

# The innovating region: toward a theory of knowledge-based regional development

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**This paper sets forth a model of knowledge-based regional development conceived as a set of multi-linear dynamics, based on alternative technological paradigms. Utilizing longitudinal data from a Swedish region, and international comparisons, four stages of development are identified: Inception, Implementation, Consolidation and Renewal. Innovation policy is created ‘bottom-up’ as an outcome of ‘collective entrepreneurship’ through collaboration among business, government and academic actors – the ‘triple helix’. The key event is the creation of an entrepreneurial university, whether from an existing academic base or a new foundation, which takes initiatives together with government and industry to create a support structure for firm formation and regional growth. The result of these initiatives is a self-sustaining dynamic in which the role of academia and government appears to recede as industrial actors come to the fore and a lineage of firms is created. Nevertheless, as one technological paradigm is exhausted and another one is needed as the base for new economic activity, the role of academia and government comes to the fore again in creating the conditions for the next wave of innovation.**

## 1. Introduction

The common objective of knowledge-based economic development efforts everywhere in the world is the creation of an ‘Innovating Region’. An Innovating Region has the capability to move across technological paradigms and periodically renew itself through new technologies and firms generated from its academic base. What are the necessary and sufficient conditions for creating clusters of high-technology growth firms and the renewal capabilities of a supporting infrastructure? San Francisco, New York and the Öresund Region (Sweden/Denmark) have high concentrations of bio-medical research but with strikingly different outcomes. San Francisco

has a long-term and thriving biotech industry; Öresund has an emerging bio-medical industry and New York City has the bare beginnings. Perhaps the most important factor in explaining these differences is the presence of an entrepreneurial university that both advances emerging areas of knowledge and puts this knowledge to use in developing the local region (Etzkowitz, 1983).

The emergence of university–industry–government interactions – the triple helix – can also be identified as a key factor in regional development (Etzkowitz, 2005). Beyond research capacity in emerging and interdisciplinary fields with potential for commercialization is the capability to effectively utilize these knowledge resources. This innovation capacity is largely dependent upon

the construction and institutionalisation of a heterogeneous network of public/private entities that can provide firm-formation expertise, gap funding, seed capital and 'collective entrepreneurship' (Schumpeter, 1951). Relatively few regions have developed the vision, inter-institutional relationships and leadership to transcend existing techno-economic paradigms (Dosi, 2000). Indeed, strong conservative forces such as large firms in existing industries, and their academic and government supporters, often retard change by using up much of the resources needed to make the transition.

The long-term criteria for innovation success is more than the founding of an initial cluster of high-tech firms. It is the ability to create growth firms as well as niche players and generate additional clusters, or transform old ones, as earlier successes are superseded (Zucker and Darby, 1998). The transition from mini-computers to biotechnology in Boston exemplifies this process of knowledge-based regional renewal across technological paradigms (Cooke, 2002). Cambridge UK has generated a significant cluster of niche firms but has had difficulty in creating high-growth firms, commonplace in Silicon Valley (Koepp, 2002). Some observers hold that Silicon Valley and Boston's Route 128 are unique and spontaneous developments. We argue to the contrary that the conditions for creating continuous high-tech social and economic growth can be identified and traced to specific organizational initiatives that have much in common. The objective of the Triple Helix Model is the identification of the specific mechanisms and institutional relationships, through which this transformation takes place (Bakkevig and Jakobsen 2003).

## 2. Aim and scope

The aim of this paper is to derive a model for knowledge-based regional economic development that is applicable to a wide variety of circumstances. We shall compare and contrast various cases of knowledge-based regional economic development to a recent Swedish case, Linköping, in order to tease out the necessary and sufficient conditions to create an Innovating Region. Linköping is an instance of a US inspired model in a Greenfield site with a history of government-industry collaboration. It allows us to examine the conditions under which a double helix is transformed into a triple helix. We hypothesize that the involvement of an entrepreneurial university is the key to the transition from regional

development efforts based on existing industry to knowledge-based regional development, from either starting point of a university-government 'double helix' supporting research without concern for use or a government-industry double helix supporting a traditional industrial cluster.

In the US, the double helix starting point was classically a university-industry relationship with government brought in at a later point, initially as a resource provider and then as a strategic partner. In Sweden, the classic double helix is government-industry, with academia increasingly brought into the picture in recent years through an explicit 'third mission'. The US cultural tradition tends to suppress the role of government in the triple helix; while the classic Swedish academic tradition tends to keep the university apart from explicit economic activity. These differences are more of appearance than reality since the Swedish university has been active on the operational, but perhaps not the strategic level since the 1980s and the same could be said for the role of the federal government in the US.

