Promoting university interaction with business and community

- a comparative study of Finland, Sweden and UK

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PREFACE

The present report consist of three country studies, including three university case studies. Interviews have been carried out at two levels: at the national policy level, and at university level.

For the Finnish study the following were interviewed:
Esko-Olavi Seppälä & Kimmo Halme (Science & Technology Policy Council, Chief Planning Officers); Jari Romanainen (Tekes, Director) & Kari Komulainen (Tekes, Head of Internationalisation Services Unit); Pekka Ylä-Anttila (The Research Insitute of the Finnish Economy, Research Director) & Terttu Luukonen (The Research Insitute of the Finnish Economy, Head of Unit); (Petteri Kauppinen (Ministry of Education, Science Policy Division); Tarmo Lemola (Ministry of Trade & Industry, Director of ProACT Technology Programme); Erkki Ormala (Nokia, Director of Technology Policy), Eero Holstila (Managing Director, Helsinki Region Centre of Expertise); Heikki Mäkipää (University of Helsinki, Director of Research and International Services); Marja Häyrinen-Alestalo (University of Helsinki, Research Director), Aaro Tupasela, Antti Pelkonen & Karoliina Snell (University of Helsinki, Doctoral Students); Camilla Elander (University of Helsinki, Director for Economic Planning); Markuu Tinnilä (Helsinki School of Economics, Research Director), Arto Hakkarainen (Helsinki School of Economics, Innovation Manager) & Mari Paloheimo (Helsinki School of Economics, Partnership & Corporate Relations Manager).

For the English study the following were interviewed:
John Barber (Department of Trade & Industry, Director of Innovation, Economics, Statistics and Evaluation & Chairman of OECD Committee on Science and Technology Policy), Ian Harrison (Department of Trade & Industry, Deputy Director, Key Business Technologies Directorate) & Chris Henshall (Department of Trade & Industry, Head of the Science and Engineering Group, Office for Science & Technology); Adrian Hill (Higher Education Funding Council for England, Director of Third Stream Funding); Caroline Gladwell (OneNorthEast, Science & Industry Council Policy Manager) & Mark Pearson (OneNorthEast, Innovation & Integration Executive); David Charles (University of Newcastle, Chair of Business Innovation and Director of Research), John Goddard (University of Newcastle, Deputy Vice-Chancellor), Ken Snowdon (University of Newcastle, Director of Research), Iain Nixon (University of Newcastle, Director, Centre for

Academic Development), Paul Freeman (University of Newcastle, Senior Advisor, Centre for Academic Development), Cathryn Harvey (University of Newcastle, Director, Careers Service), John Dersley (University of Newcastle, Director, Regional Development Office) & Dale Athey (University of Newcastle, Business Development Manager).

With regard to the Swedish report, it draws extensively on material from two recent research projects by Merle Jacob (Jacob, Lundqvist & Hellsmark 2003; Jacob 2003), an expert on Swedish science and technology policy, and at present guest researcher at the Copenhagen Business School. To supplement this material, two key experts were interviewed: Per Eriksson, Director of the Swedish Agency for Innovation Systems (VINNOVA); and Mats Lundqvist, Coordinator of Chalmers Innovation System and Director of Chalmers School of Entrepreneurship (Chalmers University of Technology).

On behalf of the Copenhagen Business School, I should like to warmly thank all of the above experts for their extremely open and helpful attitude, which made this research project such a rewarding experience. A special thanks to Marja Häyrinen-Alestalo and David Charles for their help in identifying key experts to be interviewed in Finland and UK, respectively. Further, a number of the above experts participated in a workshop held at the Copenhagen Business School in early February with the participation of key representatives from the Danish Ministry of Science and Technology. We take this opportunity to thank you all again for your participation in this event.

Finally, we should like to thank two external advisors, Bertel Ståhle (UNI-C) and Jesper Christensen (University of Aalborg), for their useful comments in the initial process of conceptualising the research design.

