off initia-

tives is costly and justified only if the “deal flow” exceeds what most universities have. For instance, since 2000, two smaller Belgian universities have closed their investment fund without having made a single investment. This issue of scale advocates for partnerships and pooling of resources among academic institutions.

It also suggests that most individual academic institutions may not be well suited to select and support spin-off ventures with high growth potential in such an environment. This is supported by the fact that academic institutions that spun off the ventures with the most potential were the umbrella research organizations and not the individual universities. Unless universities are willing to pool resources in order to develop high selectivity and high support policies, unlikely given their individualistic approaches, policy makers should probably consider putting in place an alternative structure to support such a scale-sensitive policy.

In the meantime, the Figure 14 framework can be used by administrators of academic institutions and by policy makers as a diagnostic tool to assess spin-off policies targeting the creation of growth oriented ventures. The framework can also be used as a management tool by linking each stage with the resources neces-

sary to fulfill each of its functions, highlighting what is missing at each stage. For instance, it may help to highlight that an academic institution has sufficient financial resources, but lacks relevant social networks in the scientific and/or business communities. Alternatively, the university may have social networks that are appropriate for the origination phase, but not for the concept testing phase.

In addition, if academic institutions experience resource constraints and cannot fill these gaps in resources, the framework can help determine what policies are possible given these limited means. For instance, if an academic institution has no means to exercise selectivity and conduct concept testing in the form of market test or product development, its immediate options are probably limited to encouraging the emergence of a vibrant SME population.

7. CONCLUSIONS

Our research examined whether spin-off policies affect the growth potential of academic spin-off ventures in environments

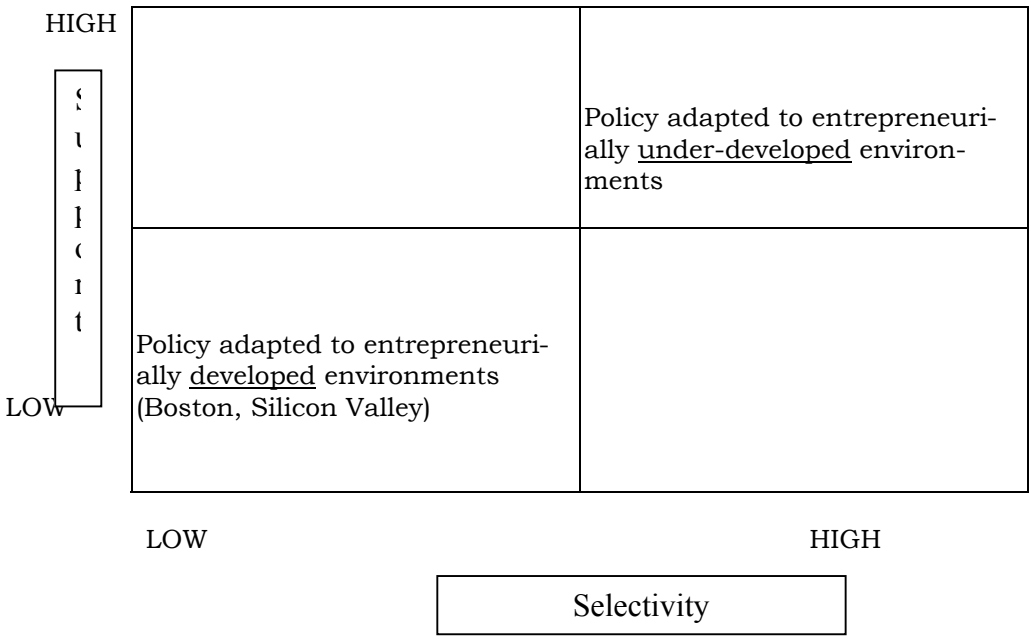
with weak entrepreneurial culture and infrastructure. Data indicate that these spin-off policies may indeed have an impact beyond macro structural and cultural obstacles to entrepreneurship, influencing the growth orientation of the ventures. Specifically, as predicted by Roberts and Malone (1996), spin-off policies involving high selectivity and high support seem better able to generate ventures capable of exploiting opportunities with high potential. Secondly, spin-off policies with low selectivity and low support predispose ventures to adopt an SME format. Under the circumstances, founders who want to build a firm that goes beyond the small business model may need to go first through a long transitory gestation period of experimentation, during which they are prone to fall into the consulting trap.

This analysis reveals that spin-off policies involving high selectivity and high support indeed appear more suited to environments with weak entrepreneurial infrastructure and culture, but to put in place such policies requires resources that are out of reach of most individual academic institutions in such regions. The data suggest that most academic institutions consider creative partnerships to overcome limitations faced by individual institutions. They

also raise the question of whether spin-off policies should not be conducted at a more aggregate level than the individual research institution?

The generalizability of these insights remains to be established by studying more cases in other regions. Such an endeavor would be worthwhile because common characteristics of regions outside high tech clusters suggest that generalization of the present observations might well be possible.

Figure 1. Academic spin-off policies and types of entrepreneurial environments



Source: Adapted from Roberts, E. and D. Malone (1996).