The Linköping case involves both the creation of the necessary conditions for an Innovating Region, establishment of a broad-based research university but also the sufficient conditions, the specific mechanisms outlined below to translate knowledge into useful economic activity. Only some of these projects are internal to the university; most involve a collaboration process with industry and government actors. At a Greenfield site such as Linköping or Stanford, the industrial actors have first to be created in order to establish the collaboration process. At Stanford, the university was built from an industrial fortune; at Linköping government-industry collaboration initiated the university development project. Both instances involved projection of a new economic base for the region based on firm-formation from academic knowledge.

## 3. The field of the triple helix

The transition to a knowledge-based society is the basic premise of the triple helix model. The university, an institution of medieval origins that played a supporting role in feudal and industrial society moves into centre stage. Whereas industry and government were the primary institutions of industrial society; university, industry and government constitute the key institutional framework of post industrial, knowledge-based societies.

The transformation of academia from a 'secondary' to a 'primary' institution is a heretofore unexpected outcome of the institutional development of modern society (Mills, 1958). Contrary to the expectation of some observers for the university's decline (Gibbons et al., 1994); its salience to knowledge-based development increases as its knowledge generating and disseminating capacities are linked to its new innovation capabilities. As a consequence, the knowledge industry in modern societies is no longer a peripheral activity of concern only to scholars and intellectuals. 'An activity that might be considered by pragmatic leaders as expendable; it is a mammoth enterprise on a par with heavy industry, and just as necessary to the country in which it is situated' (Graham, 1998).

The triple helix model comprises three basic elements. First, it presumes a more prominent role for the university in innovation, on a par with industry and government in a knowledge-based society. Second, there is a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interaction rather than a prescription from government. Thirdly, in addition to fulfilling their traditional functions, each institutional sphere also 'takes the role of the other' operating on a *y*-axis of their new role as well as an *x*-axis of their traditional function. An entrepreneurial university, taking some of the traditional roles of industry and government, is the core institution of an Innovating Region.

Institutions taking non-traditional roles are viewed as a major potential source of 'innovation in innovation' in contrast to innovation models in which departures from traditional roles are viewed as a net loss. Thus, in the triple helix, academia plays a role as a source of firm-formation and regional development in addition to its traditional role as a provider of trained persons and basic knowledge. Government helps to support the new developments through changes in the regulatory environment, tax incentives and provision of public venture capital. Industry takes the role of the university in developing training and research, often at the same high level as universities.

The triple helix model was initially derived from an analysis of the renewal of the Boston economy, through a university-industry-government collaboration for firm-formation from academic research in the 1930s (Etzkowitz, 2002). A region with a cluster of firms, rooted in a particular technological paradigm is in danger of

decline once that paradigm runs out. It was already apparent, early in the 20th century, that it was necessary to replace firms whose technologies and products had been superseded, or whose businesses had moved elsewhere. The need to renew the industrial base is an increasing national and regional concern. It leads government, as well as companies and universities, to explore ways for knowledge producing institutions to make a greater contribution to the economy and society.

The knowledge-based region is a consciously constructed entity undertaken by a variety of actors, typically including a triple helix of government, industry and university, with a 'collective entrepreneur', as its engine. The classic example of a collective entrepreneur is US Department of Agriculture's role in creating that country's agricultural innovation system (Schumpeter, 1951). High-tech Councils and Technopoles, comprising representatives of different institutional spheres, typically include university, industry and government as their core partners but other spheres such as labour and social NGOs may be represented as well.

These organizations play the role of 'Regional Innovation Organizer' (RIO) in designing new initiatives to foster economic and social development. Representatives of different institutional spheres come together, combining elements drawn from each sphere to create a new organization. Such groups usually have a spatial dimension that is regional in nature even though it may transcend previous regional definitions based on topographical, national or cultural factors. The project to create a knowledge-based region typically relies on utilising or expanding the capacities of universities or even founding new academic institutions for this purpose. Although the university plays an important role, it usually acts as part of a broader configuration. Conversely, when the university fails to play an entrepreneurial role it is often because a broader institutional coalition to encourage this role is lacking.

The location of research, previously uncontroversial since the results of research embodied in papers and publications would flow anywhere, has become a political issue. As the practical implications of research occur ever closer in time to the making of a discovery, and as new industry arises from these discoveries, the location of research becomes relevant to every locality. Thus, proponents of concentration of research resources at a few key sites, typically larger urban regions and older academic foundations, run counter to proponents of renewal of

older industrial regions and development of greenfield sites around new academic foundations. The resulting conflict sets in motion pressures to expand existing sources of research funding from national research councils and establish new sources at multi-national, regional and local levels. The university itself is seen as a future source of research funding through its technology transfer activities, as part of long-term vision of a self-generating entrepreneurial university.