Jakob Vestergaard
Copenhagen Business School
28 February 2003

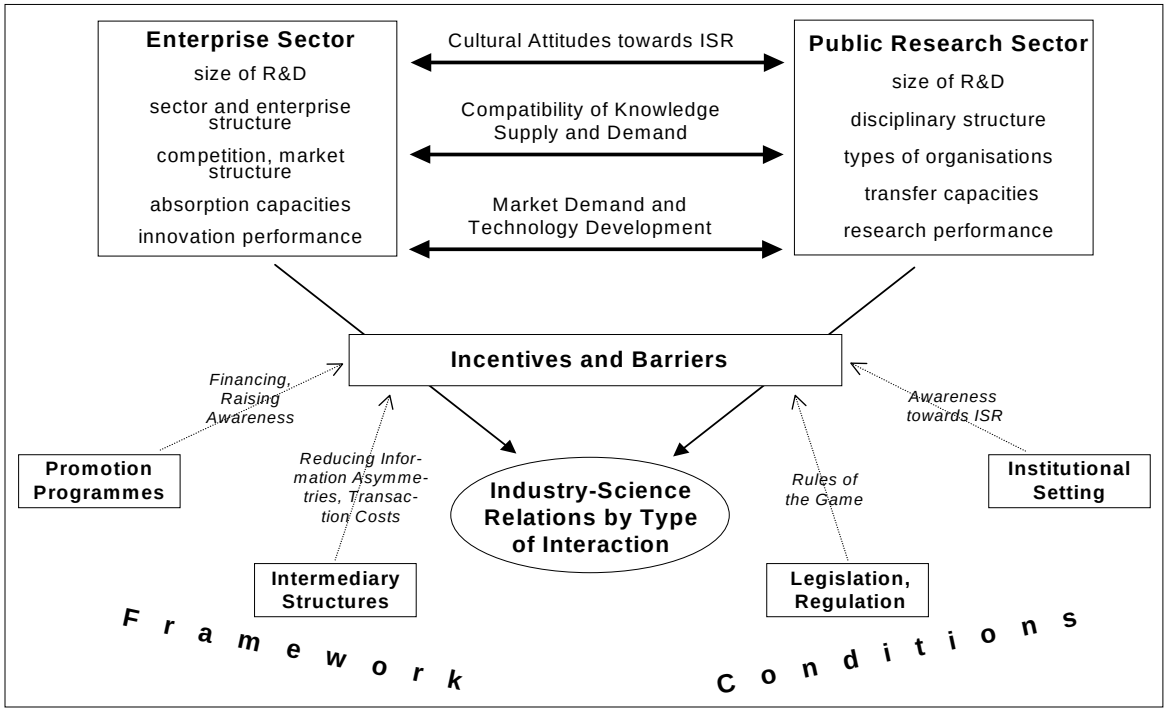
CHAPTER 1 Research design and methodology

For some years now, it has been high political priority in Denmark to strengthen industry-science interaction. Unfortunately, in Denmark high scientific productivity is not matched by high level of research-based, innovative start-ups. Previous policy reforms to improve commercialisation of research results have not yet had the desired effects. The fundamental policy question that defined the present research was how to promote university interaction with industry, by reforming the formal framework for such interaction. With the objective of gathering information on *best practices* in Finland, Sweden and UK, the overall research question was dual:

a) Which institutions, rules and policies have been introduced to stimulate university interaction with industry?
b) Which of these seem, so far, to have been the most successful ones?

The research draws upon two recently completed benchmarking research projects, by the EC (2001) the OECD (2002) respectively. In the EC report, a considerable effort was expended in conceptualising a set of issues very similar to the overall research objectives of the present research project. The below figure presents the conceptual model that framed the analysis of the role of framework conditions in promoting industry-science relations in the EC study.

Figure 1.1 A Conceptual Model for Analysing Industry-Science Relations



Source: EC 2001

This conceptualisation was adopted as the organising structure for the present research. While adopting the overall conceptual structure of the EC benchmarking project, the research design differ substantially in its focus on university-level case studies, and in its attempt to provide in-depth interviews specifically focused on identifying most enabling framework conditions in the respective countries. More specifically, the overall research design consists in combining the following three elements:

- Collection and systematisation of national data on performance with regard to industry-science relations, and with regard to policy-related framework conditions
- Validation of these national data by interviewing national experts (academic as well as governmental), with a particular emphasis on areas with learning potential for Denmark
- Interviews with top representatives at four entrepreneurial universities on their strategies and initiatives for interacting with local industry, as well as on what they see as most enabling national framework conditions

The interviews were *appreciative* in the sense that the effort was to identify key elements of successful university interactions with industry. Further, the interviews were *policy-focused*, in the sense that there was a particular emphasis on the facilitating role of framework conditions in successful interactions. And thirdly, the interviews were *change-oriented*, in the sense that all interviewees were asked to identify possible future reforms that they believed would further stimulate university interaction with industry.

