



**High tech venturing in Estonia: background  
report for the ESTPIN programme**

**Technopolis BV, Amsterdam, Dick de Jager**

**KU Leuven R&D, Leuven, Bart van Looy  
and Martin Hinoul**

**September 2001**

## **CONTENT**

<b>Section 1</b>	<b>Background and scope</b>	<b>page 3</b>
<b>Section 2</b>	<b>International best practices</b>	<b>page 5</b>
<b>Section 3</b>	<b>Assessment of the Estonian situation with regard to innovation support and high tech venturing</b>	<b>page 27</b>
<b>Section 4</b>	<b>Conclusions and recommendations</b>	<b>page 39</b>
<b>Section 5</b>	<b>Towards the ESTPIN programme</b>	<b>page 44</b>
<b>Annex 1</b>	<b>Definitions</b>	<b>page 47</b>
<b>Annex 2</b>	<b>Schematic overview of high tech venturing related issues</b>	<b>page 48</b>
<b>Annex 3</b>	<b>Interviewed organisations</b>	<b>page 58</b>
<b>Annex 4</b>	<b>Bibliography used for section 2</b>	<b>page 59</b>

## **SECTION 1            BACKGROUND AND SCOPE**

### **1.1.    Introduction**

The Estonian Technology Agency (ESTAG) has launched a study on the Estonian support for new technology based firms, originating mainly from universities and research institutes.

The study has two main elements:

- 1 An evaluation of the current situation with regard to the support for new technology based firms, in an international context;
- 2 The identification of future needs for this type of support in the context of wider national strategies, support structures, development plans and economic forecasts.

This report provides an assessment of the current situation in Estonia, with respect to SME support in general and high tech venturing, mainly around the Universities of Tallinn and Tartu, in particular. In order to assess the situation we carried out 26 interviews in June and July 2001. We have compared our assessment with international best practices. Our assessment is the basis for conclusions and recommendations aimed at the design of the new ESTPIN programme.

### **1.2.    The importance of innovation**

Innovation is the long term driver of economic growth. Economies flourish when societies create the conditions in which managers and entrepreneurs are encouraged to take risks and hence create new sources of wealth and work. Innovation includes the creation and introduction of new products, processes and services in all sectors – manufacturing and services, high-tech and low tech. It encompasses revolutionary and incremental change. It includes tangible as well as intangibles – investment in R&D and marketing as well as investment in new production equipment.

Innovative companies gain more market share, add more value and create more new jobs than other companies. Moreover, major changes are taking place in the business environment that will increase the rewards for successful innovation and raise the penalties for poor innovation performance in the future ((Unice Benchmarking Report 2000: Stimulating Creativity and Innovation in Europe). Major trends are:

- Rapid (and accelerating) scientific change and speedy diffusion of new technologies
- Increased globalization
- New customer preferences
- An emerging information society

Given the importance of innovation for regional economic development, policies should be developed as to stimulate a wide range of innovative actions. Among them, the stimulation of knowledge intensive activities stemming from universities and research centres figures prominently. Not only are these institutions placed at the forefront of new scientific and technological developments; they also play a crucial role in terms of knowledge diffusion and hence contribute to the overall innovative potential of a region.

As indicated in section 2, no ‘success’ story (ranging from Cambridge to Silicon Valley) has achieved results without the active involvement of ‘entrepreneurial’ knowledge institutions. Hence, the crucial role of the new ESTPIN programme.

### **1.3. ESTPIN: strengthening the key role of Universities and Public Research Centres in stimulating knowledge intensive economic activities.**

Research findings demonstrate that the greater the 'entrepreneurial' character of Universities and Public Research Centres, the larger the positive impact on the development of a region in terms of its innovation capabilities and competitiveness.

The entrepreneurial character of a university or research centre can be measured by the commercialisation of R&D, which can be organised in two ways:

- contract research & development
- high tech venturing: fostering research intensive business activities by means of spin off creation and patent/license policies.

As § 3.2 will indicate, the commercialisation of R&D in Estonia is not up to the standards of the member states of the European Union. Within Estonian R&D, there is still a strong bias towards fundamental research.

The ESTPIN programme, developed by ESTAG, is meant to stimulate and support activities aimed at fostering the entrepreneurial role of universities and public research centres, especially in the field of high tech venturing.

Stimulating high tech venturing however is a complex process involving different aspects and actors (see § 2.6). A multitude of concerns needs to be addressed.

Our preparatory investigations for ESTPIN, laid out in section 3, point to the fact that there seem to be not very many concrete incentives in the Estonian Universities and Research Centres for researchers to be involved in entrepreneurship. Although there is a difference in the “maturity” of the support structure in Tartu and Tallinn, all Universities and Research Centres lack a comprehensive framework for stimulating high tech venturing in which all relevant aspects are taken into account. The running spin off programmes are to a large extent training programmes on business planning, management and marketing.

We suggest therefore that ESTPIN will aim at the development of more “complete” programmes and support structures, as described in sections 4 and 5.

## SECTION 2: INTERNATIONAL BEST PRACTICES

### 2.1. Introduction

Since Joseph Schumpeter's groundbreaking body of thought, it has been clear that innovation and entrepreneurship are closely interrelated. This interrelation has become the point of departure for a wide range of studies that make the link between innovation, entrepreneurship and economic growth. In particular, in recent years the interaction between innovation, entrepreneurship and regional economic development has become a central theme in many policy circles. Examples such as Cambridge U.K. and Cambridge U.S., and, more emphatically, the phenomenon of Silicon Valley, are the driving forces behind this interest. Today almost every European region is attempting to put together the ingredients necessary for endogenous economic growth, based on the innovative capacity and the entrepreneurial dynamics that can be mobilized in a particular region. The stimulation of this kind of growth requires interaction between a multitude of actors as pointed out as well recently within an Estonian context by Hernesniemi (2000) and the Green Paper related to the development of regional cooperation for innovative entrepreneurship. Besides business and knowledge centres (including universities), the government is also involved. Over the last decade, there has been a perceptibly increasing consensus on this point of departure in the literature concerning knowledge and technology policy. A particularly important contribution in this regard is the influential work of Michael Porter (1995), as well as the notion of the 'Triple Helix', which rose to prominence in the second half of the 1990s (Leydesdorff en Etzkowitz, 1996; Etzkowitz en Leydesdorff, 1997; Leydesdorff en Etzkowitz, 1998; Etzkowitz en Leydesdorff, 1998). The 'Triple Helix' model can be seen as a way of providing greater insight into the complex dynamic between three types of actors: government, business and knowledge centres. This dynamic has a bearing on the creation and diffusion of knowledge, on the production of value added with its attendant market dynamics, and finally, on regulation. In this respect, the explicit point of departure is the notion of co-evolution, in which the various actors influence one another, each with a particular role and capacity. Karnoe & Christensen (1999) have recently added a contextualised perspective to this discussion:<sup>1</sup> the most relevant form and trait of economic organization - and thus of goal-oriented policy as well - are partly functions of the specific institutional situation of a land or a region. In this sense, it is also possible to speak of a more and more contextualised view of innovation policy. This observation is important for reaching potential policy conclusions. 'Best practices', such as those discussed below, always imply 'translation' to a particular situation and context. Moreover, this observation fits perfectly into the models dealing with technology-development as described in the work of Nathan Rosenberg (1982), in which the role and the workings of technological interdependencies are outlined.

The realization of such endogenous growth does, however, necessitate a deeper insight into the parameters and dynamics upon which it is based. The aim of this report is to contribute to such insights. On the basis of both a study of literature and empirical data, the authors offer an overview of and an insight into the manner in which knowledge-driven entrepreneurship shapes regional development. Drawing on examples from the United States, Europe and, more specifically, the Leuven region, this synthesis will be further substantiated. The results of this synthesis point to the necessity for a complex and guided interaction between institutions of learning, established businesses and new start-ups, with sufficient attention paid to the network of professional enterprises and infrastructure which frames such

---

<sup>1</sup> For an illustration in this connection see also Galbraith and De Noble (1992).

interaction. As such, this report forms a source of inspiration and guidance to develop Estonian initiatives and policy measures in order to further develop and foster the dynamics that underlie knowledge driven entrepreneurship activity.

## **2.2. Knowledge-driven entrepreneurship, an overview of the driving forces**

The literature of the last few years has paid a good deal of attention to the various factors that influence the creation and success of high-tech start-ups. In general, it is possible to distinguish three types of factors that facilitate this. In the first place there are basic ingredients, which can be almost labeled as 'conditio sine qua non', necessary for innovative starters to be able to establish themselves in a particular place and develop successfully. Second, recent literature and empirical studies have distinguished industry-or market related success factors. Finally, high-tech start-ups must themselves possess a number of qualities and competencies in order to continue to grow. Each of these factors will be further discussed below.

### *Basic Ingredients*

In their study of the innovation policy of the Malaysian government, Joseph Tidd and Michael Brocklehurst (1999) point to two important dynamics in connection with innovation: in part, innovation implies endogenous growth *and* collaboration with or investment by foreign companies in a country. Both endogenous and exogenous innovation appear only to be successful when a country or a region has at its disposal a *critical* mass of research *and* production competencies.

Closely related to this, it can be stated that the access to knowledge centres - implying the presence of such centres - is a crucial facilitating factor. This relation, cited in the models and by the authors already mentioned, has recently also been empirically confirmed in a German study. Research into eighteen technology zones in Baden-Württemberg and Nordrhein-Westfalen (Blind and Grupp, 1999) suggests a clear link between the public institutions of higher learning (Universities) and the technology-output in a particular geographical area or region.

This conclusion can be complemented by further specifying the role of knowledge centres, including universities. The greater the 'enterprising' character exhibited by these institutions, the greater the positive impact on the development of a region in terms of its innovation (Porter, 1995). Universities can here play a crucial double role, connecting to the dichotomy of knowledge-creation and -diffusion. This situation provides the universities with, as it were, the status of preferred and natural partners for high-tech innovation and venturing. Likewise, Tijssen and van Wijk (1999) underline the importance of the collaboration between academic institutions and industry. The absence of this kind of interaction between scholarship and technology is, according to these authors, one of the most important reasons for the technological inferiority of Europe compared with the U.S. and Japan. This is the so-called 'innovation deficit'. Bibliometric analyses show that Europe shares the top spot in terms of scholarship, but that the industry has only to a limited degree been able to translate this knowledge into patented applications (Debackere et al., 1999 & 2000). This opinion is shared by Porter (1995)<sup>2</sup>. In this respect the legal and institutional arrangements with respect to

---

<sup>2</sup> For instance MIT established 1397 patents between 1980 and 1996; approximately 50% were licensed (see Shane, forthcoming). A phenomenon which should be seen in the light of the Bay-Dole act established in 1980 which gave universities the rights to income from inventions that resulted from federally funded research. Before that universities could only apply for patents resulting from this kind of funding only if they received a title rights waiver from the government agency involved. In practice this implied very little incentives for Universities to actively exploit the knowledge and technology being developed within such projects.

propriety right play a crucial role. For instance MIT established 1397 patents between 1980 and 1996; approximately 50% were licensed (see Shane, forthcoming). A phenomenon which should be seen in the light of the Bay-Dole act established in 1980 which gave universities the rights to income from inventions that resulted from federally funded research. Before that universities could only apply for patents resulting from this kind of funding only if they received a title rights waiver from the government agency involved. In practice this implied very little incentives for Universities to actively exploit the knowledge and technology being developed within such projects. Within Europe similar arrangements are being developed or installed, although regional differences remain considerable.

All of this would tend to suggest an increasing complexity in the collaborative relationships between the academic world, industry and the government. For instance, Cox et al. (2000) mention that the nature of the relationship between the academic world and industry is increasingly taking on a diversified character, a situation which calls for a new balance between collaboration and competition. Universities and companies are partners in collaborative ventures, but are at the same time also competitors, since universities are increasingly commercializing their knowledge through licensing and spin-off companies. Universities compete with one another for research funds (in part given by companies) and for winning companies' sponsorship and financial assistance for training. Cox et al. (2000) emphasize the importance of intermediary structures that influence the interaction between research institutions and industry, steering it in the right direction. This role can be performed by the institutions themselves, by major laboratories or by special transfer companies set up for exactly this purpose.

A last important factor, found throughout the literature, is the presence of well-developed financial markets. Starting up a company often requires a not inconsiderable amount of external financing. Once a company has successfully survived the start-up phase, its continued growth can often only be made possible by an even greater injection of new capital. Banks are often not well-placed to assess a start-up's chances of success: they are in general averse to risk, opting for relatively safe investments with an early return on investment. For this reason, the availability of venture capital and the accessibility of more informal 'business angels' is of crucial importance for the chances of success of a young high-tech firm (Van Osnabrugge and Robinson, 2000). Such investors are better able to assess the risks and chances of success associated with a company thanks to their experience with risk management on a portfolio level; this also puts them in a position to provide advice on financial, strategic and commercial matters (Bygrave et al., 1999).

#### *Market and Industry-related success factors*

Besides the general environmental factors, Tidd and Brocklehurst (1999) also identify several sector-related supply and demand factors that stimulate innovation. The success of new high-tech ventures is highly dependent on the local demand for their products and/or services. If the local market is too small, internationalisation will quickly come up on the agenda, adding to the complexity of the total operation of the company, including the necessary financing. An orientation to local, existing needs and markets will allow a company to progress more quickly along the learning curve, with decreased risk and less financing.

On the supply side, a sufficient degree of competition appears to provide a stimulus for companies to innovate. As a result, an innovation policy should not only aim towards the expansion of a few large firms, but ought rather to allow a diversity of competing companies and even to stimulate them. Was it not Bill Gates who said that 'the problem in Europe is not

the lack of knowledge, it's the lack of knowledge-based companies'? Thus, the number of software firms that saw the light of day in the United States in the period 1980-1995 was almost 6000. This is tenfold what Europe produced in the same period (Second European Report on Science and Technology Indicators, 1997). When 'a thousand flowers or initiatives are allowed to bloom', the dynamics of failure and success can more fully come into play. Here a principle of 'the more the merrier' is in force. Or as Lester Thurow, the dean of MIT Sloan School of Management, aptly and provocatively put it in his insightful book, *Creating Wealth* (1999) : "Europe has to want entrepreneurs and be willing to reorganize itself to allow them to come into existence. " (p.98)

Additional points of interest in this kind of innovation policy clearly include the degree to which and the rate at which young starting companies are exposed to the market (cf. the notion of 'protected niches', as developed by Schot and Rip, 1997). In this connection it should be emphasized that the growth and the development of high-tech ventures must not be limited to making technology 'market ripe'. A developmental process in the running of a company is equally necessary. Here success demands a certain degree of equilibrium (however unstable to a certain extent). Over-hasty exposure to excessive competition can also have a very negative influence on a high-tech starter's chances of continued growth, a fact shown clearly in the work of Zahra and Bogner (1999), who document the ups and downs of 116 software start-ups.

Also relevant in this connection are the observations of Deeds, DeCarolis and Coombs (1997). In their study of the biotech industry in the United States, they looked at the influence of various factors on the amount of capital that IPOs (Initial Public Offerings) generated. These amounts give an indication of the worth and thus the potential success of a start-up. Geographical proximity is shown to be very influential in these cases: a geographical concentration of companies in the same sector leads to the competitive rivalry mentioned above, and to more collaboration between companies (see also Stuart, 1998). Geographical clustering thus has a positive effect on a company's market value and product-development competencies. This phenomenon will again come to light in the discussion below of a number of concrete regional initiatives.

Moreover, in the context of high-tech venturing, such an observation can be further developed. Innovation is stimulated not only by the geographical concentration of companies with *similar* technologies, but by those that are active in *different* technology sectors. New technologies and even completely new sectors often arise out of precisely this interplay between different disciplines and technologies. A good example of this is the sector of bio-informatics, which was born from data-mining/computer science on the one hand, and the bio-genetic/medical sector on the other. The physical proximity that leads to this sort of cross-pollination is an important facilitating factor in such cases.

#### *Company specific factors*

In addition to the above, it goes without saying that high-tech venturing implies a number of specific challenges in the area of operational management. Besides the relevance of general, balanced, management, a number of specific points of interest can also be underlined in connection with high-tech venturing at the company level (Zahra en Bogner (1999), Deeds, DeCarolis en Coombs (1997), Griliches (1990), Narin et al. (1987), Cox et al. (2000), McCann (1991), Bruno et al. (1992), Stuart (1998)). These concern the availability of personnel in sufficient numbers, the striking of a balance between scientific/technical ambitions and market developments and finally, the development of a suitable

internationalisation strategy. Cox et al. (2000) emphasize the importance, for a company, of well-trained employees: for high-tech ventures this is the sine qua non for the further expansion of the firm. Once again, the proximity of - and interaction with - knowledge centres (particularly universities) is of vital importance.