#### 4. The emergence of the entrepreneurial university

An entrepreneurial university embedded in a triple helix of university–industry–government relations can be found at the root of virtually any high tech region. Daniel Bell provided the groundwork for this axial principle in his analysis of the shift from manufacturing to service occupations in advanced industrial societies (Bell, 1974). Bell made this prediction in the mid-1970s and the crossover point was reached by the mid-1980s in the US. Within this occupational shift an enhanced role for scientists and the social location of scientific research and training could be identified. An active role for the university in economic and social development, rather than merely playing a supporting role providing human capital and research resources, is the defining characteristic of the entrepreneurial university.

A prerequisite for the university taking the role of entrepreneur is the ability to set its own strategic direction (Clark, 1998). Not every research university, even those setting their strategic direction is an entrepreneurial university; some remain ivory tower institutions. The second step is a commitment to seeing that the knowledge developed within the university is put to use, especially in its local region. This can take a variety of forms, including developing internal capabilities for technology transfer and commercialization of research to playing a collaborative role in establishing a strategy for knowledge-based regional economic development and participation in initiatives to implement that strategy. The entrepreneurial university presumes a considerable degree of independence from government, industry and ecclesiastical sponsors, on the one hand, while maintaining a high degree of involvement with other societal actors from this independent standpoint.

The entrepreneurial university format takes the research university model a step further into economic and social development as an academic goal. The ability to set a strategic direction is only the first step toward an entrepreneurial university, the necessary but not the sufficient condition. An orientation to seeking out the practical as well as theoretical implications of research and organizational mechanisms to assist technology transfer and firm formation fills out the picture. Next, training programmes to introduce students to entrepreneurship are required when it is not already a part of the academic culture. Finally, the introduction of organizational formats such as centres to encourage the generation of research with theoretical and practical relevance completes a virtuous circle.

The university is an especially propitious site for innovation due to such basic features as its high rate of flow through of human capital in the form of students who are a source of potential inventors. The university is a natural incubator, providing a support structure for teachers and students, to initiate new ventures of all kinds, intellectual, political, commercial and conjoint. The university is also a potential seedbed for new interdisciplinary scientific fields and new industrial sectors, each cross-fertilizing the other. A dual overlapping network of academic research groups and start-up firms, cross-cut with alliances among large firms, universities and the start-ups themselves appears to be the emerging pattern of academic-business intersection in bio-technology, computer science and similar fields (Herrera, 2001; Cooke, 2002).

Once a stream of firms are created from academic research the university tends to return to a traditional relationship to industry, provision of knowledge and graduates unless the strategy is institutionalized through the creation of internal mechanisms within the university to continue to produce new firms. Stanford University in relationship to Silicon Valley exemplifies the changing relationship of an originating university to knowledge-based industry. Once the Valley began to produce new firms from succeeding generations of firms that had originated from the university, the relationship to the original source became more distant. The university began to seem ancillary to knowledge-based economic development in Silicon Valley (Kenney and Seely-Brown, 2000). However, Stanford continues to be the source of new firms like Google.

Linköping University has also demonstrated the capacity to encourage waves of firm-forma-

tion. Of course, the relationship of knowledge to regional development is broader than the role of universities. Firms beget firms and can take the regional innovation organizer role in renewing a high-tech cluster. In the Silicon Valley down-turn of the early 1990s a firm-led organization, also including local governments and universities, developed a strategy for a new wave of innovation, based on computer networking, that took off by the mid-1990s (Henton, 2002). The latest regeneration effort, Proposition 71, providing 3 billion dollars to support stem cell research at universities and biotechnology firms, seeks to create a virtuous circle of science-based economic development – Silicon Valley's next wave – based on public credit.

## **5. From the learning to the innovating region**

The Innovating Region is based on a linear model in which firm-formation strategy becomes tied to a research base, even if it does not originate from that source. This is not the traditional linear model, based on the transfer of research results to industry through publication or mobility of graduates but rather an 'Assisted Linear Model' comprising a variety of interlocking organizational mechanism such as research centres, technology transfer offices and incubators that move research with long-term commercial potential into use.

The learning region emphasizes reverse linear formats of close relations between firms and customers to each other as the basis for incremental innovation. Innovation and Learning regions are potentially mutually supportive innovation models that can work in double harness, akin to the co-existing relationship between normal science and new scientific paradigms, even as one eventually supersedes the other (Kuhn, 1962). Nevertheless, the learning region emphasizes building upon existing assets rather than creating new ones (Ellström, 2001). Such regions are also more likely to be oriented to low-tech than to high-tech; to government–industry relations rather than to university–industry relations, to incremental rather than discontinuous innovation (Hofmaier, 2001).

The internal characteristics of universities and their strategies for academic industry relations reflect their regional orientation. A university with a high level of research capacity may be primarily tied to traditional industrial spheres. Thus, Chalmers University is in transition from

focusing on assisting technology development in large Swedish firms (now like SAAB and Volvo mostly subsidiaries of multinationals) to developing a capacity for high-tech firm formation. The focus of an entrepreneurial university will be on new academic roles such as firm-formation and the creation of organizational capacities to achieve this objective.