In all three country and university studies the search was for learning potential with regard to Danish policy reforms, particularly with a view to the formulation of a new coherent science and innovation policy. The three country chapters are organised in the same way, and the structure consists of the following four main elements:

- A brief history of science and technology policy
- An overview of framework conditions for university interaction with industry
- A university level case study
- A discussion of best practices and future challenges

CHAPTER 2 FINLAND

2.1 History of science and technology policy in Finland

Although Finland may be considered a latecomer in the early phases of science and technology policy development (Kaukonen & Nieminen 1999), concerted political effort over the past two decades have made Finland a much cited success-story of strategic science and technology policy. A key comparative strength of the Finnish national system of innovation is the high degree of cooperation among universities, companies and research institutes. As late as in the 1970s universities were not *permitted* to cooperate with industry (Romanainen 1999). The transformation that took place during the 1980s and the 1990s was to a high degree the outcome of a determined and well-coordinated science and technology policy.

The 1980s say a shift of emphasis from science to technology in overall Finnish policy-making. The establishment in 1983 of the National Technology Agency (Tekes) was one notable expression of this shift. The focus of Tekes was on technology development in key sectors of the economy. The key sectors of the Finnish economy by the early 1980s were the forestry and metals industries. Industrial and economic policies very much focused on the interests and needs of these export-oriented industries. There was, however, a tendency to consider only larger companies as an issue for national policy, leaving the concerns and interests of small- and mediumsized enterprises to be dealt with by regional authorities. This changed radically during the 1980s. Policy began recognising the importance of linkages within and between sectors, and in Tekes technology programmes the development of such linkages and networks became a key objective. From these technology programmes by Tekes grew by the early 1990s what has been termed ’the cluster approach’ (Romanainen 1999, Rouvinen & Ylä-Anttila 1999). In 1993, the National Industrial Strategy stressed the paramount importance of clusters as the fundamental basis of national competitiveness. Previously, industrial policy was focused on very specific industries. Now the new policy emphasised the importance of facilitating the economic growth of all clusters, rather than targeting a few industries. This was in part an expression of a general shift in policy that took place during the late 1980s from intervention to facilitation. This shift was closely related to the establishment in 1987 of the Science and Technology Policy Council (STP Council). The STP Council replaced the Science Council, that had been operating since 1963. Not only did the STP Council mark a strong political emphasis on integrating science and technology policies, that had

previously been formulated separately and with little coordination. It marked also the beginning of an era in Finnish policy-making where science and technology policy became a strategic core in the formulation of a whole range of other policies, including educational policy, economic policy, fiscal policy, industrial policy, regional policy and technology policy. The concept of a 'national innovation system' soon became the organising and unifying concept of this new coordination of policies. The 1993 policy review from the STP council read as follows:

> In summer 1991, the Government decided to adopt the [STP] Council's review 1990, which was based on the development of the national system of innovation, as its overall programme for the development of knowledge and know-how. In summer 1992, the Cabinet Economic Policy Committee defined the national system of innovation as a central development target in the preparation and pursuit of economic policy. These decisions created conditions for the systematic development of the national system of innovation in the future (STPC 1993: 7).

Along with the national innovation system as the overall, guiding concept of policy-making in Finland during the 1990s came a focus on 'networking', which developed to become an "all-encompassing perspective on Science, Technology and Industry policy" (Nieminen & Kaukonen 2001).

The fact that there was a general political consensus on the strategic importance of science and technology policy for the international competitiveness and economic performance of the country, was crucial for the way in which the political system responded to the severe economic crisis that hit the country in the early 1990s. In the late 1980s, Finland saw a major economic boom resulting from the liberalisation of financial markets. This boom soon turned into severe banking crisis, however. In combination with the collapse of the socialist markets, this produced a severe economic crisis. Though the public sector budget was in crisis, the commitment to progressive science and technology policy remained. In the near absence of a private venture capital market, public money were invested to provide this (Romanainen 1999). Furthermore, instead of adjusting target levels for public and private investments in R&D downwards, according to the overall economic trend, the STP council adjusted target levels upwards, aiming to reach a R&D share of GDP at 2,45 pct. by 1995 and 2,7 pct. in 2000. This policy was fully aligned with industrial policy. The 1993 National Industrial Strategy stressed that in the face of the economic recession, industrial policy should focus not on reallocating current resources, but on influencing the "quantity and quality of resources emerging in the future" through investments in the national system of innovation (cited in STPC 1993). As a result of this emphasis on the strategic importance of strengthening the national system of innovation by investing in research, the government policy of balancing the public budget by cutting expenditures was not applied to the overall level of public funding of *research*.