Figure 2. Type of data gathered

Organization	Interview	Archival data	Secondary data
GOVERNMENT ORGANIZATIONS	Y	Y	Y
Direction Générale de la Technologie, de la Recherche et de l'Energie (DGTRE)	Y	Y	Y
Erasmus European Business and Innovation Center	Y	Y	
Institute for Science and Technology (IWT)	Y	Y	
ACADEMIC ORGANIZATIONS	Y		
No. 1	Y		
No. 2	Y		
No. 3	Y	Y	
No. 4	Y	Y	Y
No. 5	Y		
No. 6	Y	Y	
No. 7	Y	Y	
No. 8	Y	Y	
Other	Y		
Other	Y	Y	
Other	Y		
VENTURES			
Androme	Y		
ANSEM	Y	Y	Y
ATC	Y		Y
Belsim	Y	Y	Y
Biocode	Y	Y	Y
Coware	Y	Y	
CropDesign	Y	Y	Y
Data Analysis Products	Y	Y	Y
Destin	Y	Y	
Easics	Y	Y	
Elias	Y	Y	
Elsyca	Y	Y	Y
Epas	Y	Y	
Eurogenetics	Y		
Eurogentec	Y	Y	

Organization	Interview	Archival data	Secondary data
Eyetronics	Y	Y	Y
Fillfactory (*)	Y	Y	
Gamma	Y	Y	
Horpi Systems	Y	Y	
Hypervision	Y	Y	Y
ICOS	Y	Y	Y
IMO	Y		
Iris	Y	Y	
ISMC	Y	Y	Y
Krypton	Y	Y	Y
Lambda X (*)	Q		Y
Lasea	Y	Y	Y
Materialise	Y	Y	Y
Metalogic	Y	Y	Y
Metis	Y		Y
Metris	Y	Y	Y
Microbelcaps	Y		Y
Micromega (*)	Q		
Mithra Pharmaceuticals (*)	Y		Y
Netvision	Y	Y	Y
Neurotec	Y		
Octalis	Y	Y	
Oligosense	Y	Y	Y
Optidrive	Y	Y	Y
Optimal Design (*)	Q		
Organic Waste Systems (*)	Q	Y	
Polyflow	Y		
Septentrio	Y	Y	
Sinvaco	Y	Y	Y
Stag	Y		
Telemis	Y		
Unisensor	Y	Y	

For more details, see Degroof (2002)

Figure 3. Data on academic institutions

Academic Institutions	Number of Students (a)	Number of personnel (b)	Patents (c)	Number of Spin-off firms (f)
No.1	22,052	3772	10	14 (5)
No.2	8,894	1,757	0	4 (1)
No.3	17,502	3,035	9	6 (1)
No.4	28,058	5,358	23	31 (15)
No.5	20,966	3,613	16	10(5)
No.6	13,385	3279	4	19 (11)
No.7	NA (d)	NA (d)	0 (e)	12 (3)
No.8	NA (d)	NA (d)	35	2 (1)
Other				8 (5)
Total	110,857	20,814		106 (47)
Out of a total for the coun-try of	134,402	25,452		

(a) Source: Universitaire Stichting, Fondation Universitaire (website), extract of Nauwelaers (2001)
(b) Same
(c) Source Capron and Cincerra (2000b:181): EPO patent applications (1980 – 1996)
(d) These data do not apply to academic institutions No.7 and No.8, because they are umbrella organizations of university labs.
(e) Academic institution No. 7 was only founded in 1995.
(f) Number in parentheses represents number of firms interviewed.

Figure 4. Founding of academic spin-off ventures over time

Year	Number of ventures
1979	1
1980	0
1981	1
1982	2
1983	5
1984	2
1985	1
1986	6
1987	3
1988	6
1989	6
1990	2
1991	6
1992	7
1993	1
1994	4
1995	6
1996	5
1997	9
1998	9
1999	11
2000	12

Figure 5. Descriptive data on spin-off ventures

Academic Institution	Number of Ventures Interviewed	Total Number of Ventures Spun-Off (end 2000)
No. 1	1	6
No.2	1	1
No.3	4	5
No.4	16	40
No.5	5	14
No.6	10	19
No.7	3	13
No.8	1	2
Others	6	

Figure 6. Proposed framework to analyze academic spin-off processes

ORIGINATION Opportunity identification	**CONCEPT TESTING** Opportunity testing	**START-UP SUPPORT** Exploitation of opportunity
• Opportunity identification • Opportunity selection	• IP protection testing • Business concept testing • Selection	• Internal advising capabilities • Network support

Figure 7. Number of types of spin-off policies observed

Types of spin-off policies	**Number of processes observed**
Absence of policies	3
Minimal selectivity / support	3
Intermediate selectivity / support	1
Comprehensive selectivity / support	2

Figure 8. Summary of first archetype: absence of proactive spin-off policies

Origination Phase	Concept testing Phase	Start-up support Phase
• **No institutional support** • Individual initiatives of researchers often resulting from interaction with industry	• **No institutional support** • Performed by researchers. Minimal: simple extension of consulting or R&D work performed for industry within the university	• **No institutional support**