Universities in a learning region focus on traditional university–industry relations such as provision of human capital and consulting relationships. Technologico Monterrey University has traditionally been a source of human capital for family firms of various sizes. In developing research, it is torn between choosing fields to assist the region's declining industries, some of whom have severely reduced their research capabilities or making bets on emerging technology areas. In this context, the state government has set forth a vision of transforming Monterrey into a Knowledge City, which is likely to take shape as a science park (Castaneda, 2005).

Science parks may be found in both types of regions. However, in learning regions they are more likely to devolve into general-purpose industrial parks rather than destination sites for research-based firms. The changing role of the science park, especially if it becomes active in high-tech firm-formation, is an indicator of transition from a learning to an innovating region. The development of a research university, with at least some fields chosen as a basis for future economic development, is another indicator of transition to an innovating region.

An Innovating Region requires multiple knowledge bases to be able to renew itself. To this end, its universities, individually or collectively must be broad enough in their remit to be at the forefront of several areas of advanced science and technology, only some of which have short-term potential for application. If a university is too narrowly focused, say on applied IT, the ability to develop alternative knowledge-based sources of economic development will not be available when and if they are needed. This appears to be the case in Karskrona/Ronneby, Sweden where it was difficult to follow up an initial IT success.

Although a variety of research capabilities is a necessary condition for long-term knowledge-based economic growth, it is not a sufficient condition. The University and region must steer a careful path between the Scylla of concentration and the Charybdis of lack of focus. Stanford and MIT, having made an early bet on the future of

molecular biology became the locus of the biotechnology industry just a few decades later. The universities that spun out these firms had just a few decades earlier made successful bets on electronics and computer research. Having developed these areas, they were in a position to capitalize on the intellectual and commercial convergence, between these fields in creating bio-informatics.

## 6. Method

As articulated in the aim and scope of this study, we decided to take advantage of the longitudinal potential of the case study method to make a comparative analysis over time of the regional role of universities. This approach allowed us to develop an in-depth analysis of the stages and phases of regional knowledge-based development and to identify and understand the potential for replication from one context to another. Our objective is also to develop a theoretical understanding of how, why, and under what conditions the linear innovation model is transformed into a multi-linear dynamic. A new political-economic imperative is influencing the internal and external lives of universities and firms. The social demand for expansion of higher education based on human capital and egalitarian principles has been supplemented by a new driving force for academic development, an economically driven imperative for the application of science and technology to restructure economies in the face of increased international competition.

We built upon previous studies of Linköping and other regions in Europe and the US, collecting additional data to explore hypotheses relating to the development and transformation of knowledge-based regions (Klofsten and Jones-Evans, 1996, 2000; Jones-Evans et al, 1999; Klofsten et al, 1999). In these previous studies attention has mainly been focused on the governmental support of the emergence of knowledge intensive firms from the university environment and on a few key actors, which are operative in that context. This study however has a broader and more historical perspective trying to understand the growth and development of a whole region. We conducted interviews with key informants at the university, the science parks, the State County Administration Board, the municipality of Linköping, VINNOVA (Swedish Agency for Innovation Systems). In total we did 10 interviews each, lasting 2–3 h. We also drew upon strategic docu-

ments such as Regional Development Plans and university memoranda and internal reports.

We utilized a semi-structured protocol to conduct dialogical interviews with our informants. The interviews were done with people representing all the triple helix functions such as science park and incubator directors (2), the university (2), the municipality (1), the regional county council (1), private firms (2) and small business support networks (2). These interviews were taped and transcribed for later analysis. We also re-interviewed some respondents to crosscheck information obtained from different sources. Thus, we presented the case to these respondents as a check on validity. We got feedback from all the respondents and did necessary adjustments.

## 7. Growing a knowledge intensive environment – the case of Linköping

Linköping, situated in the county of Östergötland, is the fifth biggest city in Sweden and has about 130,000 inhabitants. It is strategically situated between the conurbations of Stockholm and Malmö and has modern road and railway communication systems, as well as an international airport. Whilst maintaining a historical reputation for culture and learning, Linköping has developed, during the last 20 years, as a major centre within Sweden for technological growth, especially in the creation and development of new knowledge-intensive firms. Many groups within this dynamic environment have worked together to develop the region's positive synergies.

We have identified four stages, which are described in Table 1 below. Actors at the strategic level are active at stage 1 – then much more operative at stage 2 and 3 – and strategic again at stage 4. Some few individuals are crucial in the process. If the firm founders are entrepreneurs, the people who create the conditions for firm formation are as we call them 'extrapreneurs', who project a future vision and obtain the means to realize it by convincing people to take specific steps to achieve the goal. Extrapreneurship occurs among organizations and across institutional spheres. Extrapreneurs go beyond the boundaries of their organization to create a collectively of entrepreneurs.