Also, in such companies, a balance also needs to be struck between technology- and market-orientation in situations characterized by a high degree of uncertainty. In their 1999 study, Deeds, DeCarolis and Coombs state that the quality of the research team has an important influence on the product-development competencies of a company. These are then positively influenced by the experience of the entrepreneurs/CEO with the management of product development. The authors of this study recommend that management and research functions be kept strictly separate. In their opinion, the interference of scientists in the management of a company hampers the successful development and commercialization of new products, since it diverts attention and time away from research and development. Counterexamples can, however, also be found in this regard. Rather than a strict separation, it seems to come down to striking a suitable balance between technological (R&D) ambitions and objectives - the effects of which may be situated in the middle term - and the short-term realisation of turnover and value added. This sort of twofold aim demands an evenly composed management team; the same goes for the organizational forms (see also Steyaert, 1996).

Thus, for example, the ratio of Ph.D.s to non-Ph.D.s proves to be a significant and explanatory variable in the continuing growth of high-tech start-ups. Research into 117 biotech start-ups in the United States (Debackere et al., 1996) has shown that biotech firms still consisting predominantly of Ph.D.s after five years (>70% of the staff) grew at a significantly lower rate and had a greater chance of failure. High-tech ventures are thus faced with the challenge of complementing their technological/scientific strengths with those on the level of management and market orientation. The importing of experienced, complementary management skills is clearly an important factor (see also McGee and Dowling, 1994).

Finally, it should be noted that high-tech ventures are in general confronted relatively early on with questions of international growth. This observation is linked to the increasing internationalization so clearly manifested in the area of science and technology. Coupled with this is the observation that high-tech firms often occupy a niche position. The realization of a sufficient critical mass, in particular in terms of turnover and margin, generally implies some form of internationalization. In interviews with founders of successful companies in Northern California (Bruno, McQuarrie and Torgrimson, 1992), international expansion was identified as one of the critical milestones in the growth of an enterprise. This milestone will be reached more quickly in the degree that the entrepreneur/CEO embodies a positive attitude towards internationalisation, as well as a sufficient availability of the necessary competencies within the firm (Preece, Miles and Baetz, 1998). This study shows broad or all-inclusive internationalization in the initial phase to be a less appropriate strategy. In order to successfully implement this form of internationalization, the enterprise needs to have at its disposal a critical mass of knowledge, experience and means. The greater the extent to which this critical mass is lacking - a situation usually inherent in starting enterprises - the more appropriate a choice of an international focus, which is best limited to a number of well-chosen regions, wherever in the world they may be. However, if such competencies are successfully acquired and developed early on in the lifespan of a firm, rapidly seizing the opportunities of internationalisation seems to have a positive effect both on the growth of the firm and on the motivation of the entrepreneurial team (Autio et al., 2000).

### *The interaction between factors: a few recent empirical insights*

The various studies mentioned above all emphasize the importance for a high-tech start-up to both think and act locally and globally. A successful internationalisation strategy can, however, only bear fruit if the local/regional environment offers the high-tech start-up enough opportunities to build up its critical mass of both technological and market-oriented competencies (Debackere, 1998 & 2000). The importance of this local/regional embedding is further underlined by the empirical research recently carried out by 125 regional statistical entities (the so-called 'Metropolitan Statistical Areas' or MSAs) in official use in the United States (Varga, 1999). On the basis of this research, the following observations may be made concerning the stimulation of the innovation-output in a particular MSA:

1. The R&D employment in the industry of a particular region has a positive main effect on the innovation-output (as measured in this study) in the MSAs under consideration
2. The R&D expenditures in the universities of the regions under consideration have in and of themselves a statistically significant yet negative main effect on the innovation-output. As we shall presently see, a region's university-level research can only have a positive effect on the innovation-output in that region if there is sufficient interaction between the academic research and the high-tech/professional entrepreneurial environment. It goes without saying that this also calls for a sufficient presence of such a high-tech/professional environment.
3. The interaction between the presence of a flourishing texture of high-tech ventures/start-ups, coupled with the presence of a strong basis in a region's university-level research, has a significant and positive impact on the innovation-health of the MSA.
4. However, the interaction between academic research and the high-tech entrepreneurial environment is not the only factor with a positive effect on the regional innovation-output as identified. The interaction between the presence of a sufficient measure of professional entrepreneurial support systems (such as consultancy, venture capital and juridical competencies) in a region and the degree of academic research has a positive and statistically significant effect on innovation-performance in the region in question.
5. An overly strong presence of large, established firms, in interaction with a degree of academic research appears in its turn to have a significant yet negative effect on the innovation-output in the regions in question.

In short, the picture that emerges from these studies into the influence of regional embedding and location factors on regional innovation performance demonstrates the need for sufficient texture and critical mass in terms of the interactions between university research on the one hand and a high-tech, R&D-intensive industrial environment on the other, whereby sufficient attention is also paid to a professional support system.

This last observation necessitates an analysis and a contrast in more detail of the high-tech venturing policy of various regions.

### **2.3. The establishment of a high-tech venturing policy**

As touched upon above, high-tech venturing benefits from geographical proximity. This sketch of the situation will come as no great revelation per se. The creation of new products and services, depending on new insights in both scientific and technological domains, implies interaction and cross-pollination at close range. In conversations with players actively involved with the development of such initiatives (Leuven, Cambridge, Sophia Antipolis), this is repeatedly cited as a necessary - yet often overlooked - condition for the creation of a fruitful breeding-ground for high-tech venturing in combination with a diversity of high-level

knowledge. Regarding this diversity of knowledge, the role played by knowledge centres (especially universities) again becomes clear. In a recent study published in *Wired* (August, 2000), a survey is made of regions that occupy a strong position in terms of high-tech venturing. This study identifies regions which meet several different critical conditions for the development of high-tech enterprises. The regions are scored according to four factors: the presence and performance of universities and other knowledge centres, the presence of established firms, the presence of high-tech start-ups and finally, the availability of venture capital. It does not come as a surprise that Silicon Valley takes the first place, followed by the Boston region, Israel, Stockholm-Kista and Helsinki<sup>3</sup>. However, how these regions have come to this position deserves our attention. In the following paragraphs, a number of concrete initiatives for venturing policy are further discussed, while crucial ingredients concerning a policy aimed at stimulating high-tech venturing are identified.

#### *German governmental policy*

Over the past 15 years, Germany seemed to encounter difficulties in launching high-tech industries. The number of high-tech starters was extremely limited. According to Lehrer (2000), these problems were caused by missing links in the innovation chain, on the national, regional and company/employee levels respectively.

On the national level, the absence of well-developed capital markets formed an obstacle to starting up new technology firms. The German financial system was characterised by the domination of banks oriented to existing German industries, with much less interest in - admittedly riskier - investments in new, up-and-coming technologies and their related industrial sectors. On a regional level, Lehrer identified a clear lack of the relevant structures and instruments necessary for creating and supporting high-tech networks. The regions had, since the middle of the 1980s, taken on the role of technology stimulators. Regional technology parks and incubators were set up. Industrial networks were developed on a regional level, while the establishment of new branches of the Fraunhofer Institute, a highly successful centre for technology transfer, was stimulated by the states. The regional policy was directed toward the improvement of regional systems of technology transfer in connection with existing industries. There were, however, few if any initiatives for the launching of new technology sectors. And yet there was - and is - a broad base of knowledge present in the area of basic research and applied scientific research. The weak position of Germany in new high-tech industries was, rather, to be found in the manner in which this scientific knowledge was translated into commercialisation in new markets.

In the middle of the 1990s, the Länder took a number of steps aimed at improving the interaction between scholarship and industry, and stimulating entrepreneurship. For instance, over the past five years alone, Bavaria has already invested an additional DEM 5.5 billion in the setting up of a broadband IT infrastructure between governmental bodies and research institutes, in increasing the number of technology-oriented university programmes, in the development of interface cells for knowledge transfers between universities and the business world and also between research institutes and companies, and finally, in the supporting of entrepreneurs. This brings us to the individual level; Lehrer observed a climate of risk-aversion and a shortage of entrepreneurship, a situation encouraged by a public university educational system in which entrepreneurship was not stimulated. A number of auxiliary measures were also taken. German law - especially the strict rules concerning bankruptcy - was discouraging entrepreneurship. At the beginning of 1999, the law was relaxed in order to decrease risk aversion. The universities attempted to counterbalance the lack of

---

<sup>3</sup> Flanders is situated, together with Beieren, Kyoto, Tokio and Copenhagen, around the 20<sup>th</sup> place.

entrepreneurial spirit by naming specialised professors and by starting up specialised courses. Since the mid-1990s, the German government has been trying actively to finance entrepreneurship in Germany. Prizes have been awarded in order to stimulate regional biotechnical centres, the setting up of business plans and the promotion of spin-off networks around universities. The government has thus partially taken on the role of venture capitalist.

Concurrently with all these active regional and governmental measures, the less than rosy economic situation in Germany after unification also played a role. Entrepreneurship in general and high-tech venturing in particular have increasingly come to be seen as crucial for arriving at a more positive business-economics dynamic.

At the moment, the results of the new policy are becoming clearer. For example, the market capitalisation of the 'Neuer Market' was EUR 210 billion in 1999. This market capitalisation primarily benefits technology firms.

### *Silicon Valley*

The best known high-tech region - and the one that appeals most to the imagination - is without a doubt Silicon Valley. Firms such as Hewlett Packard, SUN Microsystems, Intel and Cisco were born here. However, Silicon Valley is also a gigantic innovation and entrepreneurship laboratory. For every successful tech start-up there are at least ten that fail to realise their goals. A recent survey by Saratoga Venture Finance (Chances for a High-Tech Start-Up, 2000) shows that at present in the Valley:

1. The chances of going from 'idea to IPO' are 6 in 1,000,000
2. The chances of going from 'business plan to IPO' are 6 in 1000
3. The chances of going from 'started and financed venture to IPO' are 1 in 10.

In other words, inherent in the success stories in the Valley are the cases of failure and bankruptcy. It has become something of a cliché to point out that every Silicon Valley entrepreneur has at least two failures to his or her name before success comes (Nesheim, 2000). Furthermore, naturally not all failures lead eventually to success. Some people never learn from their 'mistakes'. This explains the considerable 'failure rates' in the Valley.

However, the tolerance for and culture of entrepreneurship, the failure that goes with it, and the ability to learn from these failures has turned Silicon Valley into a success story which today we all recognise, admire and to some extent envy.

Today Silicon Valley numbers more than 8000 high-tech firms with a total consolidated turnover of more than USD 200 billion. With its two million inhabitants, Silicon Valley itself accounts for USD 65 billion of this total. The average salary in the region is twice the national average. Silicon Valley has the largest concentration of companies in sectors such as computers, semiconductors, telecommunications equipment, software and internet software and hardware. In addition, it holds a strong position in biotechnology.

One has to keep in mind that these statistics are the result of a process of development that had already begun before the Second World War and in which both Stanford University and Berkeley played key roles. Stanford University was founded in 1891. Right from the beginning there was an openness towards 'technical venturing'. In addition, the region also boasts Santa Clara University and San Jose State University, which together produce some 4000 new engineers for the workforce each year.

In 1951, Stanford University made a decision unique for its time: it opened the Stanford Industrial Park, thus making available 234ha of university land for industrial projects. The first company that set up there was Varian Industries, the second Hewlett Packard. Today this park numbers 150 firms active in the areas of electronics, software, biotechnology, financing, strategic management consulting and venture capital.

The presence of Stanford and Berkeley was not the only important element in this scenario. The very early presence of Fairchild Semiconductors (founded in 1957), itself a spin-off of Bell Laboratories, was also important (Kenney and von Burg, 1997). These collaborators at Fairchild Semiconductors helped lay the basis for a multitude of high-tech companies (the 'Fairchildren'), among which were AMD and Intel. In this sense, it is thus clear that besides 'enterprising universities', the presence of companies and a professional support network - with its own knowledge and expertise - played a part in creating regional dynamics of economic development and growth. The research laboratories set up by IBM (San Jose Laboratory, set up in 1952) and later the Xerox Palo Alto Research Centre (PARC) should also be mentioned in this regard. In a similar way, regional knowledge-networks came into being, quickly becoming recognized and legitimate interchanges in a global network of knowledge and entrepreneurship (Van Dierdonck, Debackere et al., 1991). In other words, the advantage of well-developed regional networks of knowledge and entrepreneurship is that it quickly becomes part of similar networks on a global level. There is thus an evolution from an isolated network to a network within and between other networks.

In the sixties and seventies, Silicon Valley grew quickly. The number of start-ups in the period 1956-65 within semiconductor industry was 'only' ten. In the period 1966-76 there were already sixty, while ten years later (1977-87) it was 157. And yet the 1980s saw the beginning of a difficult period for Silicon Valley. The semiconductor industry evolved more and more into a situation in which operational excellence and mass production were making the difference when it came to a firm's performance. In particular, a number of Japanese producers emerged as leaders, and the consequences were felt all the way to Silicon Valley. For example, in the eighties, Intel was forced to lay off 8000 employees, pulling out of the memory market and devoting itself completely to microprocessors. In this sense, the point of view of Kenney and von Burg (1997) becomes clear, when they rightly point out that many factors play a role when it comes to the creation of a high-tech entrepreneurial region (see also above). And we are here dealing not only with 'cultural' aspects such as values or even organizational structures; the technologies themselves and their intrinsic paths of development<sup>4</sup> equally play a role, in combination with the strategy and its implementation by the dominant players.

In other words, the success of a number of regions - and thus the relevance of a number of competencies - cannot be seen separately from the life cycle of the implied technologies (see also Langlois and Robertson, 1992 & 1995). Equally, this explains the need, on a regional level, to keep from suffering from the 'Not-Invented-Here' syndrome (Debackere, 2000). A healthy high-tech region urgently needs a mix of technologies. As in the 'old economy', technological mono-cultures are to be avoided at all costs if a regional innovation dynamic is to be maintained. A healthy diversity in the regional technology-basis is desirable and highly recommended. In its absence, there is a danger of becoming too dependent on the ups and downs of one particular technological growth cycle, with all the possible negative consequences that this entails. Europe's present role model, Finland, is right to be concerned

---

<sup>4</sup> cf. the notions, inspired by Joseph Schumpeter and Thomas Kuhn, of 'technology trajectories' and 'paradigms', Dosi (1984); see also Nelson and Winter (1982), Arthur (1988), David (1986)

about the continuity of its admittedly big success as Nokialand. Thus if the diversity of the (regional) technology-basis is poorly monitored (and here technology explorations clearly prove their usefulness, Zimmerman et al., 2000) by the actors in the 'Triple Helix', then the consequences are often incalculable when competing or new technologies start to make a challenge and exploit weaknesses.

What makes Silicon Valley so distinctive and so competitive is the breadth of the knowledge and technology available as well as the fact that the region clearly possesses the skills to continue to develop, to reinvigorate itself and to diversify. The presence of a sufficient critical mass in a wide range of domains of competence, in combination with its geographical proximity, are seen by the Stanford Research Institute as key elements: "The region possesses a special kind of infrastructure that has in effect institutionalised innovation in technical fields across the board. The Bay Area is unrivalled in sheer variety of companies and level of formal and informal networking among companies in technical fields. Hardware and software are closely aligned. Prototype development and engineering is particularly strong. It is this cross-cutting strength – and economic infrastructure comprising strong technology, human resource, capital input, and numerous industrial synergies – that makes Northern California a magnet for top engineering talent, innovative start-ups, and major breakthroughs in technical fields across the board." (SRI International, 1988)

This characteristic is also emphasized by Saxenian (1994): "Most companies or stable regions pursue a single technical option and, over time, become increasingly committed to a single technological trajectory. A network-based regional economy like Silicon Valley, alternatively, generates and pursues a *rich array* of technological and organizational alternatives."