Venture creation at early stage

Figure 9. Second spin-off archetype: minimal support and selectivity

Origination Phase	Concept testing Phase	Start-up support Phase

• **Opportunity identification:** Individual initiatives of researchers + PR campaign of universities
• **Opportunity selection:**
  • Focus on encouraging spin-offs rather than on selectivity
  • Nascent IP capability
  • Very limited capability for business opportunity selection
	• **IP protection**
	Nascent IP capability – not always relevant because many cases without IP transfer
	• **Business concept testing:** Minimal
	• **Selection: Minimal -** encouragement rather than selectivity.
		• **Internal advising capabilities:** none or limited
		• **Network support:** some at No4 through financial partners. Otherwise insulation from industry

Venture creation at early stage

Figure 10. Third spin-off archetype: intermediate support and selectivity

Origination Phase	Concept testing Phase	Start-up Support Phase
• **Opportunity identification** Attempts at pro-active opportunity search. • **Opportunity selection** Growing selectivity: pressure founders to submit more ambitious business projects	• **IP protection** Growing IP capability • **Business development:** Market research – product development within university structure • **Selection** Emerging selectivity through more extensive concept testing	• **Internal advising capabilities** Unclear • **Support network:** - Structuration of nascent local entrepreneurial community and establishment of external links - Through financial partners

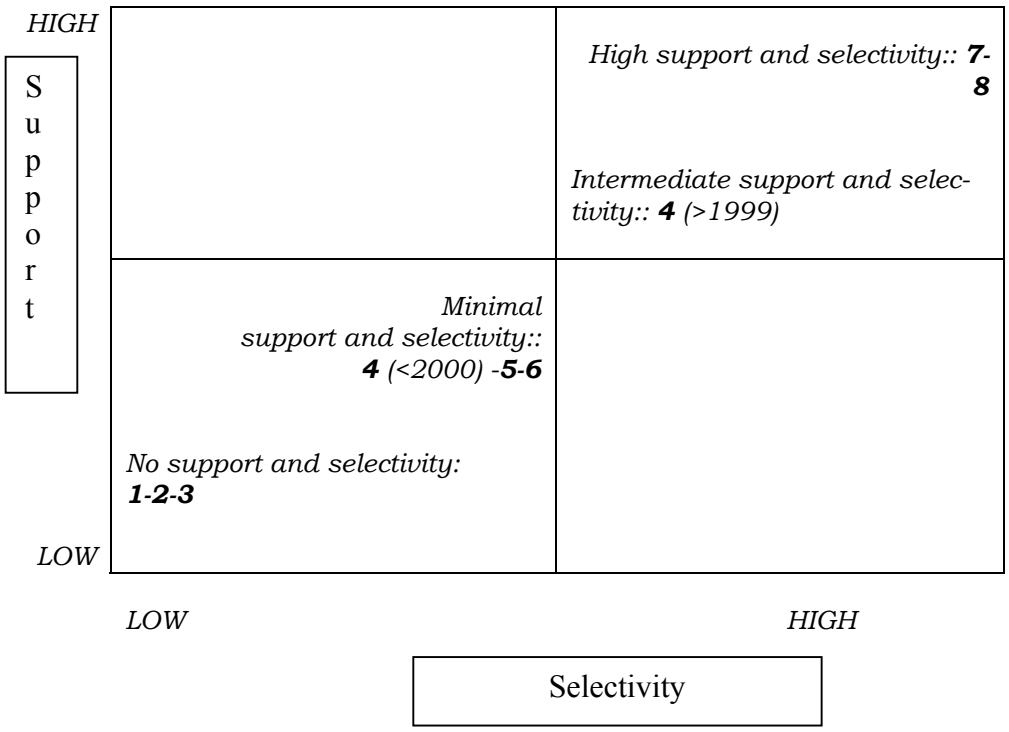
Firm creation at later stage of concept testing

Figure 11. Fourth spin-off archetype: comprehensive support and selectivity

Origination Phase	**Concept testing Phase** *12 – 18 month*	**Start-up Support Phase**
• **Opportunity identification** Pro-active opportunity search. • **Opportunity selection**. - Strong IP capability - Very selective – specific criteria for transfer of technology via spin-off strategy versus licensing	• **IP protection testing** Strong IP capability • **Business concept testing** Market research – product development with help of outside consultants • **Selection** Strong selectivity: target VC funding	• **Internal advising capabilities** Research collaborations of research institute with spin-offs • **Support network:** - Local network + strong international network of the research institutions and their partners - Firm's management, board advisors, shareholders

Venture creation at later stage with comprehensive proof of concept

Figure 12 Rating of academic spin-off policies in terms of selectivity and support (*)



Source: Adapted from Roberts, E. and D. Malone (1996)

(*) Numbers in Figure refer to specific academic institutions in our study sample

Figure 13. Third spin-off archetype: intermediate support and selectivity

Origination Phase	Concept testing Phase	Start-up Support Phase
		•
		•
		•

Firm creation at early stage after little concept testing

Adopt local model of venture SME - no growth orientation

Most concept testing must occur after founding

· Long gestation period

Figure 14. Stages of the spin-off process and necessary resources

•	**ORIGINATION**	**CONCEPT TESTING**	**START-UP SUPPORT**
	• Opportunity identification • Opportunity selection	• IP protection testing • Business concept testing • Selection	• Internal advising capabilities • Network support
	RESOURCES		
Technical	Research capabilities; management of research; IP capabilities	R&D capabilities; IP capabilities Business due diligence and planning skills	R&D capabilities; business development and management skills
Financial	R&D financing; investment in TT	Innovation grants; seed financing; investment in TT	Early stage VC; growth-stage VC
Human	Scientists; TT specialists	TT specialists; business coaches	Scientists; management; board members; advisors
Social	Scientific network	Scientific network; network in industry and in the entrepreneurial community	Scientific network; local and international network in industry and in the entrepreneurial community.