## 8. The sources of an innovating region

To describe the development, we must go back about 50 years in time. At the risk of simplifying

Table 1. Knowledge based regional development – a stage model.

Stage	Goal	Structure	Process	Activities
<i>Incipient stage:</i> Idea about new regional development model.	Generate a new economic base for the region.	Informal interaction between different actors as university, municipality, research labs, large and small firms.	Searching for success -informal meetings, discussion about regional plans, influence of external ideas and successful cases.	Building the first incubator; initial service activities for early firms in incubators, basic infrastructure.
<i>Implementation stage:</i> Starting new activities.	Supply adequate infrastructure (hard and soft) for different types of entrepreneurs.	Formation of networks of entrepreneurs, Informal educational and social activities	Starting new organizations for promoting entrepreneurship.	Spin-off-firm-club SMIL, networks, incubators and Science parks, initiatives outside and inside of the university.
<i>Consolidation and adjustment stage:</i> Integration of hard and soft activities.	Increase the efficiency of the system.	Co-operation among regional actors for the purpose of increased efficiency of resources; to get closer to firm needs in order to satisfy needs of firms.	A new networking plan and network of support organizations.	Meetings between actors to define the roles and to support each other in marketing.
<i>Self-sustaining growth stage:</i> Avoiding decline – create continuous redevelopment	Renew the system by identifying new areas of growth linked to new research – questioning existing activities.	University policy level and other actors, at highest levels a political system with power and influence emerging; need more entrepreneurs, research.	Discussion of what is lacking in region.	Activities, meetings in smaller groups, newspaper articles and brochures. All actors try to participate and place their efforts in the best light.

the picture, one may say that it all began with SAAB. Through an agreement with the Government in the early 1950s, SAAB purchased its own copy of the experimental computer BESK, the first main frame computer in the country. This agreement meant the start for the commercial computer in Sweden. This high technology venture then led to the founding of Linköping University in the late 1960s. An industry-government, collaboration to foster knowledge-based development soon resulted in the creation of a new university in order to expand and renew the knowledge base. Of course, the university also served the reproductive function of expanding the human capital base and to carry out research. However, in addition to these traditional academic functions, which could serve the needs of existing firms, the university took on additional tasks of fostering the creation of new enterprises.

Since then the University has been the driving engine behind the growth of the entrepreneurial and knowledge-intensive environment that exists today. This engine has driven the attraction of quality people and resources. Early investments in computer science and interdisciplinary sciences coupled with the University's open collaboration with the community led to greater innovation, including the generation of entrepreneurship and the effective commercialization of new business. An entrepreneurial university was established rather than a traditional isolated ivory tower university, with significant implications for the future role of the university in the region. Linköping University thus had a pre-disposition to become a significant regional actor, taking the role of RIO, originally assumed by the SAAB government collaboration.

### *8.1. The first step – developing the idea of a new regional model*

In the late 1970s there were discussions between the management of SAAB, the University and the Municipality about the future regional development due to an uncertainty regarding the future of SAAB. A cut in state subsidies could result in severe and negative consequences for Linköping considering that the company is and has been one of the biggest employers in the region. In the international arena universities were playing an increasing prevalent role in regional development. Several persons at the University had, through visits to colleagues in the USA, observed that universities were beginning to spin-off companies from technology developed through research, and

that a number of incubators and science parks had been built to support these companies. This process may be characterized as learning by borrowing, taking an innovation from elsewhere and inserting it into a new local context.

American universities actively supported these initiatives and that there was a firm belief that this was positive for the development of the universities as well as for the regional economy. During the same period similar things begin to occur in Europe. This gave inspiration to new ideas how Linköping could be developed into a growth region. At the University, an industrial liaison office was set up within a new office of external relations. Researchers within the Department of Management and Economics were expressing considerable interest in business development and entrepreneurial issues. All of these had a central role to draw up a plan to take advantage of and to exploit university technology. In 1981, the Centre for Technology Transfer opened in order to spread the University's research to industry. Not long after, new companies began spinning-off. Between 1981 and 1984 about 40 new companies with roots in the University were launched.

The municipality of Linköping served as an early and important partner for the University. During 1983 TeknikByn was created, offering facilities and office service for University 'spin-offs' – the first incubator. The Regional Development Fund also supported the project financially. Within a short time, the incubator proved to be too small and the Municipality decided to increase its investment and to build a science park affiliated with the University and Mjärdevi Science Park opened in 1984. When Mjärdevi opened, it soon became a hot environment for development-intensive companies. The close proximity to the University, the possibilities of networking with both big and small companies in the local environment, and a growing network of resource providers that helped stimulate company development, gave the area its initial attraction. And there was plenty of room for expansion on the park's 70 hectares of land.