Equally striking is the emphasis made by a good many authors (see, among others, Collins and Porras, 1994) on the management style on the one hand and the dynamic in the region on the other. In terms of management, the role model of HP has set the tone within the literature. Particular attention is here paid to the concept of participation within an a-hierarchical, informal management style, in which outward shows of status are minimized. Within the region there is seen to be, besides competition, a great deal of interaction, in the form of meetings and discussions, both between company personnel and with academic partners. These authors also note a remarkable degree of openness in exchanges of information between experts and 'juniors', concerning both technical and company-oriented matters. Besides these players' shared 'parentage' - chiefly their backgrounds at Stanford and Berkeley but also at Fairchild Conductors, one of the first large semiconductor producers, where many engineers spent the first years of their careers in the fifties and sixties - sheer physical proximity is an important element. The region is, as it were, naturally bounded by the ocean on one side and by the Santa Cruz mountains on the other. In fact, we are dealing here with an area 'only' 80 kilometres long and a few dozen kilometres wide. Thus, physical proximity plays a role equal to that of technical affinity. This facilitates the necessary interaction between a diversity of actors and competencies, so important for creating and nurturing innovative entrepreneurship. This sort of interaction is characterized by an openness and informal style that is in stark contrast to the more classic manners of hierarchical company organizations. The authors cited above point out that this more network-oriented style of organizing, in combination with an atmosphere and a culture in which risk - and thus failure - are considered to be normal<sup>5</sup> and even positive, allowed the Valley to survive the crisis of the

---

<sup>5</sup> In this connecton, Lehrer (2000) refers to the relevance of other ways of working together than the dominant German 'authority model'. He goes on to note that 'in America, if you are an entrepreneur with a new idea and you lose people's money in your venture, they'll ask you if you've got another idea. In Germany they call the District Attorney.' (Op.cit., p. 100).

1980s and emerge strengthened. This is in marked contrast to, for example, the less diversified Route 128 region (Boston), where firms such as DEC never quite recovered from their problems in the 1970s.

Hinoul (1999) goes on to list a number of these ingredients. As we have seen, the presence of knowledge centres (in this case Stanford *and* Berkeley) is crucial. Besides their technical expertise and know-how, these institutions also provide other essential specialists, chief among which are people with management skills and legal expertise. Silicon Valley is also characterised by its international orientation, according to Hinoul. The continuous influx of people from other regions of the United States as well as Europe and Asia is seen as an essential, moderating element. The resulting diversity once again helps to create the right kind of breeding-ground, suitable for (international) high-tech venturing. In terms of the work culture, a certain degree of homogeneity is noted nonetheless: the region is characterized by a 'freedom of exchange of ideas', an informal style of working together, and a culture in which entrepreneurship is stimulated, even if it leads to failure. This philosophy is shared by the academic world, the business world and the government.

Complementary to this is the strong presence of venture capitalists *and* private investors: the region accounts for a third of all the venture capital in the United States. A crucial element here is the intensity of the collaboration between investors and innovators/entrepreneurs. Collaboration and guidance involves much more than financial participation: the active contribution to the development of a professional organization, as well as networking, style and the elaboration of strategic alliances all go into this way of working (see also Hansen et al. 2000). In addition, the United States possesses well-developed capital markets which make it relatively easy to efficiently realize second and third rounds of financing; such markets form, moreover, a necessary (exit) condition for venture capitalists to pursue their goals. A additional virtue of Silicon Valley is the region's quality of life, both in terms of its climate and its culture. Finally, the connection to the American market is a crucial macro-economic factor: the extent of this connection allows for faster growth on a larger scale.

### *Cambridge*

In 1954, the government of the region around Cambridge made an explicit policy-planning decision to stem the flow of immigration into the region. There was a desire to maintain the historic university character of the city by keeping large-scale industry out of the region. Since these measures greatly hindered the collaboration between Cambridge University and industries dependent on scholarship and research, a proposal was worked out whereby certain forms of growth - in particular, the establishment of high-tech firms - would be allowed. The proposal was approved in 1970 by the regional government and has since then formed the guideline for development around Cambridge.

A number of high-tech spin-offs and consulting firms emerged from the university's competencies in the areas of electronics, instrument development and computing; this resulted, in turn, in the creation of new companies. These consulting firms coordinated the collaboration between industry and the academic world. National entrepreneurs chose to locate in the university area and large multinationals, too, established small branches in the region.

In 1996, the population of Cambridgeshire was over 700,000. Of these, 28,000 were employed in high-tech companies. In the period 1994-1995, some 87 new firms were set up in high-tech sectors. According to Jim Martin of the 3iGroup, the success of the technology

valley around Cambridge is a result of the presence of several factors: sources of innovation (knowledge), possibilities for financing and a high quality of life in the region, a sufficient critical mass of competencies in terms of management, and finally the interaction between local initiatives and international collaboration.

The first determinant is the presence of sources of innovation. Cambridge University is one of the most renowned universities in the world, with a very strong knowledge base both in the scientific and management areas. It is worth noting that here, too, there was a conscious choice to become an 'enterprising' university. A second factor is the wide possibility for financing start-ups: the proximity of London's financial centre guarantees sufficient venture capital of the best kind. A third factor identified by Jim Martin is the healthy fiscal and cultural environment. An environment that guarantees a high quality of life makes it that much easier for a region and its companies to attract the best international talent. Specifically in terms of running a business, the author emphasizes the importance of the management capabilities available and the general marketing and sales skills of the companies around Cambridge. As a final factor, he points to the importance of a balance between endogenous and foreign investment (exogenous growth) in the Cambridge area. Any time a foreign firm establishes itself in the region, the local high-tech firms have an increased chance to learn. An over-concentration of foreign companies is, however, undesirable, since the region hopes to keep the resulting economic and social benefits close to home.

All these factors were advantageous for the starting up of high-tech ventures around Cambridge University. However, at the end of the 1980s, the successfully launched firms were confronted with increasing growth problems. In 'The Cambridge Phenomenon: The Growth of High Technology Industry in a University Town' by Segal Quince Wicksteed Limited (1990), the most common problems were identified as the unwillingness of company founders to allow their firms to grow, as well as a lack of support by large companies, financial institutions and the government. There were also no large, successful firms in the area that could serve as examples for the small start-ups. Finally, there was a shortage of highly-trained personnel, an increasing pressure because of the demographic expansion, traffic problems, housing shortages and environmental problems. The local population began to protest against the continual expansion of the industry zone. The strain on the quality of life also made it increasingly difficult to attract top international personnel. By the end of the 1990s, the ICT model (information and telecommunication technology) was proposed as a possible solution to this problem. Concepts such as e-working, e-government, e-learning, telemedicine, e-commerce and smart cards were embraced in order to facilitate the technology zone's growth with a minimal effect on the quality of life. This growth to the north and south is now well underway.

### *Sophia Antipolis*

Cambridge's best-known European rival is Sophia Antipolis on the French Côte d'Azur. In 1962 an industry zone was created in Valbonne, where, among others, IBM and Texas Instruments located. In 1965, Sophia Antipolis University was founded in Nice. As an incubator for public and private, scientific, industrial and tertiary activities, the Sophia Antipolis science park was set up. From 1974, various companies and educational institutions set up on the site.

By the beginning of 1999, 1164 companies had been set up there, of which more than 300 were active in the ICT, electronics and health sciences sectors. Of the 20,530 people employed in these companies, some 10,000 work in these sectors. More than 5000 researchers

and students work for public education and research institutions in the region. Foreign companies have also established themselves on the plateau: there are 110 foreign firms in Sophia Antipolis, of which 48 are European and 43 North American.

The evolution of the science park shows clearly the importance of a local scientific infrastructure and how slow and complex the establishment of a 'scientific conurbation' is. Sophia Antipolis, hoping to become less dependent on seasonal tourism, was established in a region with no industrial tradition. The idea began as a private project, led by Pierre Laffitte, director of the 'Ecole Nationale des Mines de Paris', but was quickly taken over by the public sector because of a lack of financial means. Large firms such as France Télécom set up there. In time, two main activities emerged: ICT (65% of the park's employment) and life and health sciences (20%). The park's progress was, in fact, stimulated only by the contribution made by the large firms that settled there. In the 1980s, a number of positive changes were made. In the first place, the region's endogenous knowledge basis was broadened considerably. The University of Nice was expanded, while schools of engineering, specialized in ICT, were established. In time, all the major French research institutions had a presence in the park. All of this resulted in a generous local supply of highly trained workers and increased interaction between research and industry, via the students.

A second positive factor was the arrival of companies offering specialized services to established high-tech firms. A final positive evolution was the creation of spin-off companies out of the most important research institutions, and the setting up of SMEs; both these groups were interested in making use of the research potential in the area. All the same, the growth of Sophia Antipolis was overly dependent on the R&D departments of large concerns and not on the endogenous interactions and initiatives resulting from them.

Only at the beginning of the 1990s, with the crisis in the computer industry, did this state of affairs change drastically. The large firms had to tighten their belts and started to farm out some activities. With the well-developed local knowledge basis, there was an opportunity to deal with this situation locally, resulting in the establishment of new companies, both 'new' start-ups and spin-offs from larger firms. When these larger firms were reorganized, many of their employees wanted to keep on living in the region. They looked for new employment opportunities, leading to the creation of new companies. Large concerns such as IBM and Texas Instruments realized the necessity of collaborative ventures in order to cope with the crisis. Professional associations and clubs were set up in the region. Large and small enterprises started to work together, sharing resources, which ultimately stimulated endogenous knowledge creation.

In contrast, activities in which no endogenous growth or diffusion of knowledge was created and no local collaboration was undertaken, as in health sciences, have seen little success in Sophia Antipolis, despite the fact that a local market for such activities does in fact exist. The present success of Sophia Antipolis is thus due to the presence of the set of factors previously described in this article, which in this case came into being sequentially, rather than the multiplex, multifactoral environment encountered in Silicon Valley.

At present, the Sophia Antipolis region offers a critical mass of knowledge. Established companies as well as research institutions and universities have at their disposal the competencies crucial for the areas of natural and health sciences and ICT. Public educational and research institutions have developed in such a way that they can meet the requirements of (large) companies. Collaboration and partnership between public institutions and companies

have led not only to excellent results for industry, but also the educational and research programs have as a result been validated and improved, to the good of the international reputation of these programs. The international character of the companies and their employees has tended to encourage this knowledge creation.

The presence of two international schools has also contributed to this situation. The attractive environment and the quality of life in the south of France represent additional environmental factors that have led to the success of Sophia Antipolis. This environment has made it possible to attract high quality personnel, who are enticed by both the working and living opportunities. The region has an infrastructure able to support international cultural, scientific and political events. The advanced telecommunications infrastructure and the proximity of Nice airport make it possible for companies to work internationally. Finally, the broad spectrum of services and relations between firms on the site also constitute an important success factor. Service and consulting firms, hotels and other facilities provide the necessary support system for businesses. Perhaps even more important are the many socio-professional associations, discussion groups and clubs, where business people can meet the partners they need for starting and successfully developing their activities. This dynamic of endogenous growth has, however, only taken place over the last ten years. All the necessary ingredients were in fact present before this, but a shock to the business economy was needed in order to produce the culture shock that legitimated and stimulated 'entrepreneurship'.

#### *Leuven*

As early as the 1970s, a cell was created at the Katholieke Universiteit Leuven - K.U.Leuven Research & Development - geared to transferring scientific and technological knowledge to society-at-large and in particular to the business world. In order to effectuate this transfer, many initiatives were undertaken and instruments developed. This movement was - and is - supported by university policy, one of the core elements of which is the concept of the 'enterprising university'.

K.U.Leuven R&D consists of a multidisciplinary staff of legal experts, economists and engineers/scientists, as well as specialized administrative and financial personnel. They offer advisory (legal, financial, technical), coordinating, administrative and information support in the areas of innovation advice and technology mediation ; contracts for consultancy, research and development, in connection with new products, production techniques and technologies. Furthermore, K.U.Leuven R&D developed an active patenting and licensing policy. Licensing and sublicensing agreements are regularly concluded with Belgian and foreign companies. The strategy, which aims to valorise the research, involves the setting up of a patent fund in order to facilitate and encourage the general accessibility to patents for the results of innovative research.

Complementary, K.U.Leuven R&D plays an active role in the setting up of new, research-oriented and innovative companies. This is stimulated by offering advice and support to entrepreneurs, and offering them access to risk capital through the Gemma-Frisius Innovation fund (since 17/10/1997). The Gemma-Frisius fund has already financed the launching of fourteen spin-offs, including eight in the course of 2000. This brings the total number of spin-offs from the K.U.Leuven to 41. Accommodation and management support are available from the Innovation-and Incubation centre, which, with its location on the campus, stimulates close cooperation between the university laboratories and the research units. The success of a number of different spin-offs enjoying international renown is the result of the technology transfer policy which has grown up over the years.

Finally, there is active involvement in the starting up of business activities for national and international research-intensive firms in the science park. New, innovative firms, spin-offs from universities and research institutions, and R&D departments of existing firms can take advantage of the science park's location, close to the K.U.Leuven and IMEC, the Inter-University Centre for Micro-Electronics. This creates a stimulating environment for the transfer of knowledge and technology between internationally renowned researchers and entrepreneurs.

K.U.Leuven R&D and IMEC recently formed Leuven.Inc (in close collaboration with Cambridge Network), in which the local business world, professional advisors and the university are undertaking a number of joint initiatives aimed at increasing prosperity in the region. The ambition of this project, supported at the highest levels of the university, IMEC (the local spin-off entrepreneurs) and the municipal and provincial governments, is to increase prosperity through endogenous and exogenous creativity and through the growth of knowledge-intensive companies in the region. Besides providing the necessary infrastructure, the project sets out to stimulate actively the exchange of ideas and the forming of networks. Existing, established R&D-intensive firms in the region, such as Philips and Telindus, are thus equally involved in this initiative.

This network-forming is of vital importance for attracting and supporting new firms and spin-offs. To this end the multidisciplinary team at K.U.Leuven R&D is involved with the following activities:

#### *Encouraging entrepreneurship*

In cooperation with the Faculty of Economical and Applied Economical Science, an annual course in 'entrepreneurship' is offered to researchers and all students in their final year, regardless of their specialisation. Entrepreneurship is continually stimulated through internal and external publications and presentations of success stories.

#### *Elaborating business plans*

Researchers are taken step-by-step through the process leading 'from idea to enterprise' with the aid of internal and, if necessary, external advisors. Considering the highly innovative character of the products and services on offer, the elaboration of a business plan is a complex and highly individual undertaking for any spin-off project.

#### *Seeking sources of financing and industrial partners*

K.U.Leuven R&D and the Gemma-Frisius Fund are able to contribute to a business's starting capital. Through an extensive national and international network of relations, the multidisciplinary team, together with the founders, considers whether participation by other commercial partners can offer value added. If necessary, contacts can of course be established with external sources of investment and venture capital.

#### *Protecting intellectual property*

Protecting one's own knowledge forms a very important element in the successful start and growth of an enterprise. Working out an effective patenting strategy and drawing up collaborative and licensing agreements are essential in this regard.

#### *Supporting set-up*

The formulation of statutes, as well as agreements concerning shareholders, set-up and remuneration, are important parts of the advice on offer.

### *Supporting management*

Advice concerning strategic decision-making in the area of international growth is facilitated by participation on boards of directors, contacts with K.U.Leuven R&D advisers and, through involvement with the Gemma Frisius-Fonds, the presence of external, independent board members.

### *Providing infrastructure*

In collaboration with the K.U.Leuven R&D divisions, the Innovatie- en Incubatiecentrum and the science parks, a suitable infrastructure is sought out for each spin-off. The Innovatie- and Incubatiecentrum of the K.U.Leuven offers premises and services for the use of research-oriented and innovative start-ups, allowing them to concentrate on the core activities. Besides general infrastructure such as meeting rooms, a cafeteria and a car park, the centre provides services such as the advice of an experienced manager, secretarial support and financial processing. K.U.Leuven has at its disposal a science park in Haasrode with an area of 120ha, where dozens of high-tech firms are located, including the university's own spin-offs, such as LMS, ICOS Vision Systems and Materialise, but also important international firms such as Heraeus and ITCL (Philips). In total, some 5000 people work here. In the near future, the Arenberg and Termunck science parks will be made available, offering an additional area of more than 50ha.

The growing culture of entrepreneurship at the K.U.Leuven has already resulted in 41 spin-offs over a period of 25 years, a number of which are highly active on the international scene. Their combined turnover at the end of 2000 was BEF 15 billion, with a workforce of more than 2000.

## **2.4 A comprehensive innovation system aimed at economic acceleration: the Irish example**

Since the early 1990s, the Republic of Ireland has had a strong track record of successful industrial policy and enterprise support. National policy has been formulated to make effective use of EU programmes and Ireland has been very successful in attracting inward investments. As a result Ireland is the second largest exporter of software and related products. Unemployment is at a record low level and overheating of the economy was until the current economic dip the most evident threat to the stable development.

The success of Irish industrial policy and enterprise support is largely based on an effective organisation at the ministry and agency level. Many of the key tasks have been assigned to one ministry and one development agency, both of which have sufficient power and resources to make things happen.

At the highest political level, the Department of Enterprise, Trade and Employment has a leading role and a wide mandate in the industrial development matters. The work of the Department is supported by Forfás, the high-level policy advisory and co-ordination board which provides strategic level recommendations. The Irish system is rather centralised, resulting in effective decision making at the policy and implementation levels. Such capability coupled with sufficient resources provides a basis for well functioning industrial policy framework. Overall, the policy process can be described as systematic and well structured.