APPENDIX 1

1. First spin-off policy archetype: no selectivity and support.

With the exception of academic institution No7 (and of course No8, which was founded only in 1995), universities had no policies of technology transfer and some, such as No4 and No5 viewed spin-off initiatives of researchers or faculty members negatively. Even after between 1995 and 2001, when interest of policy makers increased for technology transfer and especially for spin-off initiatives, three out of the eight academic institutions had no policies in place. Academic institution No1 did not have a spin-off policy. No2 had only had one spin-off initiative among its members. As a result, it did not consider that it was worth putting in place resources and devising a policy. It decided to send candidate entrepreneurs to an outside consultant for assistance. Finally, No3 created an investment fund with financial partners in 2000-2001 towards the end of the data collection period. During the period under review, the fund did not make any investment and the university did not support any spin-off project. All the firms spun-off from No3 were created under conditions of no selectivity and no support.

2. Second spin-off policy archetype: limited selectivity and support.

1.2 Summary data on academic institution No. 4

Up until 1997 academic institution No. 4 had a passive policy towards academic spin-off ventures. Unlike other Belgian universities, however, it did not oppose the few individual initiatives of researchers to found academic spin-off ventures. In 1997 it adopted a new proactive policy that translated into enlarging the mission of its division dealing with contract research to include the

support of the creation of academic spin-off ventures. This division started to actively encourage its members to get involved in entrepreneurial projects aiming at commercializing research by the establishment of new ventures. A major development was the establishment of a seed fund in partnership with two major local banks to create a EUR 6 million investment fund. The aim of the fund was to make first round individual investments in the range of EUR 200,000 – 250,000 in new ventures spun-off from the university.

Origination phase. The identification of technologies with commercial opportunities relied on individual initiatives of entrepreneurial researchers. These initiatives were encouraged by public relations campaigns of the university advertising the support available for entrepreneurial projects, primarily seed funding. The focus of the academic institution was more on encouraging entrepreneurial initiatives in a context where academics had little interest in that area, rather than selecting the best projects. Also, the university had little capability for assessing commercial opportunities and selecting projects.

Concept-testing phase. The university had an embryonic capability in intellectual property management with only one dedicated person. (We observe here that the number of IP staff is by no means the only or even the best indicator of an institution's capability for assisting in the development and management of intellectual property. However, this number was readily available over time in all of the universities we studied and therefore is used here as a proxy for IP capability.) Since most venture projects did not involve much transferred intellectual property anyway, the concept-testing phase did not include much IP management. The concept testing of the business aspect was minimal, with the university providing potential founders with a template of a business plan. The business opportunities identified by the researchers were generally limited to extending technical consulting work from contract-based work already performed from within the university lab. Again, at this stage, selection was less of a concern for the university than encouraging entrepreneurial initiatives, even if they were modest and not well tested.

Start-up support. The university did not provide any start-up support once ventures were founded, other than a distant supervi-

sion at the board level. It had hoped that financial partners in the seed fund would have been more involved, but this did not turn out to be the case.

A major consequence of such a spin-off policy was that ventures were created at an early stage when founders had only a vague idea of the commercial potential of their technology and how to exploit it. As a result, ventures tended to take the form of technical consulting firms.

1.2 Summary data on academic institution No. 5

Around 1999 academic institution No. 5 changed from a negative attitude towards spin-off initiatives to a more supportive one. In 1999 the university created an investment fund and hired one person with a background in intellectual property management in industry. In 2000 this university initiated “strategic partnerships” with industry that offered synergy, whereby the university lab takes over the research part of the project. In 2001 the university broadened the scope of the original fund structure to include the management of intellectual property at the university. The objective was to foster patenting and licensing that had not been actively pursued until then (only 16 patents between 1980 and

1996). The technology transfer unit grew to five staff members by 2001. The university also encouraged candidate entrepreneurs to take advantage of a new subsidy of the regional government that funded researchers for one year to explore the feasibility of their entrepreneurial project.

Origination phase. No proactive technology opportunity search existed. Identification of the commercial potential of a technology depended on initiatives of researchers. The academic institution did not exercise much selectivity among venture projects, because its concern was more on encouraging projects in a context where very few researchers were interested in entrepreneurship. Support for spin-off projects translated primarily into public relations campaigns encouraging researchers to embark on entrepreneurial projects.

Concept-testing phase. Concept testing of intellectual property occurred when the spin-off project involved technology transfer. Concept testing of the business potential was, on the other hand, extremely limited, due to little capability within the university and to its isolation from industry circles. At this stage the policy also seemed to target generation of spin-offs rather than se-

lecting and targeting ambitious projects. Also, typical of universities was the fact that, without incubating capabilities, ventures were spun off at a very early stage. Support consisted primarily of providing various sizes of seed and of expansion funding depending on the size of the spin-off project. Its own funding was often coupled with a subsidy of the regional government. On the other hand the university discouraged founders from seeking funding from outside sources.