### *8.2. The second step – starting new activities*

Now there was an infrastructure – premises and basic service – but there was a lack of professional consulting, financial resources and different forms of support for business development adapted to the new knowledge-intensive companies. Within



the industrial liaison office an initiative was put forward to start a club to help develop new ideas into viable business form. With help from some entrepreneurs, the club was re-shaped over time into a new organization and in 1984 SMIL was founded. SMIL grew out of the need of its founders to develop their own business skills.

In the beginning, activities comprised breakfast meetings that featured lectures on subjects of current interest. This activity grew rapidly and in the late 1980s SMIL offered a portfolio of activities from informal networking to more sophisticated trainee programmes for business development and management. The number of members in SMIL increased considerably as more companies spun out and by 1990 there were some hundred companies in SMIL.

A hybrid interface organization played a key role in the organization process. It is important to note that SMIL was not a part of the University but a private organization managed by a board consisting primarily of entrepreneurs. An affiliation to the University was essential for SMIL's success, however, thanks to an assistant within the industrial liaison office who could offer part time support to the organization. The University also secured additional financial resources for SMIL's operations. The reason for the latter was that the different government financiers preferred to support activities inside the University before supporting private foundations. Therefore, a co-operation was established which utilized the energy and competence existing within the SMIL network thereby forming an active demand side, and which utilized the University to host essential activities and programmes – thereby becoming the physical anchor for the organization and active supply side.

The support activity increased and the University became more and more engaged. During 1993 the vice president for external affairs decided to establish a new centre – Centre for Innovation and Entrepreneurship (CIE) – with the principal aim to integrate practical development activities focused on knowledge intensive companies with research and education on entrepreneurship. The relation to SMIL remains as before and the fertile co-operation continued. With the founding of CIE the number of activities increased leading to a new programme for start-ups called The Entrepreneurship and New Business Development Programme – ENP. This led to the first academic courses in entrepreneurship offered at the University. Thus, firm formation was inte-

grated into the educational as well as to the research mission of the university.

The economic development office in the municipality functioned as the early management body of Mjärdevi Science Park. But within the same year that CIE was started, the municipality formed a new company dedicated to the management of the park's unstoppable growth, including new incubator facilities, where among other things new companies from the ENP-programme could establish on favourable terms.

### *8.3. The third stage – the consolidation and adjustment*

The University has grown substantially from a few thousand students at the start, to almost 20 000 in the end of the 1990s. The University's early investment in computer science had made the University an attractive place for researchers and students in this field. This investment significantly influenced the kinds of companies that spun-out of the University. Companies such as Ericsson and Nokia established research and production facilities at Mjärdevi Science Park. The creation of new knowledge intensive companies increased rapidly during the second half of the 1990s and statistics show that since the first company spun-off in the end of the 1970s, there were now over 400 knowledge-intensive companies in the region (Östgöta Correspondenten, 1996). Several faster growth companies such as IFS, Intentia and Sectra expanded into the international market and today are listed on the Swedish stock exchange. The companies and the entrepreneurs received rewards as well. Sectra was awarded 'The Swedish IT-company of the year' 1996; Kenth Ericson (founder of Softlab) was awarded 'The Swedish Entrepreneur of the year'; and Idonex received two important awards in 1998: 'The Gold Mouse', for the Swedish software of the year, and 'Best Internet Software' at Comdex in Las Vegas.

The evolution of support activities for companies from the mid-1990s up to 2000 brought about several new activities and the formation of new organizations including

- Financial participants both public and private, which offer subsidies, loans or equity capital to companies. Some of these include The Technology Bridge Foundation, University Holding, Innovationskapital Novare and Linktech.

- The County Administrative Board, in co-operation with Almi/the regional development fund, introduced an opportunity for additional funding.
- Service around patent issues was introduced to support the University environment through the organizations Forskarpatent and University Holding. This instrument gave Linköping university the ability to take ownership and equity in firms arising from the university. On the whole, activities around the 'idea environment' at the University increased in numbers.
- Incubators and science parks as Berzelius Science Park, Pronova Science Park and Mjärdevi Business Incubator.
- New local networks (spin-off from SMIL) as Kunskapsföretag I Norrköping (KiN), Motala Vadstena Kunskapsföretag (MOVAK).
- Several new courses in entrepreneurship and new 'företagande', and a new MBA-programme for growth companies were established at the University.
- A professorship in innovation and entrepreneurship was established at the University.

The creation of these new organizations meant both an increase in the existing support to the companies, but also widening of the supply of financial resources. An important benefit resulting from the expansion was better alignment of support for a developing company. What's more, the establishment of new incubator facilities meant that the participants in the entrepreneurship programmes could get immediate access to suitable premises. The creation of KiN meant that the companies in Norrköping did not have to go to Linköping to participate in network activities, but these could be adapted to the companies in Norrköping. Teknibröstiftelsen placed at the disposal seed capital for young start-ups, which in principle had not existed before.