The Irish support system has been evolving in line with the country's rapidly changing industrial base and the agency structure has been subject to frequent changes. In its current form Enterprise Ireland was created in 1998 as a merger of several agencies.

Enterprise Ireland is a single outlet which can offer tailored support for a great variety of enterprises. It has a business process driven by customer needs and is able to offer support, which combines soft management development and hard financial measures. As an independent government agency Enterprise Ireland has a relatively strong position. The fact that its operational activities are isolated from lobbying, and that regional boards have only an advisory role, further strengthens its independent position.

Enterprise Ireland benefits from very clear and measurable enterprise development goals. It seeks to develop firms which employ more than 10 staff and are willing to grow in terms of sales, exports and employment. In the Irish system, locally based County Enterprise Boards take care of the remaining micro firm population. EI and CEB are actively working together and sign post customers to each other when ever it is necessary.

Detailed operational targets for each regional office of the Enterprise Ireland are worked out from the growth potential of their customer base. Hence the offered enterprise support is firmly based on local needs and targets are based on bottom-up estimates.

Another strength of the Irish system is that regional development is clearly separated from enterprise support. The key task of regional development is to create a fertile ground for enterprise development. This has been achieved by offering sufficient infrastructure and well educated labour force for the industry. Local colleges, FAS –the Training and Employment Authority - take care of this by offering a large portfolio of industry related training programmes and training grants for the SMEs. Shannon Development and Údarás na Gaeltachta are agencies which offer additional help to deprived regions which have specific problems. The available support can be used among other things for community development, and for creating sustainable jobs.

Some interesting aspects of Enterprise Ireland related to important aspects of high tech venturing are:

### *Financing*

Enterprise Ireland's objective in providing finance to clients is to share risk in their growth and accelerate their competitive development. The focus is on helping to build *capability* within company as well as adding *capacity*. EI is also working to create the conditions where the private sector becomes the primary source of equity finance for expanding companies. A comprehensive information package and manual on financing has been developed. This package is a reader friendly presentation of available financing and it offers step-by-step financing advice for the aspiring entrepreneur.

The process is iterative, so that EI representatives work actively together with the applicant. They do not simply hand out grants. The financing decision is typically made as a part of wider development process where soft capability development is coupled together with loans and grants.

In Ireland, the private sector takes care of commercial loans, and banks work in good co-operation with the EI. The parties discuss the market situation and one outcome of these efforts are the joint Venture Capital funds. EI has established a string of VC companies as joint ventures with private enterprises. These funds are driven by private sector partners.

However, according to EI there is still need for further intervention in venture capital markets, in particular funds are needed which are able to handle large projects.

*The existing support for business start-ups includes i.a. the following measures:*

- Fast Track Start Up Companies
- Millennium Entrepreneur Fund
- Feasibility Studies: grant supports

#### *Fast Track Start Up Companies*

The support for start-up companies is targeted to meet the needs of high calibre, experienced managers, academics and entrepreneurs creating and building new companies likely to reach significant scale quickly with high growth and export potential. Enterprise Ireland can help by offering

- Multi-disciplinary development teams specialised in helping potential entrepreneurs to develop their concepts into commercially viable business plans
- By advising and assisting in all aspects of the crucial start-up phase.
- Continuous advice and support until the new enterprise grows to its full potential.

Regional offices can help the company to liaise with specialists as required. If needed, Enterprise Ireland will assign a Development Adviser who acts as a key point of contact and gives an access to financial and other supports, including

- Help for evaluating and developing new business concept, including challenging and assisting in formulating the business plan
- Providing both practical and financial assistance for a feasibility study leading to the business plan
- Introduction to potential business partners, investors and financial & legal advisors
- Financial supports including management development, employment grants, capital grants and equity investment
- Access to the full range of Enterprise Ireland services such as: overseas offices, specialist technical expertise and market research resources.

Other categories of start-up enterprise may find appropriate supports through their local County Enterprise Boards.

#### *Millennium Entrepreneur Fund*

This fund provides

- Seed Capital investment of up to I£100,000
- An experienced Company Mentor to work closely on key business aspects
- A Patron Company (a successful Irish based company) to advise and counsel the entrepreneur
- An Enterprise Ireland Development Advisor to assist in all aspects of business development

The target is to award 10 full investments of I£100,000 over a three year period. They will only be approved where high quality applications have been received which meet the Fund criteria. The Fund Board, consisting of representatives of the sponsors, will review applications and agree investments. When applying, the key Irish national should be resident overseas, and have lived and worked overseas for a minimum of 3 of the 5 previous years.

Applications, at the sole discretion of the Fund Board, may also be considered from suitable applicants returning to Ireland within the six months prior to application, provided they meet the other overseas residency requirements.

#### *Feasibility Study Grant Programme*

helps businesses and individuals evaluate the viability of a new manufacturing or international services project. Grants may be available from Enterprise Ireland towards supporting feasibility studies such as investigating the viability of manufacturing a completely new product or process. Enterprise Ireland provides solutions, directly or with partners, to the problem of a shortage of finance for emerging companies seeking high growth. The aim is to support the private sector in developing financial instruments, which increase the number of options for Irish entrepreneurs.

*Third party funding* provides small and medium sized enterprises in Ireland with equity capital through the medium of Seed/Venture Capital funds. Enterprise Ireland administers this scheme which is co-financed by European Structural Funds. The scheme is targeted at Venture Capital Funds, which have the resources and management skills to make commercial investments in growth oriented SMEs. The overall objective of the measure is to stimulate growth and employment potential in these enterprises by the provision of additional equity funding. Funds of 44.5 M EUR (I£35Mill) have been allocated to the measure and, when matched with private sector finance, the total amount available for investment exceeds 89 M EUR (I£70Mill) over the period of the Operational Programme for Industry 1994-1999. Some 15 Venture Capital Funds have been set up by Enterprise Ireland in partnership with the private sector under the Seed and Venture Capital Measure of the Operational Programme 1994-99. A more recent plan is to establish also some larger venture capital funds, which can offer financing for major projects.

#### *Business incubation facilities*

Business incubation facilities and provide supports for graduates are offered under the following programmes:

- Community Enterprise Centres
- Business Incubation Centres
- Campus Companies Programme
- Graduate Enterprise Programme
- Intellectual Property Assistance Scheme

#### *Community Enterprise Centres*

These centres assist community groups in establishing enterprise centres and the programme applies to large urban areas where the rate of long term unemployment exceeds the national average. It runs parallel to the existing Community Enterprise Centre Programme. Funding for this initiative comes from a special allocation in the 1999 Budget. These Centres have achieved good results in helping long-term unemployed to get back into the working life.

#### *Business Incubation Centres*

Enterprise Ireland's Business Incubation Centre programme is aimed at expanding the base of high tech companies operating on college campuses by providing funds to develop and expand incubation space facilities. Campus Companies Programme, Graduate Enterprise Programme, Intellectual Property Assistance Scheme provide supports for graduates planning to set up new businesses. A number of support measures are offered for R&D projects set up in connection with educational institutes.

### *Programmes in Advanced Technology*

The Programmes in Advanced Technology (PATs) are partnerships between Enterprise Ireland, industry and third level colleges. They were established to meet a need for a strategic expertise base in certain key technologies. They help industry to access new technology; improve the competitiveness of existing production and move into new higher value areas.

They also assist industry in attracting overseas and domestic investment in high technology areas that lead to the establishment of new technology based start-up companies. The seven PATs are located across more than thirty centres based within Ireland's universities and institutes of technology.

## **2.5. High-tech venturing: some considerations concerning regional dynamics**

In order to continue to stimulate a region's economic growth based on knowledge-intensive entrepreneurship, the technology portfolio of the region must maintain a balance between routine technological activities (which are often oriented towards process and incremental development as the technology's life cycle matures) and non-routine technological activities (which are often oriented towards new products and more fundamental development). The local knowledge centres - in particular the universities and research institutes - can play a major role here. Such knowledge centres are more solidly embedded in the local and supra-regional context than are the young start-ups. This embedding can assume both structural and non-structural forms and associations. Table 1 presents a survey of the mechanisms and dynamics that knowledge centres can adopt in order to effectuate lasting development on both local and supra-regional levels. Of crucial importance is the exploration of new domains of knowledge - often not yet part of a routine - and the subsequent spreading of that knowledge among the actors in the region.

It is precisely because of this double dynamic that knowledge centres can be accorded a place and a fundamental role in any regional innovation network; such institutions are best able to give visible support to the dual challenge of local and global knowledge development. If this dual task fails to be made a priority in regional innovation policy, the region can fall prey to the threats inherent in the growth-stagnation-relapse model which characterizes the technological life cycle. A region's adoption of a 'dominant technology model' leads inevitably to limitations in terms of diversity and thus equally to a possible 'lock-in' phenomenon regarding the routine technological knowledge basis present in the region and further consolidated there. This existing knowledge basis is generally geared towards efficiency, and over the longer term can work to the detriment of innovation. In order to keep in check this dominant logic inherent in 'technological trajectories', we underline the pivotal role played by knowledge centres when they pursue non-routine research activities and emphasize their supra-regional context. Every regional innovation network thus clearly requires knowledge centres that are both regionally active and internationally competitive.

**Table 1: Knowledge centres and Supra-Regional Dynamics**

	Accent on development and embedding of locally created content	Accent on supra-regional development and embedding
<b>Structural-Institutional Arrangements</b>	Incubators Research parks Spin-offs Education and permanent training	R&D collaboration Affiliation programmes Licenses Consortiums
<b>Non-structural/Project Initiatives</b>	Labour market for researchers and technologists Seminars Professional associations Local networking	Consulting and professional advice Publications Seminars Professional associations International networking

## 2.6. Conclusion: ingredients for a policy aimed at stimulating high-tech venturing

It will be clear from the above discussion that high-tech venturing, and in particular the development of a policy to encourage it, is a complex matter, implying a multiplicity of elements, instruments and actors. Table five which can be found at the end of this article summarizes these different elements. Moreover, the development of such a dynamic implies a long-term approach: the seeds of today's Silicon Valley phenomenon were sown before World War II; Germany spent some thirty years developing a (lasting) dynamic in this area; and the examples in Leuven and Cambridge also illustrate how their basis was laid in the 1970s and how the effects that are now visible imply a genesis of several decades.

The dynamics of high-tech venturing presuppose active roles for the government, the business world and the available knowledge centres. If the government can take a number of supporting measures in the interest of a favorable climate for enterprise, a more 'enterprising' positioning is demanded of the knowledge centres and the firms themselves.

As has become clear, the presence of knowledge centres in a region is a primary precondition for developing high-tech ventures. Both companies and knowledge centres and research can together provide the necessary critical mass of knowledge. In this connection it is important that a broad spectrum of competencies be available. *Innovative* entrepreneurship implies a process of cross-fertilization, involving a diversity of knowledge domains. This conclusion forms the clearest substantiation for the importance of physical proximity: the creation of new combinations involves interactions at close range.

The ability to generate this sort of dynamic naturally assumes that the various actors make their expertise visible and accessible. Companies must be prepared to collaborate, while knowledge centres need to play the role of 'enterprising universities'.

In this regard, the importance of the supporting instruments cannot be stressed enough. Interface cells, built on crucial expertise and networks, stimulate the interaction and collaboration between the different actors. Besides these supporting instruments, an essential role is played by the 'project champions' and 'sponsors'. Both within the interface cells and outside the business, academic and governmental worlds there must exist strong, motivated

pivotal figures who are driving forces in the high-tech developments in the region and who have extensive know-how and networks at their disposal.

In addition, it must not be forgotten that innovative or high-tech entrepreneurship calls for solid management expertise. An entrepreneurial attitude and high-tech know-how need to be complemented by skills in professional management. When dealing with new technology, such skills quickly gain an international dimension. The presence of both knowledge centres (universities/polytechnics with a curriculum oriented towards business economy and law) and established enterprises forms an important facilitating element in this regard.

When it comes to financing, the presence of venture capital is essential. On the one hand this takes the form of risk-capital with all that this implies: in particular, both the provision of capital and the support - strategic/commercial/organisatory - for the development of a balanced and sustainable business. On the other hand, the accessibility of well-functioning financial markets is also important. The presence of such markets - Nasdaq, Easdaq, Neuer Market - geared towards technological growth-firms is crucial for generating a dynamic in the 'early/first-stage investments'.

Finally, a number of socio-cultural elements are equally relevant. Regional cultures characterized by openness, informal networks and interaction, willingness to take risks, and other such qualities, facilitate innovative entrepreneurship. This sort of 'culture' is of course partly built up through concrete projects and accomplishments. Complimentary to this, the general quality of life should not be underestimated in the task of attracting - international - human capital.

## SECTION 3: ASSESSMENT OF THE ESTONIAN SITUATION WITH REGARD TO INNOVATION SUPPORT AND HIGH TECH VENTURING

### 3.1. General economic framework

Out of our interviews and literature reviews, the general picture emerges of two stages in the post-Soviet economic development of Estonia. The first period (1997-1997) can be labelled as the period of “wild west capitalism”, without too much rules and government intervention and without a strong business support infrastructure. The “Roebel crisis” of 1998 was a fissure in government policies. From 1999 onwards, there has been a tendency towards more strategic planning, stronger government intervention and stronger business support services. People in the government acknowledge that this is not only because of an internal paradigm shift. The negotiations with the European Commission about accession and the implementation of pre-accession Structural Funds (PHARE) are also important in this respect. However, the strategic plans are still in the making. One problem is that the wish for stronger economic development policies conflicts with the very strict monetary policy, aimed at low taxes.

The general feeling of our respondents is that Estonia is, after the 1998 crisis, in “quite good shape”. Government policy is open and positive towards the business community. The banking system is working well and the legal framework for doing business is sound. However, the small size of the Estonian population is regarded by many respondents as a main problem hampering further economic developments<sup>6</sup>. The home market is very small. Resources in terms of human capital, materials and capital are limited. There are only 600.000 people employed nowadays in the country, and the fertility rate is relatively low, even in the context of the former Soviet-countries.

Out of our interviews the following important general notions about the future economic development of Estonia can be distilled:

- There is a need to lay more stress on quality instead of quantity. To achieve higher quality levels, investments in human capital are very important. The education system is still too much focussed on higher education, instead of improvements and modernisation on all levels. More specific, there’s a shortage of skilled engineers on all levels. The relationship between higher education and vocational training needs improvement.
- There is an urgent need to find new opportunities for traditional industries. The time for competition with low wages is running out. To prevent a “cold reorganisation” of traditional industries (agribusiness/wood processing) in the near future, the country must find new opportunities for these industries now.
- “Not a single Estonian company is yet successful in the global market”. More international linkages could improve this situation. There is a need for more foreign high quality investments and windows on global developments. Some respondents think that better investments packages for foreign investors (providing land, tax cuts and other incentives) are at least as important as investing in science parks. Also, there’s a need to choose certain spearheads in the field of FDI.
- The development models of Ireland (see also § 2.4.) and Norway are worth studying: these two scarcely populated and peripheral European countries with

---

<sup>6</sup> Some respondents pointed at the lack of interest in technological careers by young people in Estonia. They perceive this as a remarkable difference with the situation in Finland. The amount and diffusion of technological magazines is regarded as a token in this respect.

agrarian backgrounds did manage to become modern, highly developed countries. Especially the way in which Ireland used European money to attract foreign investments and build indigenous industries around them is worth while looking at.

- Estonia could profit from the location between the EU and the Russian market and should exploit opportunities in transit/distribution/assembly and telecommunication.

### 3.2. SME developments, innovation and R&D

There are 26.300 SMEs in Estonia (28.500 in 1997), while to Western European standards there should be around 60.000. (The Dutch comparable figure for a population of 1.400.000 would be approximately 61.000 SMEs) One of the problems is that it isn't easy for new entrepreneurs to supply the necessary capital, although the legal costs to start a firm are not very high in the European context (only 40.000 EEK) and there's nothing amiss with the legal system (none of the respondents marked the legal system as inadequate in relation to starting or running a private firm).

In a study by Emor for the Ministry of Economic Affairs<sup>7</sup> a survey amongst entrepreneurs showed that 54% of the start-up firms encountered financial problems and 32% problems related to a lack of knowledge and skills (especially knowledge and skills related to juridical problems, marketing, sales, financing and accounting).<sup>8</sup> So it comes as no surprise that most firms would have needed help in their start-up phase in the form of subsidies, compensations or loans and in the form of training, consulting and juridical help. The lack of founding capital and the lack of knowledge and skills were also mentioned by Estonian citizens as the most important factors for not starting a firm.