Start-up support phase. Once the ventures were spun-off, the university provided no support. Its requirement to own a majority of shares in ventures and to exclude other investors cut off ventures from alternative sources of start-up support and reinforced the isolation of the founders.

As a result of this process, firms were created at a very early stage with little proof of concept. Before growth could become a priority those founders targeting more than a technical consulting business model needed to go through a lengthy gestation phase consisting of learning basic business and management skills. They had to experiment in isolation with management skills and business models.

From the mid 1980s to the end of 2000, the university had spun-off fourteen spin-off ventures (including 4 in 2000).

1.3 Summary data on academic institution No. 6

Until 1996 spinning off new ventures from this university was explicitly prohibited. In 1997 the policy changed and in 1999 the university broadened the mandate of its industry liaison office to include technology transfer through the creation of enterprises. It hired a former executive from industry to oversee the structure and a staff member with experience in marketing to assist candidate entrepreneurs among researchers with writing a business plan. In 1999 support for spin-off projects was advertised. It primarily took the form of seed financing provided by a fund created with a regional public agency.

Origination phase. Similar to the two previous cases, no technology opportunity search existed within the university and the origination of the commercial projects relied on researchers, the large majority of whom had no interest in an entrepreneurial endeavour. Encouraging entrepreneurial projects was more a pri-

ority than selecting among the couple of projects, which were submitted each year.

Concept-testing phase. Concept testing was extremely weak due to limited experimentation with intellectual property management, primarily through outsourcing. It was also limited due to an absence of business assessment capability within the university and few connections with a weak local entrepreneurial community.

Start-up support phase. No support phase was provided to ventures after founding either directly or indirectly through connections with the local entrepreneurial community.

Between the mid 1980s and the end of 2000, the university has spun-off 19 ventures.

1. Third spin-off archetype: intermediate selectivity and support.

2.1 Summary data on academic institution No. 4 (>1999)

Of all universities in Belgium, academic institution No. 4 had developed in the late 1990s the first and the most proactive policy of spinning off ventures from the university's labs. From 1996 to 2000 the policy consisted primarily of encouraging researchers to

get involved in entrepreneurial projects and of providing early stage funding. It involved little support in terms of expertise in management and entrepreneurship and included little selectivity, the focus being more on encouraging initiatives in an environment where few researchers were interested in entrepreneurial endeavours. The collapse of the technology and financial markets, as well as the disappointing results of the earlier spin-off policy involving little selectivity and support, triggered a change in policy. The academic institution became more selective by pushing its candidate entrepreneurs to submit more ambitious projects and it provided some level of concept testing before the ventures were founded.

Around 2000 academic institution No. 4 thus changed its policy. In 1998 it had hired two senior persons to head its technology transfer office. It expanded the scope of its technology transfer division to include intellectual property management, started to manage the university's patent portfolio that was until then minimal (only 23 patents between 1980 and 1996), and started to encourage researchers to patent the results of research that had commercial potential. It also entered a new phase of development of its science parks.

By 2001 the technology transfer division included five part-time staff members dedicated to supporting various aspects of spin-off projects, including intellectual property management.

Origination phase. In 1999 the technology transfer division initiated a formal technology opportunity search process to identify technologies that had commercial potential. Consistent with its expanded mission, the technology transfer unit built more intellectual property capability by hiring additional staff members. By 2001 its web site listed five staff members involved at least part time in intellectual property. It also became more selective by pushing its candidate entrepreneurs to submit more ambitious projects than technical consulting firms.

Concept-testing phase. In 2000, as technology markets experienced a crisis and financial markets became more risk averse, the financial partners of this university required more proof of concept from the ventures spun off from the university. Its technology transfer division changed its spin-off strategy by providing promising spin-off projects small amounts of money (EUR 30,00 – 60,000) for concept testing in the form of product development and market research. Assistance in concept testing of the business po-

tential was introduced by providing small funding in the range of EURO 30,000 for market studies and product development before the actual creation of the venture. This occurred before ventures were founded, when researchers were still working within the academic institutions. The objective was to allow the candidate entrepreneurs to reach a sufficient level of proof of concept to submit their project to the university's fund. At this stage again, more selectivity was exercised by the university by pushing candidate entrepreneurs in pursuing more ambitious business opportunities and business models with more growth prospects.

Start-up support phase. The university had little internal resources for start-up support, but could provide some advisory capability through the financial partners in its investment fund. It was also instrumental in founding a forum for the local entrepreneurial community, in partnership with a number of established firms and with local entrepreneurs. This forum provided an embryonic entrepreneurial community on which young spin-off ventures could rely for advice and network support. The forum linked with a high tech cluster abroad.

Between the early 1980s and the end of 2000, this university had spun-off 40 ventures, with a great acceleration of spin-off creation in the late 1990s – early 2000 under the proactive policy of the university.

2. Fourth spin-off archetype: strong level of selectivity and support.

3.1 Summary data on academic institution No. 7

Created in 1984, academic institution No. 7 is one of the two inter-university research institutions involved with spinning off new ventures. Since the mid 1980s, the institution had made several attempts at spinning off ventures, which was very unusual for the time. These attempts were not successful, because of a lack of risk capital and of local entrepreneurial experience to draw from, but also because the model of growth-oriented venture was unfamiliar.