At the end of the 1990s directives came from the Swedish government to the regions to put together Regional Growth Agreements. These comprise different issues that concern regional development in general. In Östergötland it was agreed to focus on company support with State financing. This was a general theme of national innovation policy to systematize government's role in financing initiatives. There was a feeling at the time of a need to create synergies among previously scattered initiatives. The purpose was to create regional co-operation between support participants and in that way make the State

subsidies of development activities aimed at companies in different areas more effective.

Within this frame the participants that gave different kind of support to knowledge intensive companies, gathered in order to formulate a common model for support to these companies. This became the start for 'Growlink', a formal designation for the regional network that had evolved over nearly 25 years as it provided entrepreneurs with an easier and more flexible way to take part in the variety of support that is available in the region. During the period the successful programmes from Linköping gradually began to spread to other regions in Sweden. The ENP-programme that among other places started in Västerås, Umeå, Örebro and Kista should particularly be mentioned here, but also the development programme that was spreading to Uppsala, Karlskrona and Borlänge.

#### *8.4. The fourth stage – self-sustaining growth*

In the beginning of 2000 the University made substantial new investments in life science technologies and biomedicine. Sixteen new professorships within these disciplines were announced. The University's new rector, who had a research background in bioscience, championed these investments. He strongly pushed for a widening of University activities. The University that from the start has promoted interdisciplinary teaching and research saw great possibilities to combine the traditional concentrations on Home Communication (IT, complex systems, communication and electronics) with the new focus on Life Science Technologies.

The recession of 2000 affected mainly the IT-related industry, leading to the closing of Nokia's Linköping office with 180 employees in Mjärdevi Science Park. Ericsson cut back its staff by over 1000 employees. Smaller companies also faced a difficult market situation. Rather quickly there was a shared consternation over the future development in IT and consequently, the future development of the entire region.

During 2002, the Swedish Agency for Innovation Systems (VINNOVA), announced 'Vinnväxt' with the aim to promote sustainable growth based on an ability to compete internationally in regions through financing of demand motivated research and development through effective innovation systems. The regions could apply for money on condition that they were able to show active

participants in industry, academia, and in the public sector. The county Administration Board took an initiative to write an application and the University co-operation was rapidly enlisted to partner in the project. VINNOVA put aside a considerable amount of money for the winning applications (total 400 MSEK), in combination with a long-term financing (up to 10 years). This promise of investment provided keen incentive for the engagement and co-operation among high level decision makers and organizations. A work group was appointed to go ahead with the aim to produce an application with secure support in the region.

During spring 2002 an application was delivered to VINNOVA to develop a regional innovation system based on life science technologies and tools related to biomedicine, innovative electronics, and Home Communications, and join these with the existing system in the region. The purpose is to produce a robust regional strategy with an action plan to create new platforms for continued growth in the region. This initiative has been named 'New Tools for Life'. The response from VINNOVA was favourable and money was received to continue to the next application step (complete realization plans) where a few regions in the end will receive the long-term financing.

Today the University, through its holding company, will lead the job to submit the final application. A reference group with representatives from the University, the public sector, and private firms, are appointed to carry out this work. In addition to the work in formal groups, a large number of people from these sectors are contributing to create a common strategic idea and mobilize energy to reach the common goal. Linköping University has expanded into new research areas, selected both for their theoretical and industrial potential. A flexible and expanding academic base, rather than a narrowly specialized academic institution, is essential for this purpose.

## **9. Creative reconstruction**

The objective of this paper is to derive a model for knowledge-based regional economic development from a wide variety of circumstances. Traditional concepts of region based on geographical, political or cultural criteria are superseded by projects for high-tech development. Heretofore, labels for 'Knowledge-based Regions,' such as Silicon Valley and Route 128, were affixed after the objective had been achieved. More recently, names have been invented as part of a 'branding process' in

the early stages of regional development, as in Medecon Valley and Silicon Alley. Various cases of knowledge based regional economic development may be compared to a recent Swedish case, Linköping, in order to tease out the necessary and sufficient conditions to create an 'Innovating Region'.

An innovating region has the capability to creatively reconstruct itself on a new knowledge base. In Linköping, a reverse linear process began from a large firm, with government encouragement. The initial organizational innovation was a linking mechanism between high tech start-ups, bringing them into closer association with each other and the university in order to facilitate collaboration and access to resources. A university entrepreneurship training programme, expanding firm-formation activity, intersected with an industry driven start-up dynamic. The expansion of academic research capacities in the biomedical sciences, including hybridization of these new capabilities with the existing IT base, provided a base for creative reconstruction.

Linear regional development, such as the process that resulted in Route 128, begins with the development of a knowledge base. This is followed by interaction among triple helix actors to identify regional strengths and weaknesses and an organizing process to build upon strengths. Companies formed from academic research in the early 20th century suggested the special potential of New England was its concentration of universities. Given a missing link of business advice and seed capital; the venture capital firm was invented to create a stream of firms. The mini-computer industry that was developed has since been replaced by a biotechnology industry created from academic research.