In the interviews the low value of real estate was mentioned as a problem to use mortgages as financial guaranties.

According to the organisation of SMEs, EVEA, the major issues constraining SME development after the start-up phase are:

- High taxes on salaries
- High interest on loans<sup>9</sup>
- Accessing capital for investments
- Bureaucracy
- Availability of professional labour staff
- The small home market.

These issues are still very much in line with the issues raised in the 1998' PHARE report on Estonian SMEs<sup>10</sup>, in which the major recommendations for improving the business climate for SMEs focus on salary-related taxes, the delay in recuperating VAT, the SMEs access to financing (lack of credit guarantees, high interest rates on loans)<sup>11</sup>, the availability of skilled labour and support for export activities.

---

<sup>7</sup> Small scale business in Estonia, Tallinn 2000

<sup>8</sup> It is estimated that 48% of the company owners has a technical education

<sup>9</sup> The average interest on EEK loans was in 1998 15%, since then it has decreased to 9/10% for commercial undertakings and 11/12% for individuals (source: Bank of Estonia).

<sup>10</sup> The state of small business in Estonia; PHARE report 1998

<sup>11</sup> Only 20% of the SMEs used bank loans as an investment source in 1997

The feeling amongst most of the respondents is that in general Estonian SMEs are not ready yet to innovate structurally and to carry out R&D. That's why, according to the respondents from the general business support infrastructure, human resource development must be priority number one with respect to general SME policy. The low level of management skills and the quality of the employees are inhibiting a more quality driven development of the SME community<sup>12</sup>. Also, the lack of capital (reductions in loan offerings and increased interest rates) inhibits investments in new technologies. That's why access to finance must be priority number two.

According to one of the respondents: "executing R&D requires long term planning and a lot of resources, which, given the present low business revenues, is very hard to implement for most of the Estonian SMEs. The only possibility is to outsource R&D to the Universities. But these are still too academic and apart from the business community."

This is reflected in statistics which point out that the total Estonian expenditures on R&D are only 1/3 of the EU average and that the bulk of these expenditures have been made by the public sector<sup>13</sup>. The *share* of public expenditures in total R&D is double the EU average (although as % of GDP it is still less than the EU average), *which leads to the conclusion that private R&D investments are only on a level of 17% of the EU average (situation 1998)*. Within state funded R&D there is a very strong bias towards Research, instead of Development.

Some respondents have the opinion that Estonian government policy has been too much focussed on stimulating exports of traditional products and too little on innovation, modernisation and new product development. One high tech entrepreneur pointed at the difference between Estonia and Finland, concluding that "the effort which has been given in Estonia until now to supporting innovation is very limited indeed".

### **3.3. Development policies**

In Estonia, development policies are mainly implemented by the Ministry of Economic Affairs, which consists of 5 Departments: Trade, Energy, Industry, Building industry and Housing and Economic Development. The Economic Development Department co-ordinates the policy planning process inside the Ministry. The SME Division is responsible for SME-related policies and the Innovation Division for the R&D and innovation related policy aspects.

Until two years ago Estonia focussed mainly on the day-to-day problems accompanying the transfiguration of a Soviet economy towards a market economy.

Of course, before two years ago, there were some government interventions, mainly through the work of seven Foundations, amongst them the forerunner of ESTAG, the Innovation Foundation. But the actions taken were not led by a strategic framework. Accelerated by the negotiations with the European Commission on accession, there is more attention given to strategic planning.

The updated version for the years 2001-2004 of the National Development Plan (NDP) 2000 – 2003 doesn't have an official status and is not regarded as the principal policy document. However, for the activities in the field of innovation, the NDP has been a strategic base for the Ministry for budgetary planning and activities taken by ESTAG in 2000 and beyond.

---

<sup>12</sup> According to some interviewed entrepreneurs it's not only difficult to find skilled production staff, marketing specialists are also extremely scarce

<sup>13</sup> Knowledge based Estonia, The strategy of Estonian R&D, 2000

Innovation financing, innovation support structures and services, human resource development and effective policy making and delivery systems are four priority areas to improve. In line with these priorities different support schemes and capacity building programs are implemented by the ESTAG.

The NDP will be replaced by a SPD (Single Programming Document), expected in January 2003, which will be the reference base for EU Structural fund investments.

In the meantime, the government has approved an “anchor document”: the Pré-Accession Economic Programme, which focuses on the macroeconomic framework and structural reforms need to be taken. Investments in R&D are outlined as a priority under structural reforms to increase the competitiveness of the economy. Public sector investments in R&D are foreseen to increase up to 1% of GDP in 2006.

Macro-economic policies limit the scope for structural reforms and development expenditures. In Estonia monetary policies are strict<sup>14</sup> and aimed at tax reductions. “The government will continue to follow it’s conservative budget and loan policy” and will “reduce government sector expenditures”<sup>15</sup>.

Nevertheless, the Ministry is working on an “Economic Development Policy White Paper”, with a comprehensive vision on R&D, innovation, transfer of knowledge, competition and access to finance. The first draft will be finished by the end of this year. The, widely supported, vision on R&D development is already given in “Knowledge Based Estonia”<sup>16</sup>. But to raise substantial funding for the policy issues of “knowledge based Estonia” will be a tough struggle. The activity plan for the realisation of the strategy will be ready at the end of 2001.

There are nevertheless some regional innovation support activities under the Phare funding with the aim to support the development in target regions, like the Jõhvi IC/incubator pilot in the North-East and the new TRIS and CARIN initiatives for the South-Eastern part of the country.

In the field of general SME policy, strategic thinking has also just started. The main general support structure is now developing, formed by the business advisory services in the counties, also in connection with the work of the RDA.

A strategy document on SME support, i.e. setting the framework for start-up policy and financing SMEs is now in the making.

The five priority issues are: developing human resources, improving access to finance, building a stronger network for business support, improvement of the provision of information on the economic situation and diminishing “red tape”.

The Division for SME doesn’t deal with innovation and R&D issues, which is the field of the Technology and Innovation Division. The general SME scheme’s are nevertheless accessible for both low and high tech SMEs, but seem to be very much focussed on the knowledge level of low tech firms and on social and regional development.

In general the support policies don’t take the “stairway of competences” for different types of SMEs into account (see next page).

---

<sup>14</sup> Estonia National Development Plan 2001-2004

<sup>15</sup> idem

<sup>16</sup> Knowledge based Estonia, the strategy of Estonian R&D, 2000

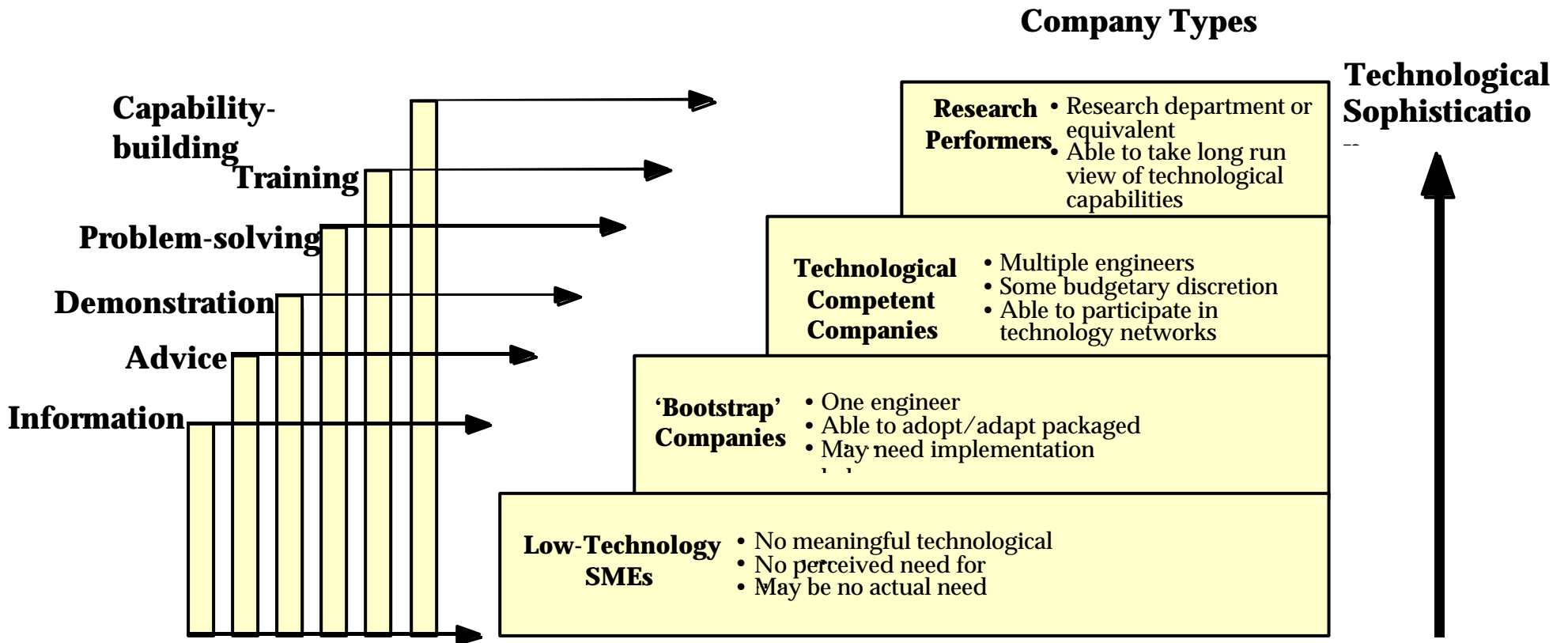
Outside the government itself, organisations tend to perceive a lack of synergy in relation to issues. Every Department and support organisation is focussed on their own jobs, without looking too much at their role in the overall policy framework. This is slowly changing. Outside the government, there is no perception of the existence of a coherent investment strategy or clear policy instruments to relate to. However, our respondents are not blaming anybody, because “during the last 10 years, there was no time to think about planning, everybody was busy going ahead”.

There is also a need for longer term stability in government measures<sup>17</sup> and for real government participation, instead of “just giving money away” (see also the Irish example in § 2.4).

---

<sup>17</sup> Co-operation platform for innovative entrepreneurship support by national, regional and local actors, Green Paper, Tartu Science Park, 2001

The “stairway” of business types: different types of SMEs need different types of services.



### 3.4. The Estonian business support and innovation infrastructure

The Estonian business support infrastructure is in reform and still very much in development, although the main elements of the structure are now emerging.

The “Foundation reform” within the central government is almost finished. The old foundation structure has been dissolved as too inadequate to meet the needs of a more strategy led approach to economic development. There are now two institutions emerging as umbrella structures for implementing central economic policy: EAS and KREDEX. ESTAG is part of EAS. KREDEX is already fully developed; EAS not yet, but the framework is ready. The general idea is that ESTAG is ahead of other agencies. Some people in the business community seem to have problems distinguishing EAS from the Ministry. “EAS should be a linking pin between the business community and the Ministry, but they are still too much intertwined”.

KREDEX is well endowed with capital, but will be mainly focussed on regular SMEs. It will be active in the field of guarantees, also for export activities. It won't be very important in the field of innovation/high tech stimulation. ESTAG will take up venture tasks in the field of high tech. If there need to be additional structures is still the subject of study. The very small amount of business angels can only be a very small part of the solution.

One of the organisations that is brought under the EAS flag is the Regional Development Agency, which is in the process of transfer from the Ministry of Internal Affairs to the Ministry of Economic Affairs.

The RDA acts as an umbrella institution for the county based structure of business advisory services, which is the main Estonian structure for general SME support. On average 1,5 fte per county (15 counties, there's no service in Tallinn) are providing the services (loans; training; consultancy on finance, management, marketing, strategy and legislation). *The business advisors are legally private and free to pursue their own private consulting.* The RDA buys services of them, thus providing them with financial support out of the state budget. In this way the state wants to ensure a kind of “minimum advisory service” for SMEs, in which each SME can get 3 hours of advice free of charge.

There are special packages for start-ups, including training courses, start up loans, information days and access to a materials package “how to establish your own business”.

The regional centres can provide or mediate for guarantees and investment loans.

The problem is that until now the quality of the services has been varying and unstable. The SME Division of the Ministry of Economic Affairs is now working on minimum quality requirements.

The RDA business services are strongly focussed on two target groups: SMEs oriented at export and SMEs that fit into the objectives of the regional development strategy<sup>18</sup>. High tech companies are not excluded, but the services are not acuminated to them and the services are not available in Tallinn.

PHARE money has been used to set up initiatives in the peripheral areas (IC/incubator in Ida-Virumaa, PHARE Start Up Fund and plans for three Business Incubation Centres in the South-East). Further initiatives in the South-East will be developed under the flags of TRIS (regional innovation strategy) and CARIN (concrete initiatives, but with a strong focus on

---

<sup>18</sup>Regional Development Strategy of Estonia, 1999

Tartu). Some respondents have expressed their doubts about the critical mass outside Tallinn and Tartu for Technology Parks and Incubators.

There are three SME related business organisations: the Estonian Association of SMEs (EVEA), the Estonian Confederation of Employers and Industry (ETTK) and the Estonian Chamber of Commerce and Industry.

EVEA is a non-governmental, non-profit organisation, which provides information, counselling and training to its 500 members (maximum 500 employees). There are three people working in EVEA. The services provided are business consulting, business missions, seminars and partner search. There are up till now no special services for start ups. EVEA is however partner in training courses in entrepreneurship for unemployed people organised by the Ministry of Social Affairs.

According to the director, EVEA has three principal goals in the next years: increasing membership (membership seems to have been diminishing since 1997), improving the services for members and strengthening the network and information exchange with other organisations (ETTK and ChoC but also others). The ideal is to reach a “one entry point” system giving SMEs access to all important services, regardless of the organisation the SME turns to. This ideal is however very new and it will take time to be realised. To reach these goal, EVEA has to find means to find and pay extra personnel.

The main activities of ETTK lie in the field of labour market and social affairs. It represents employers' interests in collective bargaining. Members are 33 branch organisations and ± 30 big companies. ETTK provides trainings on labour and social issues, also in relation to the EU. The associated branch organisations provide more specialised trainings, i.e. on quality management. There are no specific services for start-ups.

The Chamber of Commerce has 3.000 private members. The Chamber specialises in furthering domestic and foreign trade contacts, i.e. an internet database for trade offerings.

The Chamber perceives a new era in foreign investments in Estonia. In the past years investments were mostly related to privatisations. Nowadays, Estonia must focus on more difficult “greenfield” investments. In the perception of the Chamber, there is still not a good “incentive package” for foreign investments in Estonia.

The Chamber nowadays doesn't play a role in new business development, but is willing to be active in this field.

As it is, several organisations are still pondering their future strategies and services. There is a general willingness to cooperate and establish platforms and “round tables” (like the one in Tartu/South-East Estonia). But some respondents from the general business support infrastructure state that they don't feel ready yet to work with the University related institutions like the IC's.

The amount and range of services specifically focussed on starters is limited (mainly to KREDEX and RDA and PHARE related programmes and advisors) and there seem to be no special networking activities (like business clubs for starters) for them.

### 3.6. High tech venturing in Estonia

High tech venturing initiatives in Estonia are mainly focussed on the Tallinn Technical University (TTU) and Tartu University.

Both Universities have the about the same size. In international perspective the Universities are quite small, for example about half the size of the University of Lund in Sweden.

With respect to contract research and spin off creation, Tallinn Technical University could, at a first glance, seem better endowed with possibilities for high tech venturing (it is after all a *Technical* University!). Tartu University has a wider range of faculties, and many of them are not of primary importance to industrial research and high tech venturing (Theology, Law, Philosophy, Exercise and Sport, Social Sciences).

In reality though, the high tech venturing support structure is more mature in Tartu than in Tallinn. Initiatives to set up a science park in Tallinn in the past were not successful and in more direct connection to the University, the support structure provided by the TTU Innovation Centre is of a very recent date (1998). Even more recent is the strengthening of the TTU R&D division (in total 6 persons).

In Tartu there is a well established science park and a large R&D department (25 people), from which a new IC is now emerging (out of the Innovation Office of the R&D department) as a pilot project for the establishment of the technology transfer institution of the University.

In Tallinn the respondents acknowledge that they are just at the very beginning of a more focussed and structured approach with regard to contract research and spin off development, backed up by a new University management (several respondents remarked upon the change of attitudes in a positive direction). The University at this moment has 6 structural research contracts with big companies, only one of them a real high tech company. There are also contacts with foreign firms like Nokia and Ericsson. The R&D Department wants to increase the share of industrial funding for University R&D from 23% to 40% and develop standards to secure a higher and stable quality of contract activities. The aim of the R&D department is to develop a service package for scientists who want to develop their own business. They will have to pay for it, for example by distributing shares. According to the R&D Department the TTU is willing to be a shareholder, but not more than 50%.