In the mid-1990s this academic institution concluded that it was not equipped to fund and to coach technology start-ups. It wanted to professionalize the management of its spin-off process. It decided to focus only on spin-off projects with high potential that

would meet criteria of venture capital firms (“IPO driven” ventures) and would require initial investments of EUR 1 million at the minimum. In 1996 academic institution No. 7 partnered with local financial institutions to set up a EUR 65 million venture capital fund to which it submitted its spin-off projects. By 2000 this institute had spun off 12 ventures.

Origination phase. The institute put in place a formal search mechanism to identify technology with commercial potential within its member labs, which was conducted by some of the twenty members forming its technology transfer unit. The choice of candidate technologies was very selective with specific criteria for commercialization via licensing versus formation of a spin-off. Examination of intellectual property started at this early stage.

Concept-testing phase. This phase lasted between twelve and eighteen months. It involved testing of the intellectual property of the technology and testing of its business potential. This included market research and product development. It relied on individuals with domain expertise that the institute and its business partners identified and hired often as consultants, to conduct the business plan process and raise funds for the venture. Those individuals

were also expected eventually to lead the venture project and assemble a management team. Selectivity was high, because the project had to be eligible for venture capital from the outset. In 2001, after financiers became more conservative, the institute realized that it had become harder for venture projects to be eligible for venture capital after only twelve to eighteen months of incubation and it created a seed investment fund with two local financial partners. Ventures were only formed after this incubator period when they had significant proof of concept in terms of market potential, product development and management team.

Start-up support. Once the ventures were formed, the institute mainly provided support in terms of further research collaboration. Business support came primarily from the institute's contacts in industry and from the institutional shareholders and board members of the ventures and their network. In 1998 the institute formed a network linking domain specific research institutions, established technology firms, and start-up firms involved in its domain of expertise. Later, it also initiated, along with academic institution No. 4, a local entrepreneurship forum. These groups served as an embryonic entrepreneurial community that provided

various sources of support and facilitated circulation of relevant information, as well as best practices.

Between the mid 1980s and 2000, this institute spun off thirteen ventures. Prior to 1996, most ventures took the form of traditional SMEs, while firms founded in 1996 and thereafter pursued opportunities with higher potential and exhibited a higher growth orientation.

3.2 Summary data on academic institution No. 8

Academic institution No. 8 is the second of the two inter-university research institutions involved with spinning off new ventures. It is an inter-university biotech research institute, founded in 1995.With its creation, the Flemish government made a substantial commitment to biotech. It provided an annual budget of EUR 25 million. While research was conducted in nine university departments and five associated laboratories, the institute focused on identifying research findings with commercial potential, on protecting the intellectual property of the research results, and commercialization. In order to do that, the institute had a technology [transfer team of seven people with research and industry experience. By 2000 the institute had spun-off two ventures, both

ambitious projects raising initial capital of EUR 8.5 million and EUR 4.5 million. The institute had a privileged financial partner, the public investment fund of the regional government, and its ventures also raised capital from international venture capital firms.

The institute's policy towards spinning-off ventures was thus similar to academic institution No. 7 's, focusing on high potential venture projects meeting criteria of venture capitalists.

Appendix 2. Founding characteristics of spin-off ventures

FIRM	(1)	(2)	Capital	Owner-ship structure	Manage-ment	Indica-tions of Growth Orienta-tion	Types at founding
ICOS	1982	No.4	1	1	1		SME
Iris	1983	No. 5	1	1	1	1	SME
Frontier Design	1979	No. 6	1	1	1		SME
Gamma	1983	No. 6	1	1	1	1	SME
Eurogentec	1985	No. 6	1	1	1	2	SME
Belsim	1986	No. 6	1	1	1	1	SME
DAP	1988	No. 4	1	2	1	1	SME
Sinvaco	1988	No. 3	1	1	1		SME
Androme	1989	Other	1	1	1	1	SME
Tri-consult	1989	No. 4	1	1	1	1	SME
Biocode	1989	No. 6	1	1			SME
Materialize	1990	No. 4		2	1	1	SME
IMO	1991	No. 4	1	2	1	1	SME
Metalogic	1991	No. 4	1	2	1	1	SME
Easics	1992	No. 4	2	2	1	1	SME
Epas	1992	No. 3	1	1	1	1	SME
Destin	1993	Other	1	2	1	1	SME
Stag	1994	Other	1	1	1	1	SME
Neurotec	1994	No. 5	1	2	1	1	SME
ISMC	1995	No. 4	1	1	1	1	SME
Krypton	1995	No. 4	1	1	1	1	SME
Netvision	1995	No. 4	1	1	1	1	SME
Microbel-cap	1995	No. 6	1	1	1	1	SME
Euroge-netics	1984	Other	2	2	1		NC (3)
Polyflow	1984	No. 5	1	2	1		NC (3)
Hypervi-sion	1990	No. 4	3	2	1		NC (3)
OWS	1988	No. 3	2	2	1		NC (3)
Optimal Design	1997	No. 3	1	1	1	1	SME (3)
Oligosense	1998	Other	1	1	1	1	SME
Lambda X	1996	No. 1	1	1	1	1	SME
Lasea	1998	No6	1	1	1	1	SME