Scepticism has been voiced whether a generalizable model can be derived from success cases such as Silicon Valley and Route 128 (Pohlmann, 2002). We suggest that such a project is feasible, based on a broader range of cases including emerging successful regions. Although each regional development project is a unique instance, with its special peculiarities, some general elements can be identified such as the triple helix and the entrepreneurial university (Krige, 2004). Even if not present in the origins of the project, they likely appear at a later phase to fill gaps such as those in science parks that have been developed in a relatively isolated environment such as Kista in suburban Stockholm and Sophia Antipolis in the exurbs of Nice. Universities or branches of universities have been started at both of these sites

to infuse the project with new sources of knowledge and potential start-ups,

Universities, heretofore seen as a source of human resources and knowledge, are looked to for technology and future industry. Many universities, even those in countries such as Japan that until recently relied almost wholly on informal ties have developed the organizational capabilities to formally transfer technologies. Universities are also extending their teaching capabilities from educating individuals to shaping organizations in entrepreneurial education and incubation programmes. Moreover, rather than technology transfer existing as an isolated island, some universities are combining their research, teaching and technology transfer capabilities in new formats, with each academic mission enhancing the other. This process is most visible in 'Greenfield' sites such as Linköping and Stony Brook, New York but it is also apparent in 'Brownfield' areas like Pittsburgh, Recife, Brazil, Albany, New York, Newcastle, England and Monterrey, Mexico.

Entrepreneurship is found in academia and government as well as industry. New hybrid organizations, such as High-Tech Councils, cross-cut the institutional spheres, creating a dynamic element that sparks further organizational innovation. Out of a variety of possible candidates for a new technological paradigm, a few foci must be selected to concentrate resources and effort. The entrepreneurial university takes in inputs and problems from the local environment and translates the outputs of academic knowledge into economic activity. After generations of firms are spun off from the original university start-ups, academic links revert to the traditional ones of supplying human capital and knowledge in Silicon Valley. The role of Stanford University as the source of regional innovation is forgotten, even said to have been a myth. Nevertheless, the university is called upon when an old technological paradigm is exhausted and a new source of innovation is required.

## 10. An endless transition

The triple helix introduces a lateral approach into Innovation Policy, conceived as collaboration among the institutional spheres. Thus, rather than solely a 'top down' initiative of national government, innovation policy should also be seen as the cumulative result of interaction among governments at various levels, businesspersons, aca-

demics, and NGOs comprising membership from all of these spheres, especially at the regional level. Networks are generated from a variety of sources; e.g. they may emanate from collaborations between large firms and academic researchers, e.g. Pharmacia and Uppsala University that left in place a substrate of ties that became the basis for new firm formation in biotechnology. It also appears informally among firms in a common area of activity which then may be formalized into a 'valley' through the organization of an association, e.g. radio valley in Gothenburg Sweden or the effort to organize a photonics cluster in Recife, Brazil.

Innovation can no longer be assumed to take a conventional linear path, whether from research through development or from identification of market opportunities to product introduction. In some countries, there is a movement away from an assumption that there is single starting point of research and an end point of the economy: an autonomous linear model based on laissez-faire assumptions in which innovation takes its own course. Innovation was expected to largely take place within industry with other institutional spheres playing only a limited contributing role, government, e.g. acting only when clear market failures could be identified. In countries that, to one degree or another, relied on central planning, it has become accepted that government programmes have an important role to play, not only from the national level – top-down – but also from the local level – bottom-up, often in collaboration with other organizations in civil society.

In contrast to biological evolution, which arises from mutations and natural selection, social evolution occurs through 'institution formation' and conscious intervention. Knowledge-based economic development can be traced to specific actors, typically operating in collaboration with each other. The institutional elements most conducive to success can also be identified as emanating from the academic, industrial and governmental spheres. When one sphere is lacking, part of a knowledge based-strategy will be to substitute for that actor and fill the gap. Due to its special abilities in integrating organizational teaching, group research and collective entrepreneurship, we suggest that the university, will be pre-eminent as the source for new science-based firms. This is not to say that industry cannot be a source for such firms. Indeed it often is but such firms tend to be close to the market companies rather than ones based on emerging technologies.

A relatively few regions have exhibited self-renewing capabilities. A continuous flow across

technological paradigms, moving beyond creative destruction to creative reconstruction, without sharp downturns, is the ultimate objective. The triple helix provides a flexible framework to guide efforts, from different starting points, to achieve the common goal of knowledge-based economic and social development. The result is an 'Assisted Linear Model', with intermediate mechanisms, that integrate the traditional starting points of science and technology policy: the laboratory, the market and a government procurement requirement. Innovation policy is then directed toward enhancing the interaction between human needs, research goals and resource providers; science, technology and society; university, industry and government. Innovation becomes an Endless Transition.

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