The TTU representatives will need, according to themselves, 2 to 3 years to achieve visible results. It's too early to formulate longer term strategic goals, because they are still trying to get a clear picture of "what is actually going on".

The infancy of developments also holds true for the relation between the R&D Department, the IC and the future Technology Park, which should be developed into a clear and synergetic division of tasks within the framework of shared strategic goals. At this moment there is a danger of a duplication of tasks, especially in the assistance of researchers in their relations with industry and business.

The IC is responsible for the execution of the spin off programme, which started in 1999 and in 2001 will be organised for the 3<sup>d</sup> time. The programme provides an 8 days' training course for students and researchers, with parallel consulting, resulting in a business plan, followed by 3 days of more specialised group training with mentoring. In 1999 there were 11 participants, in 2000 13 and in 2001 the aim is to involve 25 participants, resulting in ca. 12 new companies.

There's also a programme for training students in entrepreneurship and enabling them to execute projects in firms.

Follow up support activities are less focussed, although entrepreneurial researchers and students can make use of several activities of TUIC in the field of commercialisation and marketing of R&D results and international contacts, i.e. by means of association agreements (12 associated companies at present). The lack of incubators is a recognised white spot, although there is a possibility to rent rooms in University buildings and there is a Cybernetica House Technology Park with at present 70 companies. Some respondents pointed towards the difficulty to make use of University assets.

The representatives of the TTU list a range of possible problems inhibiting the start-up and growth of spin offs: lack of micro-seed capital and growth capital, the lack of IPR knowledge and support ("how to commercialise knowledge against a fair market price"), the lack of management knowledge and management support and a lack of cooperation.

They'd prefer a project based support for new spin off programs aimed at better services for scientists.

One of the issues is IPR, the R&D department strives at stronger bonds with (foreign) patent offices, i.e. the two patent law offices in Estonia. One of the people in the department is going to be responsible for IPR issues.

There are plans to develop a Technology Park within the TTU area. According to the TTU, the infrastructural development is only possible with financial support from the Ministry of Economic Affairs and the City of Tallinn. This Technology Park will contain an incubator, but will also be open to mature firms. A possible location has already been chosen.

The development of the Technology Park is one of three issues for which the TTU is looking for government support. The other two are the establishment of one or more NUTEC-like competence centres and the establishment of a new spin off programme.

Then there's the question of focussing on the most promising knowledge fields. According to the R&D Department they need one year of development to be able to pick out the most promising fields of research. Until then, they don't want to bias their efforts into specific directions.

The most promising fields of research could be IT (design and testing; semi-conductors) and different fields of engineering (i.e. maintenance engineering). Solar Cell research was also mentioned. In Tartu the strongest research basis seems to be in Materials and Bio-related research fields. Critical mass could more easily be attained if in the fields of Biomedical research and Materials Technology both Universities would cooperate.

All in all, the new developments in Tallinn will be a real challenge, because it looks like the researchers are, in general, either not interested in external contacts or that they're already having all kinds of long established private contacts (i.e. with traditional food or wood processing firms) on their own account.

A serious problem is the average high age of scientists (55% over 50; 25% over 60) and the lack of influx of young scientists. The activities of the R&D department must contribute to a broader range of possibilities for young scientists, thus increasing the attractiveness of an academic career.

This problem is obviously also present in Tartu: the average age is lower (45), but the Tartu scientists are either old or very young, the in-between generation is missing.

Tartu University has the advantage that there is already a basis in existence, furthered by a very dedicated vice-rector and R&D Department.

The impression is that they are more experienced and certain about the issue of business relations and business development. Nevertheless the industry funded research budget is almost the same as in Tallinn (31.1 million EEK vs. 30.6 million EEK).

The division of tasks between the Tartu R&D Dep. and the IC seems to be more clear and stable, with the R&D Department focussing on international contacts, contracts and large projects and the IC supporting researchers (mainly IPR), spin offs and initiating knowledge transfer seems to be more clear than in Tallinn. It is important to monitor the division of tasks during the process of establishing the new Technology Transfer Institution of the University.

The IC executes the spin off programme, as part of the Tartu University Innovation Support System project. The founding and support of spin off companies is explicitly backed by a motion from the University Council of June 1999. The spin off programme consists of a training course (especially business planning, marketing, IPR and project management) and support on business planning, marketing, accountancy and contracting.

There are now 10 official spin off companies listed, especially in the field of gene technology and medical technology.

In Tartu, the representatives see a number of possibilities for improvement (management, IPR and capital being the three priority items in relation to spin offs)

Also, the difficulty to find people with entrepreneurial skills who can be joined with the scientists is a major problem. An interesting idea is the plan to start an "Entrepreneurial Centre" at the Faculty of Economics, although it has to be taken into account that running a business is a multi-disciplinary job, broader than economics alone.

It should be noted that initiatives in Western Europe aimed at students doing projects in SMEs turn out to be best suited for "medium tech" firms.

It is clear that even in Tartu there seem to be not very many concrete incentives for researchers to be involved in entrepreneurship. IPR support (especially information on patenting) is stronger developed than in Tallinn and there seem to be less bureaucratic inhibits, but, apart from the spin off programme, which is also accessible for students and has a limited size (15 people in the current training programme), there isn't a comprehensive facilitating infrastructure aimed at tackling *all* crucial aspects of high tech venturing.

Maybe the relation between the University and Tartu Science Park can act as symbol for this conclusion: the bonds between the park and the University are quite loose. There is no explicit relationship with the spin-off programme.

The science park as such is firmly established, although the development has been pragmatic and stepwise, hindered by lack of money. There is a limited incubation function. The science parks uses varying rent levels for it's clients. The average occupation is 24 to 28 firms, with approximately 8 firms originating from the University. At this moment there is only one firm of foreign (Swedish) origin. The science park is fully occupied, with 8 firms on the waiting list. 10 externally located firms are associated with the science park. There's a strong need for further development, with quality standards which are able to attract more knowledge intensive (foreign) investments. Because of this, the science park offers no opportunities for "spin off programme graduates" in search of a location.

Like in Tallinn, there are plans in Tartu to establish one or more government supported competence centres.

In annex 2 a detailed schematic overview of high tech venturing related information and issues is given.

## **SECTION 4 CONCLUSIONS AND RECOMMENDATIONS**

### **4.1. General SME and start up support infrastructure**

The general SME support structure is mainly focussed on the basic business issues. Innovation is hardly an issue (except of course in specific organisations and programmes in and around Tallinn and Tartu Universities and the Jõhvi pilot, which doesn't live up to the expectations). Too many people see innovation and R&D as the same subjects, thus ignoring the more basic status of innovation.

The only general support structure for SME support is the RDA related network of county based support services. The number of advisors seems to be sufficient, but the "minimum package" of RDA steered support is relatively "thin" and quality seems to vary too much between the counties. In Tallinn the City government should not wait too long in building an own support structure, as the bulk of the RDA money is directed to the peripheral counties.

We perceive a "gap" between basic support for low tech firms and "commercialisation of R&D"-related support for university related high tech firms in Tallinn and Tartu.

Innovation support for "medium tech" firms and also more general innovation management support for high tech firms is missing. The idea that "the SMEs in Estonia are just surviving and are not ready to innovate" is dangerous in the sense that it could become a kind of self-fulfilling prophesy.

Cooperation and networking between organisations is still in it's infancy. The preconditions seem to be better in Tartu (round table, TRIS, CARIN) than in Tallinn.

There are no synergies between the general basic (eg. RDA-related) SME services and the Innovation Support Infrastructure in Tallinn and Tartu, which is necessary to fill in the gap and to obtain "smart" solutions for the new spin off programme. It is also important to establish links with the Investment Agency. The general services could act as preparers and could fill in certain basic training and consultancy needs, without the need to build up high tech venturing skills themselves. Maybe the TRIS project could work out some frameworks for this in the Tartu area.

### **4.2. Research capabilities**

In general there is a broad range of disciplines and knowledge available. Even for insiders, given the infancy of the support structure, the use of focussing spin off creation on certain research fields is still a question-mark. But given the timeframe and resources needed to enter certain markets, the development of an active patenting/licensing policy might be better suited for certain areas (i.e. Biomedicine). This latter implies an international orientation and critical mass in terms of research. Therefore, opportunities for cooperation between Tallinn and Tartu (or between an individual university with research groups abroad) should be exploited (especially in the fields of biomedicine and materials technology).

### **4.3. Spin off creation and support**

Although there is a difference in the "maturity" of the support structure for spin off creation and support in Tartu and Tallinn, both Universities lack a framework for stimulating high tech ventures in which all relevant aspects of spin off creation and spin off support are taken into account. The running programmes are to a large extend training programmes on business planning, management and marketing.

Government support for new spin off programmes should be aimed at influencing the development of more “complete” programmes and support structures, that in themselves have to be in conformity with the demands of the market.

In building these programmes, a clear and synergetic division of tasks between different actors (R&D departments, ICs, science parks, competence centres) should be an important issue. The role of the competence centres could lie in bridging the gap between fundamental research and applicable research. In relation to spin off creation they could be important sources for new spin offs, but they could also be relevant as R&D partners, suppliers of facilities and windows on new technological developments (for SMEs and SME advisors and (college level) vocational training). There are also opportunities for stronger links with branch organisations. We suggest a tuning between choice of the research fields of the competence centres and the spearheads for high tech venturing.

An aspect not to be underrated is the necessity to build in enough incentives for young Estonian and foreign scientist to work at the Universities.

The PHARE IC/incubator initiative in Jõhvi is generally not regarded as a success, but maybe this is also a result of the specific, larger scale, economic structure of Ida-Virumaa. Several respondents uttered their doubts about the critical mass for Business Incubation Centres in peripheral areas, although there could be possibilities in Pärnu or the Haapsalu area. Apart from that it's important to stimulate the introduction of new med-tech and high-tech developments in existing traditional sector firms.

#### **4.4 The importance of FDI**

With respect to the development of a texture of knowledge intensive firms, foreign direct investment might be an important accelerator, especially for smaller countries. The benefits of the presence of international firms are manifold and relate to closeness and access to the latest developments within technical fields, managerial expertise and competencies and might as well imply possibilities in terms of international market development.

Competition in terms of attracting such knowledge intensive investments is fierce however. In that perspective it is important to concentrate efforts and to propose a unique profile towards the international business community.

The following points of concern are relevant:

- Presence of endogenous critical mass in certain areas (e.g. materials, biomedicine, ICT)
- Presence of well educated work force in target areas (engineers, medicine,...)
- Attractive working and living conditions (e.g. modern infrastructure/buildings, network facilities, housing,...)
- Low cost/tax structure for potential investors.
- Targeted efforts to attract such investments

Notice in this respect that the development of the physical infrastructure of the science parks is a point of attention as well.

## **4.5 Venture Capital**

Currently, the financial markets within Estonia are characterised by a limited amount of available venture capital. This is especially the case for early stage investments, which are characterised by high levels of risks. In the case of high technology venturing, these risks tend to increase as both market development and technology are characterised by uncertainty and imply development paths which cover longer time periods. On average one can state that for these companies it takes about 7 years to evolve towards mature self sustaining entities. Given such time periods one can even rise the issue whether the market will provide funding for this type of companies. As such, several countries and/or universities are creating specific seed funds (e.g. K.U.leuven) which focus on these early stages.

These funds imply a joint effort of both university and private, financial, partners. The latter play a crucial role with respect to the introduction of professional expertise. Creating such a mixed fund might be a relevant ingredient for Estonia's policies to stimulate innovation and especially high tech venturing. In a first phase the amount of capital required for such a fund might be moderate (e.g. 2/3 M EUR). With investments of on average 250.000 Euro such a fund would be able to support about 10 companies; given the current scale of the universities involved this might cover a two/three year time period.

In this respect it should be noticed that certain sectors aimed for are capital intensive by nature. This is especially the case for biomedicine. The capital intensive nature of this industry relates to both development efforts and international market development. Hence it might be argued – given a limited amount of resources – that for such sectors policies are targeted towards an active patenting and licensing policies rather than having a venturing oriented nature.

## **4.6. Development of Infrastructure**

At this moment, one can observe a contradiction between the state of the science park infrastructure and the actual demand for facilities. While the infrastructure clearly asks for modernisation and further development the demand for such facilities seems to exceed the supply. As such one can state that there are opportunities for development of the premises based on market mechanisms. Private initiative could coincide with government/university support and regulation and would allow for accelerating the development process. Practices that might be relevant in this respect are granting land to project developers for a longer time frame (e.g. 50/100 years); the construction and exploitation of the facilities would then be handled by such a project development consortium while university would be involved in decisions on the selection of the firms etc. Notice that more 'prudent' actors on the financial markets might be interested in the investment opportunities of such projects; especially pension funds which take a longer time horizon for investment, combined with lower risk, might be involved in financing these developments.

## **4.7. Comparison with the international best practices**

As the overview within section 2 makes clear a multitude of elements are important for stimulating and fostering high tech entrepreneurship, and more specifically the development of spin off activities at knowledge generating institutes like universities and research centers.

Not only do knowledge generating institutes have to install adequate transfer mechanisms in this respect; interactions with several other contributing actors are essential to achieve sustainable results. Table 2 on the next page summarizes this logic:

---

**Table 2: ingredients of a high tech venturing policy**

---

**Government Policy Framework/Regulation**

- Property Right legal framework
- Funding/VC involvement
- R&D policies and priorities
- Regional development policies

**Existing Business Support Infrastructure**

- Kredex (loans and grants)
- RDA (general SME support network)
- Investment Agency & Estonia Trade promotion agency (FDI - international business development)
- Synergies with Carin, Tris, ...
- Competence Centres
- ...

---

**Entrepreneurial Universities/Research Centres:**

Initiatives with respect to spin off's, patenting/licensing, contract research  
Supporting specialised services  
Facilities (temporary offices, lab infrastructure,...)  
Development of balanced and stimulating institutional/legal framework

**Business Community**

- Co-operation with existing companies/employers organisations/chambers of commerce (contract research, co-development, transfer of 'business know how' towards spin offs, ...)
- Funding/VC involvement

**Science Park Infrastructure**

- Real estate development, maintenance and exploitation
- Basic services
- Specialised services (?)
- Attract relevant FDI
- Formal and informal information exchange and networking initiatives
- Financial support/services?

When the ingredients of international best practices are compared with the actual state of affairs both within the Tallinn and Tartu region, the following points of attention can be advanced<sup>19</sup>:

- Broad Range of disciplines and knowledge available
- Strategic intent/willingness at the top to further enhance the entrepreneurial nature of the knowledge generating institutes
- Unclear task division/coordination between different actors (both at University R&D/IC level, as with respect to other intermediaries (Competence Centres, RDA,...))
- Lack of supporting financial arrangements
- Unclear policies with respect to patent/licensing versus spin off activities
- Real Estate Development initiatives (science parks) can be significantly improved
- Interaction with the existing business community could be improved; this includes cooperation on the level of FDI as well as contract research (incl. consortia formula) and education (whereby company professionals can take on a role as teacher/coach as well).

Of course, it is clear that the ESTPIN programme, given the available resources and time-frame, can not address all issues involved in the development of knowledge intensive entrepreneurship. Hence, the priorities lined out in the next section have been put forward in the call for proposals of the ESTPIN programme.

---

<sup>19</sup> The scheme with can be found in Annex 2, contains a more elaborated description of the current state of affairs in the Tallinn/Tartu region organised by the different ingredients stemming from international best practices.

## SECTION 5 TOWARDS THE ESTPIN PROGRAMME

### 5.1. ESTPIN goals and focus

Based on sections 3 and 4, the ESTPIN programme should aim at achieving the following general goals:

- Strengthening the international competitive power of the Estonian economy, by developing new knowledge-intensive economic activities;
- Furthering the commercialisation of the R&D activities executed in the Estonian Universities and research centres;
- Strengthening the position of Estonian Universities and research centres as sources and supporters of entrepreneurship;
- Strengthening the overall Estonian innovation support system.

ESTPIN should support “packages” of activities, in which two complementary types of action have to be addressed:

*Type 1 (§ 4.2 and 4.3 and the central box in table 2 on page 27):*

- a. actions that directly support the creation and sustainable development of knowledge intensive start up companies stemming from the scientific and technological competences present within the universities and knowledge centres involved (spin offs).
- b. the development of contract research, patent and license strategies, establishing R&D collaborations and affiliation programs between research institutes and private companies.

It is important to focus spin off creation and especially patent and licence policies on certain research areas. However, given the scale of the Estonian Universities and research centres, critical mass can be more easily obtained when universities, institutes and disciplines cooperate. Therefore one of the goals of ESTPIN should also be to enhance this cooperation.