FIRM	(1)	(2)	Capital	Ownership structure	Management	Indications of Growth Orientation	Types at founding
Unisensor	1998	No6	1	1	1	1	SME
Horpi system	1999	No6	1	2	1	1	SME
Micromega	1999	No6	1	2	1	1	SME
Elsyka	1997	No2	1	2	1	1	SME
Septentrio	2000	No7	3	3	2	3	Early growth
Coware	1996	No7	3	3	3	3	Early growth
Fillfactory	2000	No7	3	3	3	3	Early growth
CropDesign	1998	No8	3	3	3	3	Early growth
Metis	1998	No4	2	2	1	2	Gestation
Metris	1999	No4	2	2	1	2	Gestation
Ansem	1998	No4	2	2	1	2	Gestation
Eyetronic	1998	No4	2	2	1	2	Gestation
Telemis	1998	No5	3	2	2	2	Gestation
Octalis	2000	No5	2	2	2	2	Gestation
Mithra Pharmaceutical	1999	No6	2	2	3		Gestation

(1) Founding year

(2) Academic institution

(3) NC = not classified. These were cases with inadequate information to allow clear classification.

EXPLANATION OF THE CODING

1) Capitalization

Capitalization, as well as the four other dimensions, were scored on a three-point scale.

- 1 indicates that the firm is incorporated with the minimum legal capital, a characteristic common to technology SMEs. This minimum legal capital for the two most common types of legal commercial entities is either EUR 6,250 or EUR 62,500.
- 2 indicates a capitalization of a multiple of the minimum legal capital.
- 3 indicates a capital of EUR 1 million or more, which seems to be amounts that generally only venture capitalists invest.

2) Ownership

Firms differ greatly in ownership structure. Traditional SMEs tend to be closed to outside investors; in firms starting with the support of venture capitalists, founders retain only a small share of the ownership. There are, however, intermediate situations where firms have outside capital from non-venture capital sources, such as industry, or, more typically in the last few years, from seed

investment funds set up by academic institutions in partnership with traditional private or public financial partners.

- 1 indicates that the ownership of the firm is closed to outsiders.
- 2 indicates that the ownership includes non-venture capital investors, such as funds related to a research institution.
- 3 indicates that venture capital firms are the primary investors in the firm.

3) Management structure

SMEs tend to have a simple management structure dominated by one or two founders. Technology SMEs tend to be characterized by founders with a technical background (e.g. Mustar, 1995; Storey and Tether, 1998). More ambitious start-up projects need a stronger management team with more variety of expertise (Eisenhardt and Bird Schoonhoven, 1990; Roberts, 1991).

- 1 indicates that management of the firm is composed of technical persons only, without business experience.
- 2 indicates junior business experience in the management team, or experience in another sector.
- 3 indicates senior business experience in the industry of the start-up.

4) Growth orientation

As mentioned above, growth is a low priority for SMEs compared to keeping control of the firm, or being able to deal with cutting edge technology. On the other hand, growth goals are inherent to the American model of technology start-up, in particular to venture capital-backed firms.

- 1 indicates no growth orientation identified, for instance, by comments of founders stating that they want to stay a small firm or that maintaining control over the firm is more important than growth.
- 2 indicates intermediate cases where founders do not reject growth, but it is not a current priority.
- 3 indicates a high growth orientation, such as in the case of firms that go instantly global or firms that try to raise venture capital.

APPENDIX 3. Description of three selected ventures

1) STREAMCO

Streamco illustrates such as case. Streamco was founded in 1992 by a Belgian professor of microbiological ecology and technology and three of his research assistants. Based on its expertise in microbiologic processes, Streamco helps firms solve environmental problems, such as water purification. In the mid-1980s the lab was increasingly called upon by industry to help solve such problems. This new demand, combined with university budget restrictions which limited career opportunities for his researchers, led him and three of his researchers to set up a commercial structure to meet industry needs.

After considering the new venture for a year, the founding parties established Streamco in 1992 as an extension of the "commercial work" already performed within the university lab. The university did not have any involvement with the creation of Streamco. The founders formed their company with EUR 32,000, the minimum capital required by law in 1992. Choosing to incorporate with the minimum legal capital and trying to maintain this level is typical of founders of SMEs. Only the founders were share-

holders and board members; they were opposed to outside capital, since independence was a key part of their project. This case thus illustrates the closed ownership structure of this type of firm and the minimal management structure. Initially they operated out of the university lab, using its equipment. Later they moved to the university's scientific park where there was an "incubation center." This structure was limited to provision of space for start-up firms and did not provide business coaching. Nevertheless, Streamco remained there for eight years and thus kept strong connections and a strong identity link with the university.

The founders did not actively seek growth opportunities. They welcomed such opportunities only on the condition that independence from outside shareholders could still be maintained. They concentrated more on technical issues than on commercial ones. As one founder said, "Streamco's main investment was in its laboratory, because that is the heart of the firm." In 1999 Streamco, which started with three founders, had fifteen employees. Its original capital of EUR 31,250 grew to EUR 250,000 by internal financing. One founder commented that the reason for increasing the capital to this level was that it was the minimum re-

quired to be able to bid for certain governmental projects. This example illustrates the closed ownership mode of governance at the heart of this type of firm and the priority of independence over growth.

In Streamco we recognize characteristics of the SME archetype of venture: low capitalization, weak founding team and major focus on the technical side, rejection of outside investors and board members, and priority to maintaining control of the firm over pursuing growth opportunities with the most potential

2) MAGNES

Magnes was founded in May 1998 by two researchers from a university lab, which specializes in the generation and use of high magnetic fields for scientific experiments. Magnes built on this expertise to produce industrial magnetizers.

While the two founders were still researchers, people in industry regularly asked if they would sell equipment similar to that which they had created for their research work. They could not do this within the context of the university, but it triggered the idea that they might be able to do it in the context of a firm, especially since their employment contract at the university was about to ex-

pire. Around the same time, they learned about the university's new supportive policy towards spin-off initiatives.

Once the founders started exploring the idea of forming a company in 1997, they met with the technology transfer office of their university, which reacted positively, but encouraged them do more "homework" and provided a template for a business plan. They went back to the technology transfer office in October 1997 and were given useful support, which, they acknowledge, helped them elaborate upon and consolidate their business plan. This assistance forced the founders to enlarge their focus beyond the scientific lab market and into the industrial market.

Magnes was founded with EUR 200,000, a higher capitalization than the typical EUR 62,500 of SME firms. The founders each invested EUR 12,500, which represented an important financial effort on their part, while the balance, 75%, was provided by the university and an investment fund set up in the late 1990s by the university in partnership with financial partners. The board of the company was composed of the founders, a marketing professor from the university, a banker representing the investment fund,

and a professor of management of technology representing the industrial liaison office and thus the university.

The firm was composed of the two founding scientists. Thus, like SMEs the management structure was quite weak. However, their culture was completely different from that which we described in most founders of technology SMEs. These founders were aware of their lack of experience and were eager to learn from outsiders. They did not exclude outside capital. At the time of the interviews, when the firm was two years old, they were still primarily in a phase of learning basic business skills and concept testing. Indeed, they were engaged mostly in market exploration and product development, trying to define clearly what their product line needed to be. They felt that their shareholders realized that they needed time to refine the concept of their business and acquire the necessary skills. According to the founders, the shareholders gave them from 1998 until early 2000 to go through this stage of concept testing.

In terms of business model, Magnes' founders, like so many academics turned entrepreneurs, initially wanted to create a consulting firm. However, their early explorations made them change

their mind. They realized that firms which have problems with magnetic issues want a piece of equipment to solve them; consulting alone is inadequate to meet their needs. The founders said they also realized that consulting, with training and follow-up on problems, grows as a by-product of selling equipment. Clients who order equipment want consulting along with their purchase.

The founders' initial model was one of a small firm with a couple of employees. Initially, they also targeted the academic market because "this is the one we knew the best." While working on their business plan, however, the people from the university's technology transfer office and the investment fund pointed out that this market was too small and pushed them into targeting the industrial market instead.

The academic market thus became no longer an end in itself, but a step towards gaining entry into the industrial market. One way they tried to penetrate the industrial market was by talking to lead users and learning about their needs. This was an idea that the professor of marketing sitting on the Magnes board suggested.

Until the time of the interview, they had been doing either consulting or they had produced tailor-made equipment, but they

realized that they needed to start producing small batches of equipment in order to gain economies of scale. They envisioned that they would reach this stage within one to two years perhaps. Ultimately, their aim was to produce a large series of small equipment.

3) FULLSOFT

Fullsoft was founded in October 1996 based on a technology developed at one of the specialized research institutes. The firm provides tools for hardware and software co-design that cuts overall cost and integrated circuit design time in half, compared to traditional design methods, and speeds new products to market. The institute estimated that the technology offered enough potential to justify a spin-off project that could attract venture capital. It offered the scientists the opportunity to further develop their technology and study their market for about a year. The research institute assisted the business process notably by providing external consultants from the USA, helping the founders to raise funds, providing their first client, and, overall, providing credibility.

Thanks to this incubation period, the firm started with a product that was ready for market and had a client. It was able to

raise an initial round of capital of EUR 4 million from two local and one American venture capital firm. Early on the firm established a presence in Silicon Valley, in a move to become a “born global” venture. Experienced managers were hired in the USA, notably with the help of the American venture capitalist. The firm adopted a product orientation right from the start. This did not rule out consulting, but consulting was conducted “in order to gain the trust of our clients.”

In contrast to most founders of academic spin-off ventures, one founder said, “right from the beginning in 1996, we wanted to become big, although this project of becoming big quickly ran against the Belgian culture.” The founders explain this orientation because of the role models provided by firms in their sector and the need to have a critical size to deal with their clients, which were typically multinationals. Also, the research institute, which had disappointing experiences with early spin-off ventures with little ambition, was selective in supporting Fullsoft and pushed the founders to opt for an ambitious entrepreneurial project.

We clearly find in the case of Fullsoft the characteristics of high capitalization, complete and experienced founding team, ex-

perienced investors and board members, and the pursuit of opportunities with the most potential.

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