*Type 2 (§ 4.1; 4.4; 4.5 and 4.6 and the other boxes in table 2 on page 27):*

As mentioned, best practices clearly indicate that entrepreneurial universities and research centres cannot act in isolation. Sustainable progress in terms of regional development implies a variety of interactions with other actors. These actors include:

- existing companies - both local and international -,
- intermediary organizations and employers organizations,
- agencies that are involved in the development of real estate and infrastructure (especially in connection with science park infrastructures),
- suppliers of venture capital
- local and national authorities (also related to stimulating foreign direct investments).

Given the necessity of such interactions for developing and embedding knowledge driven economical activities, the ESTPIN program should support initiatives that foster such interactions as well.

## 5.2. Mandatory actions

As mentioned, the two themes bring along a multitude of potential actions. The following actions should be considered mandatory for ESTPIN:

- Initiatives aimed at the development of a stimulating legal/institutional framework that affects the entrepreneurial dynamics within knowledge generation institutes.
- Initiatives with respect to spin off creation.  
These might include, but need not be limited to: the creation of awareness with respect to spin off creation, the development of specialized know how and services relevant to move from idea to business plan and the development of a network of experts in this respect.
- Initiatives with respect to fostering the sustainable growth of spin off companies.  
These might include, but need not be limited to: the development of specialized expertise specific for the growth of high tech ventures, the development of networks aimed at making accessible such knowledge and the creation of consortia/round table formulas in which entrepreneurs can exchange insights and experiences
- Initiatives aimed at developing patent/license policies.  
These might include, but need not be limited to: the development of specialized know how and services regarding IPR in general and patents and licensing in particular and the development of a network of (international) experts that can support the patent application and valorization process (licensing)
- Initiatives with respect to funding and creating access to (international) capital markets.  
These might include, but should not be limited to: support in funding spin off companies, including setting up structural arrangements in this respect with local and international partners.  
Notice however that within the ESTPIN program direct participations in spin off companies (capital investments) should be non-applicable costs.
- Initiatives aimed at enhancing the amount of contract research and co-development.  
The focus within the framework of ESTPIN should be on the improvement of the institutional and organizational basis and the *framework* for contract research activities.  
The initiatives might include, but need not be limited to the further development of a professional communication strategy towards potential contract research partners; the development of adequate interface arrangements (e.g. with respect to contracting), the development incentive mechanisms and their legal/institutional translation, initiatives with respect to communicating (marketing) the knowledge intensive activities taking place in Estonia within the Baltic region and beyond in order to establish international involvement and collaboration.
- Initiatives aimed at fostering information exchange and collaboration between relevant local and international actors.

These might include, but need not be limited to setting up forums where local research groups and private enterprises can share insights and experiences regarding emerging science and technology domains; the creation of platforms where business development issues can be explored and discussed, the development of transfer arrangements whereby expertise available within industry is made available to research groups and/or starting entrepreneurs/spin off companies, and initiatives that relate local know how and competencies to international networks and centres of excellence.

The actual package of activities should relate to the present strengths and weaknesses of Estonian high tech venturing as described in sections 3 and 4.

## **Annex 1      Definitions**

### **Public Research Centres**

Institutions, independent or owned by a University, where the execution of fundamental and/or applied research is a core activity. Ownership must be at least for 50% in public hands. The research itself might be publicly or privately funded.

### **Contract Research**

Research executed by Universities or Public Research Centres by order of and paid by one or more third parties (not other Universities or Public Research Centres).

### **Spin offs**

New commercial enterprises founded or co-founded by students and/or researchers working in Universities or Public Research Centres, in which the core competences must be – at least substantially – based on research activities conducted at the University or Research Centre.

### **Patent/licence policy**

The active development by Universities or Public Research Centres of a patent portfolio, based on pre-selected research areas, and the active commercial exploitation of these property rights by granting licences to third parties against licence fees.

Patent definition: a writing securing to an inventor for a term of years the exclusive right to make, use, or sell an invention.

### **High tech venturing**

A longer term dynamic process - based on interactions between Public Research on the one hand and a high technological, R&D-intensive, industrial environment on the other – aimed at the creation and growth of internationally competitive high-tech firms and the attraction of R&D intensive foreign direct investments.

This dynamic process asks for active and interwoven roles to be played by a government creating favourable conditions, ‘entrepreneurial’ universities and research centres, a business community willing to cooperate and share knowledge and facilitating intermediary organisations.

In this process sufficient attention has to be paid to high risk seed and growth capital, internationally attractive business locations (incubators and science parks), access to financial markets and a professional innovation support system, also giving general business support.

### **Innovation support system**

The organisations providing support and services to SMEs related to their innovation management (the organisation of innovation, the use of internal and external knowledge, process renewal, product development, IPR, human resource management, market development and financing innovation).

An ideal innovation support system takes into account the segmentation of firms and provides different support ‘packages’ for each type of firms (research performers, technological competents, minimum capability companies, and low-technology SMEs) . The aim of the system is providing services which are capable of moving firms a considerable distance up the “capability staircase”.

## Annex 2 Schematic overview of high tech venturing related issues

	<b>Tallinn Region</b>	<b>Tartu Region</b>
<i>Research Capabilities (incl. range)</i>	<b>Research Budget 133 mio. EEK (23% Industry – 59% Gov + ESF – 12% EU) 225 Doctoral Students – 286 Professors – 141 research staff – 55% age over 50 (25% over 60) 9 faculties (Civil Engineering/Power Engineering/Humanities/Information Processing/Chemistry/Economics and BA/Mathematics and Physics/Mechanical Engineering/Systems Engineering 9 affiliated Institutions incl. Institute of Cybernetics.</b>	<b>R&amp;D budget 173 Mio EEK (2001 estimation) (57% Gov – 18% industry – 25% ESF-EU) 510 Doctoral Students – 120 professors – 180 researchers – 600 ass. prof./lect./ass. 10 faculties (Theology, Law, Medicine, Philo., Physics &amp; Chem., Exercise &amp; Sport, Econ. &amp; BA, Mathematics, Social Sciences) + institute of Physics Industry research focuses on healthcare, medical sciences, gene-and biotechnology, material science and social studies</b>
	<b>Focus on ICT and engineering</b>	<b>Focus on Biomedical and Materials</b>
<i>Strategy/vision Universities</i>	<b>R&amp;D should contribute to the development of Estonian Economy R&amp;D should create new knowledge and transfer it into teaching</b>	<b>Assure efficient transfer of know how and new technologies to industry Laying the foundations of high-technological Estonia by promoting entrepreneurship and a stimulating environment for innovation at the university</b>
<i>Issues</i>	<b>Broad range of disciplines/knowledge available Focus/Strengths (on an international level) is a questionmark Critical mass is important → Also search for possibilities for cooperation between Tallinn and Tartu (esp. biomed. and materials)</b>	

---

	<b>Tallinn Region</b>	<b>Tartu Region</b>
<i>Transfer Mechanisms (University/Industry) Available expertise and networks (incl. Project champions/role models)</i>	<p><b>TTU Innovation Centre (founded in 1998 by TTU, MoE, Tallinn City, ECEI, Helsinki University):</b> Active Marketing of R&amp;D projects originating from TTU</p> <p>Offering expertise to researchers with respect to contracts with industry</p> <p>Launch and management of spin-off and incubation system for start-up companies</p> <p>Patents and licensing activities limited</p> <p>Broader structure is emerging: strengthening of R&amp;D Department (6 people), aiming at a higher share of industrial funded R&amp;D (from 23% → 40%), quality standards and a service package for entrepreneurial scientists. TTU is willing to be a shareholder</p> <p>Plans to develop a Technology Park with an incubator.</p> <p>Stronger support and transfer structure is still in it's infancy. Need to work out a clear division of tasks and develop synergies between R&amp;D Dep., IC and new Technology Park</p> <p>There are government plans to develop competence centres in the next years</p>	<p><b>TU Innovation Support System Project:</b> Spin-off program (training + support activities) Promotion of knowledge-based services and technologies (incl. spin off firms – n=10) Technology Transfer services (IPR/PatentTM/Licensing – Develop. &amp; commercialisation support)</p> <p><b>TARTU Science Park (Tartu City &amp; County, University, Eston. Agricultural University and Institute of Physics):</b> creating a favourable environment for the emergence and development of knowledge intensive business activities (EU Industrial Pilot Project – Science Park Incubator initiative (facilities) – Start-up Fund (grants) – Services (assist in funding, entrepr. skills, admin. &amp; infrastructure support)</p> <p><b>Innovation Centre (pilot project for the establishment of a technology transfer institution (foundation or company) of the TU (supported by CARIN).</b> Originated out of Innovation Support System (Innovation Office within R&amp;D Department ) : Focus on Management of Spin off program, Contracts with Spin offs (incl IPR), Contracts with Industry - Enabling Services Participation within TRIS (EC)</p> <p><b>The R&amp;D department (25 people including IC)</b> focuses on international contacts, on contracts and on large projects</p> <p>There are government plans to develop competence centres in the next years</p> <p>Transfer project North-East Estonia (Ida-Viru) and</p>

*Issues*

**Task Divisions and synergies between different actors (R&D divisions, IC, Science Parks, competence centres)**  
**Synergies with general SME support infrastructure (general business support, partner search, marketing support, etc.)**

---

	<b>Tallinn Region</b>	<b>Tartu Region</b>
<b>Infrastructure (ICT, buildings, parks,...)</b>	<b>Internet Economy Lab</b>	<b>CAD/CAM Training Centre/Laser Chamber</b>
	<b>Cybernetica House – Technology Park (70 start ups and spin offs – 14.000 sqm – n= +/- 400)</b>	<b>Carin Project for development around areas of biomedical and material technologies (biotech incubator, material technologies centre of excellence)</b>
	<b>Testing and certification Centre</b>	<b>Private investments in Science Park infrastructure amounted to 2.5 mio EEK (2000) Science Park infrastructure: 4000 sqm (heated) – territory 0.8 ha.</b>
<b>Presence and interaction with larger established companies</b>	<b>12 companies associated Presence of Cybernetica Ltd. As Research Company ( n= 95 - ICT) Presence of Biotech Res. Institute Tallin Region counts for majority of FDI (however most in traditional sectors)</b>	<b>25 companies present on TSP – Majority SME's</b>
<i>Issues</i>	<b>The development of the Infrastructure could be accelerated by setting up project development initiatives (real estate development) Such initiatives can too a large extent be financed and realised by private industry Synergies with other Economic development initiatives should be looked after (attracting relevant FDI, keep the science parks open for knowledge intensive firms whether or not they originate out of the University) University/Government could act as 'architect' and policy maker</b>	

	<b>Tallinn Region</b>	<b>Tartu Region</b>
<b>Entrepreneurial/managerial capabilities (education)</b>	No general efforts at TTU (see Spin off program)	Stimulating entrepreneurial spirit by organising lectures with successful entrepreneurs (ICT) (TSP)  Idea for Entrepreneurial Centre within Faculty of Economics
<b>International Orientation (including FDI)</b>	Tallin Region counts for majority of FDI (however most in traditional sectors)	Only one foreign company present at Science Park
<b>Networking/co-operation characteristics (regional) International nature of networks</b>	International Association of Science Parks Participation in EU programs Int. Conference organiser	Member of Int. Ass. of Science Parks Participation in EU programs
<i>Issues</i>	<p>Attracting more FDI within knowledge intensive areas (package of incentives). This will require the articulation and development of 'unique selling points', hence focus in terms of disciplines/capabilities and distinctiveness in terms of facilities (e.g. availability of certain lab infrastructure, d-bases etc.)</p> <p>Initiate broader initiatives towards entrepreneurial knowledge and skills (e.g. course for all graduates) Entrepreneurial Centre(s) must take multi-disciplinary nature of entrepreneurship into account</p>	

	<b>Tallinn Region</b>	<b>Tartu Region</b>
<i>General SME support infrastructures</i>	<p>No county based and RDA related centre for business support</p> <p>City of Tallinn plans to play active role: one stop shop for start ups in relation with RDA and ESTAG Other services not implemented yet</p> <p>Employers organisations: Chamber of Commerce; brancheorganisations (part of ETTK) and EVEA: services for members (training, btob contacts, seminars, fairs, counselling)</p> <p>KREDEX (see next page)</p>	<p>County based and RDA related centre for business support: loans; training; consultancy on finance, management, marketing, strategy and legislation (3 hours free of charge advice per SME)</p> <p>Employers organisations: Chamber of Commerce; brancheorganisations (part of ETTK) and EVEA: services for members (training, btob contacts, seminars, fairs, counselling)</p> <p>KREDEX (see next page)</p>
<i>National initiatives aimed at stimulating entrepreneurship and innovation</i>	<p>Foundation reform: EAS with 5 Agencies: RDA for general SME support (via network of county based services) and ESTAG for technology based developments. ESTAG and KREDEX for financial support (next page)</p> <p>National technology programmes coordinated by ESTAG: spin-offs; support for Tallinn and Tartu science parks; competence centres (2002); human resources (grants) and awareness raising.</p> <p>RDA and ESTAG coordinate European projects (Structural Funds, IRC, 5<sup>th</sup> Framework, Eureka)</p> <p>Reforms very recent. No guiding policy documents (all in the making)</p>	

---

*SME texture and it's innovative potential*

**Low rate of SMEs per capita ( $\pm$  half of EU standard)**

**In general two main thresholds for SMEs to innovate on structural basis: human resources and capital.**

**Innovation is not a priority issue (export is often regarded as more important)**

*Issues*

**The general SME support structure is very much aimed at supporting basic business issues. Innovation is hardly an issue (except of course for ESTAG). The only general structure for SME support is RDA related network of county based support services.**

**ESTAG itself will be strongly focussed on high tech developments in Tallinn and Tartu.**



**There seems to be a “gap” in innovation support for SMEs between the level of low tech firms and high tech firms.**

**Cooperation/networking between institutions is still in it's infancy. There are no synergies between general SME services and Innovation support infrastructure in Tallinn and Tartu.**

**There's a lot of “waiting” for central government initiatives: not moving before it is known what EAS is going to do.**

---

	Tallinn Region	Tartu Region
<b>Education level of workforce – Cost of labour</b>	+	+
	<p>general level seems to be OK. But there is a shortage of engineers and technically skilled people in general. Also lack of management skills.</p>	<p>general level seems to be OK. But there is a shortage of engineers and technically skilled people in general. Also lack of management skills</p>
<b>Presence of Financial support - VC – Financial Markets</b>	<p>ESTAG provides grants or soft loans for innovative product/service development  Grants enabling young people to transfer their knowledge by working in companies  Grants and Soft loans from ERDF/ERDA (SME in general)  KREDEX provides state guarantees for loans/leasing/export  On the level of early stage/seed money for knowledge intensive companies: still in it's infancy –  No funds from University/Government  At the moment no secondary market  VC for high tech very limited due to the longer time horizon and perceived risks</p>	<p>ESTAG provides grants or soft loans for innovative product/service development  Grants enabling young people to transfer their knowledge by working in companies  Grants and Soft loans from ERDF/ERDA (SME in general)  KREDEX provides state guarantees for loans/leasing/export  On the level of early stage/seed money for knowledge intensive companies: still in it's infancy –  No funds from University/Government  At the moment no secondary market  VC for high tech very limited due to the longer time horizon and perceived risks</p>
<i>Issues</i>	<p>Establishing a public Venture Capital University/Government Fund (together with private sector?) aimed at early stage funding (250.000–1.5 mio. Euro)</p> <p>Notice also that given the timeframe and resources needed to enter certain markets, the development of an active patenting/licensing policy might be better suited for certain areas (e.g. biomedicine). This latter implies again an international orientation and critical mass in terms of research.</p>	

	Tallinn Region	Tartu Region
Stimulating institutional/legal Arrangements (incl. IPR)	Unclear how the propriety rights are being organised and to what extent they stimulate entrepreneurship	IPR Arrangements whereby University grants license to spin off company – Royalties are divided as follows (after deduction of patenting costs): 65% Inventors, 15% Faculty, 20% University
Overall quality of life	+	+ Transport facilities? (e.g. small airport – railways – roads)
<i>Issues</i>	Need for transparent IPR arrangements that are beneficial (stimulating) for all parties involved.	

---

*General issues*

**Although there is a difference in the “maturity” of the support structure for new business developments in Tartu and Tallinn, both Universities lack a framework for stimulating high tech ventures in which all relevant aspects of spin off creation and spin off support are taken into account.**

**Given the limited possibilities in terms of available money, there is a need for “smart” solutions making optimum use of possible synergies between existing structures, not only involving the University related support structures but also the general SME (start up) support structures.**

---

### Annex 3 Interviewed organisations

Tallinn Technical University	- Prof. P. Sürje, vice-rector
	- A. Kamratov, Ph. D., head of R&D Division
	- T. Tamm, R&D Division
	- M. Kivilo, R&D Division
TTU Innovation Centre	- R. Tamkivi, Ph. D., managing director
	- R. Ruubel, Ph. D., project manager
Krates (Tallinn spin-off company)	- T. Näks, R&D manager
Rantalon (Tallinn spin-off comp.)	- Prof. A. Taklaja, director
City of Tallinn	- Mrs. K. Kaleviste, Business Development Unit
	- Mrs. I. Hindrikson, Business Development Unit
	- J. Vahesalu, Business Development Unit
University of Tartu	- Prof. Mrs. H. Everaus, vice-rector
	- Mrs. S. Kahu, project leader Innovation Centre
	- A. Tasa Ph. D., head of R&D Department
	- P. Tamm, R&D Department (CARIN)
	- R. Luht, R&D Department
	- Mrs. T. Rinke, Ph. D., spin-off company
Quattromed	- M. Ustav, Ph.D., director
(Tartu spin-off company)	- E. Mölder, CEO
Tartu Science Park	- E. Erme, CEO
Archimedes	- R. Tönnisson, project coordinator
Inbio OÜ (Tartu spin-off comp.)	- K. Kogerman, Sales Manager
Clifton (Tartu spin-off company)	- R. Pärn, CEO
Regional Development Agency	- J. Roos, director
	- A. Leisalu, Ph. D.
Chamber of Commerce	- M. Relve, director general
EVEA	- T. Kurs, manager
	- Mrs. R. Altpere, foreign affairs manager
ETTK	- Mrs. E. Päärendson, advisor of internat. relations
	- A. Höbemägi, Ph. D., Federation of Estonian
	Engineering Industry
	- I. Link, Estonian Association of Construction
	Entrepreneurs
Cresco	- O. Schults
Estonian Investment Agency	-
Compensation Fund	- A. Tammemäe, Chairman of the Board
Ministry of Economic Affairs	- Mrs. K. Kubo, Head of Technology and
	Innovation Division
Ministry of Economic Affairs	- R. Malmstein, Deputy Secretary General
Ministry of Economic Affairs	- P. Konsa, Head of SME Division
ESTAG	- A. Kolk, director general

#### **Annex 4 Bibliography used for section 2 (international best practices)**

**Ablett, S., Broers, A., Clevely, D., Cover, S., Echenique, M., Hauser, H., Radley, P.** (1998), "Cambridge 2020: Meeting the Challenge of Growth," Analysys Publications, Cambridge.

**Arthur, W. B.** (1988), "Competing Technologies: An Overview", in G. Dosi et al. (Eds.) "Technological Change and Economic Theory", London: Frances Pinter Publishers.

**Autio, E., Sapienza, H.J., Almeida, J.G.** (2000), "Effects of Age at Entry, Knowledge Intensity, and Imitability on International Growth," *The Academy of Management Journal*, Vol. 43, No. 5: 909 – 924.

**Bantel, K.A.** (1998), "Technology-based, Adolescent Firm Configurations: Strategy Identification, Context, and Performance", *Journal of Business Venturing*, 13: 205-230.

**Blind, K. en Grupp, H.** (1999), "Interdependencies between the Science and Technology Infrastructure and Innovation Activities in German Regions: Empirical Findings and Policy Consequences", *Research Policy*, Vol. 28, No. 5: 451-468.

**Bruno, A. V., McQuarrie, E. F. en Torgrimson, C. G.** (1992), "The Evolution of New Technology Ventures over 20 Years: Patterns of Failure, Merger, and Survival", *Journal of Business Venturing*, 7: 291-302.

**Business Co-operation Platform for Innovative Entrepreneurship Support by national, regional and local actors (2001).** Green Paper of the Pilot Project No.2. Development of Regional Co-Operation Network for Innovative Entrepreneurship.

**Bygrave, W.D., Hay, M., Peeters, J.B.** (1999), "The Venture Capital Handbook," London: Prentice Hall Publishers.

**Chee Meng Yap en Souder, W.E.** (1994), "Factors Influencing New Product Success and Failure in Small Entrepreneurial High-Technology Electronic Firms", *Journal of Product Innovation Management*, 11: 418-432.

**Chrisman, J.J. en Katrisha, F.** (1994), "The Economic Impact of Small Business Development Center Counseling Activities in the United States: 1990-1991", *Journal of Business Venturing*, 9: 271-280.

**Collins, J.C. en Porras, J.I.** (1994), "Built to last – Successful habits of visionary companies", Harper Business Publishers.

**Cox, D., Georghiou, L. en Salazar, A.** (2000), "Links to the Science Base of the Information Technology and Biotechnology Industries," SPRU Mimeo, Sussex.

**David, P.** (1986), "Understanding the Economics of QWERTY: The Necessity of History", in W. Parker (ed.) "Economic History and the Modern Economist" (New York : Basil Blackwell).

**Debackere, K. en Van Looy, B.** (2001), "Cluster Policies to Stimulate Innovation: An Analysis and an Assessment," DTEW Working Paper to be presented at the 2001 R&D Management Conference.

**Debackere, K.** (2000), "Academic R&D as a Business: Context, Structure and Processes," R&D Management, Vol. 30, No. 4: 323-329.

**Debackere, K., Luwel, M., Veugelers, R.** (2000), "Patent Data as a Tool to Monitor S&T Portfolios," DTEW Working Paper 00-40, accepted for publication in Scientometrics.

**Debackere, K.** (2000), "Clusterbeleid en Innovatie: Implicaties voor Regionale Ontwikkelingsdynamiek," IWT Observatorium, Rapport No. 30.

**Debackere K., Luwel, M., Veugelers, R.** (1999), "Can Technology Lead to a Competitive Advantage? A Case Study of Flanders using European patent data," Scientometrics, Vol. 44, No. 3: 379-400.

**Debackere, K.** (1998), "Clusters en Innovatie: een Methodologische Reflectie," Tijdschrift voor Economie en Management, Vol. XLIII, No. 2: 235-266.

**Debackere, K.** (1997), "Towards an Ecological Understanding of Firm Founding and Growth in Emergent Populations," DTEW Working Paper 97-15, presented at the 1997 IFSAM Conference.

**Debackere, K., Rappa, M.A., Clarysse, B.** (1996), "The Impact of Networking on Innovative Performance of New Biotechnology Firms: A Combined Econometric and Scientometric Analysis," DTEW Onderzoeksrapport 9748, gepubliceerd als abstract voor de Social Studies of Science Conference, U. Bielefeld, Duitsland.

**Deeds, D. L., DeCarolis, D. en Coombs, J. E.** (1997), "The Impact of Firm-specific Capabilities on the Amount of Capital raised in an Initial Public Offering; Evidence from the Biotechnology Industry", Journal of Business Venturing, 12: 31-46.

**Deeds, L., DeCarolis, D. en Coombs, J. E.** (1999), "Dynamic Capabilities and New Product Development in High-technology Ventures: An Empirical Analysis of New Biotechnology Firms", Journal of Business Venturing, 15: 211-229.

**Dosi, G.** (1984), "Technical Change and Economic Transformation", London: Macmillan

**Doutriaux, J.** (1992), "Emerging High-Tech Firms: How Durable Are Their Comparative Start-Up Advantages?", Journal of Business Venturing, 7: 303-322.

**ETAN** (1998), “Internationalisation of Research and Technology: Trends, Issues and Implications for S&T Policies in Europe,” Brussels/Luxembourg, July 1998.

**Etzkowitz, H. en Leydesdorff, L. (1997), “Introduction to special issue on science policy dimensions of the Triple Helix of university-industry-government relations,” Science and Public Policy, Vol. 24 No. 1: 2-5.**

**Etzkowitz, H. en Leydesdorff, L. (1998), “The Role of Research Centres in the Collectivisation of Academic Science”, Minerva, 36: 271-288.**

**European Commission (1997), “Second European Report on S&T Indicators.”**

**Galbraith, C. S. en De Noble, A.F. (1992), “Competitive Strategy and Flexible Manufacturing: New Dimensions in High-Technology Venture-Based Economic Development,” Journal of Business Venturing, 7: 387-404.**

**Griliches, Z. (1990), “Patent Statistics as Economic Indicators: A Survey”, Journal of Economic Literature, 28: 1661-1707.**

**Hansen T., Chesbrough H., Nohria N. & Sull N.S. (2000) Networked incubators – hothouses of the new economy. Harvard Business Review, September-October 2000.**

**Hernesniemi H. (2000) Evaluation of Estonian Innovation System. Phare Report – Support to European Integration Process in Estonia. 10.03.2000.**

**Hinoul, M. (1999), “Silicon Valley”, Universitaire Pers Leuven.**

**Innovation and Technology Transfer, Vol. 5/00, September 2000, European Commission.**

**Karloe, P., Christensen, P.H. en Andersen, P.H. (1999), “Mobilizing Resources and Generating Competencies,” Copenhagen Business School Press.**

**Kenney, M. en von Burg, U. (1997), “Bringing Technology Back In : Explaining the Divergence between Silicon Valley and Route 128,” Working Paper presented at Path Creation and Dependence Workshop, Copenhagen, 1997.**

**Laitinen, E. K. (1992), “Prediction of Failure of a Newly Founded Firm,” Journal of Business Venturing, 7: 323-340.**

**Langlois, R. en Robertson, P. (1995), “Firms, Markets and Economic Change,” London: Routledge.**

**Langlois, R. en Robertson, P.** (1992), “Networks and Innovation in a Modular System : Lessons from the Microcomputer and Stereo Component Industries”, *Research Policy*, Vol. 21: 297-313.

**Lehrer, M.** (2000), “Has Germany Finally Fixed Its High-tech Problem? The Recent Boom in German Technology-based Entrepreneurship”, *California Management Review*, Vol. 42, No. 4.

Leydesdorff, L. en Etzkowitz, H. (1996), “**Emergence of a Triple Helix of University-Industry-Government Relations**”, *Science and Public Policy*, Vol. 23, No. 5: 279-286.

Leydesdorff, L. en Etzkowitz, H. (1998), “**Triple Helix of Innovation: Introduction**”, *Science and Public Policy*, Vol. 25, No. 6: 358-364.

**McCann, J. E.** (1991), “Patterns of Growth, Competitive Technology and Financial Strategies in Young Ventures”, *Journal of Business Venturing*, 6: 189-208.

**McDougall, P.P., Robinson, R.B. en DeNisi, A.S.** (1992), “Modelling New Venture Performance: An Analysis of New Venture Strategy, Industry Structure, and Venture Origin,” *Journal of Business Venturing*, 7: 267-289.

**McGee, J. E. en Dowling, M. J.** (1994), “Using R&D Cooperative Arrangements to Leverage Managerial Experience: A Study of Technology-intensive New Ventures”, *Journal of Business Venturing*, 9: 33-48.

**Narin, F., Noma, E. en Perry, R.** (1987), “Patents as Indicators of Corporate Technological Strength,” *Research Policy*, Vol. 16: 143-155.

**Nelson, R. en Winter, S.** (1982), “An Evolutionary Theory of Economic Change,” Cambridge: Harvard University Press.

**Nesheim, J.L.** (2000), “High-Tech Start-Up, Revised and Updated,” New York: The Free Press.

**Niederkofler, M.** (1991), “The Evolution of Strategic Alliances: Opportunities for Managerial Influence,” *Journal of Business Venturing*, 6: 236-257.

**OECD** (2000), “Main Science and Technology Indicators.”

**OECD** (2000b),” Science, Technology and Industry Outlook.”

**OECD** (2000c), “A New Economy?: The Changing Role of Innovation and Information Technology in Growth,” Paris.

**Pavia, T.M.** (1991), "The Early Stages of New Product Development in Entrepreneurial High-Tech Firms," *Journal of New Product Innovation Management*, Vol. 8: 18-31.

**Piore, M. en Sabel, C.** (1984), "The Second Industrial Divide," New York : Basic Books.

**Porter, M.** (1995), "The Competitive Advantage of Nations," New York: The Free Press.

**Preece, S. B., Miles, G. en Baetz, M. C.** (1998), "Explaining the International Intensity and Global Diversity of Early-stage Technology-based Firms", *Journal of Business Venturing*, 14: 259-281.

**Pugh, E.W.** (1995), "Building IBM," Cambridge, US: The MIT Press.

**Robertson, P. en Langlois, R.** (1995), "Innovation, Networks and Vertical Integration", *Research Policy*, Vol. 24, No.4: 543-562.

**Rosenberg, N.** (1982), "Inside the Black Box," Cambridge, UK: Cambridge University Press.

**Saxenian, A.** (1994), "Regional advantage – Culture and Competition in Silicon Valley and Route 128," Boston: Harvard Business School Press.

**Schot, J. en Rip, A.** (1997), "The Past and Future of Constructive Technology Assessment," *Technological Forecasting and Social Change*, Vol. 54: 251-268.

**Shane S.** (forthcoming, *Management Science*) *Selling University Technology: patterns from MIT.*

**Souder, W.E., Buisson, D. en Garrett, T.** (1997), "Success through customer-driven new product development: a comparison of U.S. and New Zealand small entrepreneurial high technology firms," *Journal of Product Innovation Management*, 14: 459-472.

**SRI International** (1988), "Assessing Northern California's Engineering Strength in Selected Technical Fields," Center for Economic Competitiveness, Menlo Parc, Ca.

**Steyaert, C.** (1995). "Perpetuating Entrepreneurship through Dialogue: A Social Constructionist View." Ongepubliceerde Doctoraatsverhandeling, KUL.

**Stuart, T. E.** (1998), "Network Positions and Propensities to Collaborate: An Investigation of Strategic Alliance Formation in a High-technology Industry," *Administrative Science Quarterly*, Vol. 43: 668-698.

**Technopolis group** (2000), "The Norwegian fund for business and regional development in an international context".

**Technopolis group** (2000), “International good practice in supporting SMEs to innovate”.

**The Cambridge Phenomenon.** “The Growth of High Technology Industry in a University Town,” Segal Quince Wicksteed Limited, Cambridge, 1985.

**The European Innovation Scoreboard.** “A report prepared under the European Trend Chart on Innovation” Project of DG Enterprise (Innovation Directorate)”, October 2000, Contact: Peter Löwe, European Commission.

**Thurow, L.** (1999), “Creating Wealth,” London: Nicholas Brealy Publishing.

**Tidd, J. en Brocklehurst, M.** (1999), “Routes to Technological Learning and Development: An Assesment of Malaysia’s Innovation Policy and Performance”, Technological Forecasting and Social Change, 62: 239-257.

**Tijssen, R.J.W., en E. Van Wijk** (1999), “In search of the European Paradox: an international comparison of Europe’s scientific performance and knowledge flows in information and communication technologies research”, Research Policy, Vol. 28, No. 5: 519-543.

**UNICE** (2000), “Stimulating Creativity and Innovation in Europe,” The UNICE Benchmarking Report 2000.

**Van Dierdonck, R., Debackere, K., Rappa, M.A.** (1991), “An Assessment of Science Parks: Towards a Better Understanding of Their Role in the Diffusion of Technological Knowledge,” R&D Management, Vol. 21, No. 2: 109-123.

**Van Horn, R.L. en Harvey, M. G.** (1998), “The rural entrepreneurial venture: creating the virtual megafirm”, Journal of Business Venturing, 13: 257-274.

**Van Osnabrugge, M. en Robinson, R.J.** (2000), “Angel Investing: Matching Start-Up Funds with Start-Up Companies,” San Francisco: Jossey-Bass Publishers.

**Varga, A.** (1998), “**University Research and Regional Innovation,**” Dordrecht: Kluwer Academic Publishers.

**Wintjes, R. en Cobbenhagen J.** (2000), “Faciliteren van Doorgroei bij High-Tech Starters,” Rapport in Opdracht van Stichting CIVI.

**WIRED,** The World’s Venturing Hot-Spots, July 2000.

**Zahra, S.A. en Bogner, W.C.** (1999), “Technology Strategy and Software New Ventures’ Performance: Exploring the Moderating Effect of the Competitive Environment”, Journal of Business Venturing, 15: 135-173.

**Zahra, S.A.** (1996), "Technology Strategy and New Venture Performance: A Study of Corporate-Sponsored and Independent Biotechnology Ventures," *Journal of Business Venturing*, 11: 289-321.

**Zimmermann, E., Van Looy, B., Debackere, K., Ranga, M.** (2000), "A Methodological Framework for Examining Science and Technology," *Proceedings of the 7th International Product Development Conference*: 585-601.