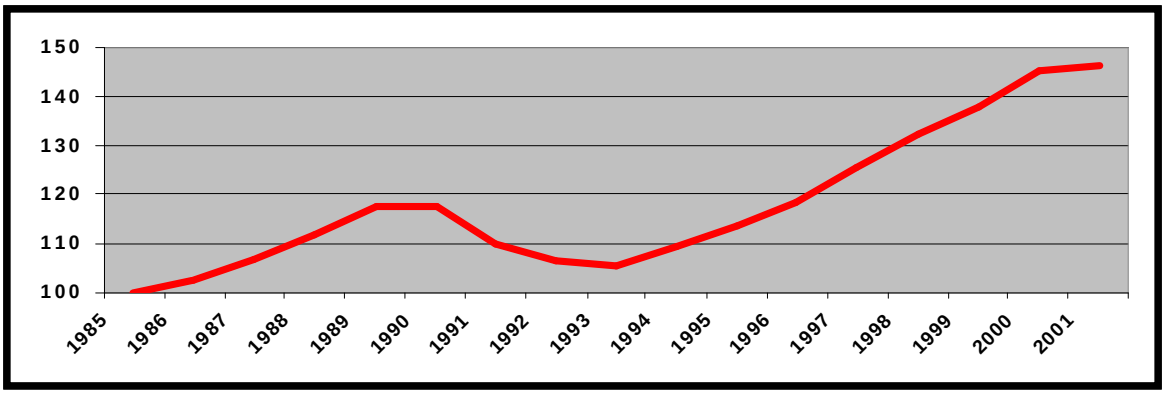
Table 2.1 Government research appropriations by organisations 1991-93 (FIM million)

	1991	1992	1993	Real change (in pct.) 1991-93
Universities	1513	1541	1481	-5.3
Academy of Finland	449	450	449	-3.2
Tekes	930	1040	1347	+40.2
Research institutes	1580	1624	1560	-4.5
Other funding	790	836	897	+9.9
Total	5262	5491	5734	+5.5

Source: STPC 1993

By the late 1990s, the Finnish economy had more than fully recovered from the crisis. In fact, a quite unusual economic growth had been achieved, and the remarkable success was noticed across the world.

Figure 2.1 GDP in Finland 1985-2001



Source: Seppälä 2003

In the late 1990s the emphasis of Finnish science and technology policy shifted from promoting R&D, to promoting R&D, *internationalisation and commercialisation*. The country has achieved a remarkable economic growth and international competitiveness during the course of the 1990s, but there is a widespread recognition in the country that weaknesses remain, that need to be addressed, if this strong position is to be withheld in the future. To these issues, we shall return in the section on *future challenges*.

2.2 Framework conditions in Finland

2.2.1 Introduction

The overall cultural attitude toward university interaction with business is heavily influenced by the general that notion that it is of paramount importance that public science contributes to industrial innovation. This attitude is seen to be the result, more than anything, of a coherent science, education and technology policy during the 1980s and 1990s (EC 2001: 99). Further, observers emphasise the 'sense of urgency' that the economic recession in Finland in the early 1990s brought about – a progressive science and technology policy was widely recognised by the public to be absolutely crucial for recovering for the prospects of recovering from recession (Seppälä 2002; Tuurkonen 2002). Despite this generally favorable cultural attitude in the Finnish society toward UB interaction, universities themselves seem very divided on the issue, with some researchers being quite sceptical, if not hostile, towards the political pressures to increase interaction with business. Finland has a strong tradition of autonomy in research and education, and some researchers feel that independent, basic research is endangered by this political agenda of increased interaction with industry. In fact, the achievements of Finland in the area of industry-science relations are even more remarkable in view of this scepticism. A key to understanding Finland's success in the field of stimulating industry-science relations is no doubt the restructuring of Finnish public R&D funding that took place from the mid-1980s onwards. To this we shall return shortly. The remainder of this chapter describes the framework conditions for university interaction with business in Finland. The description is divided in the following four sub-sections: Legislation; Institutional setting; Intermediary structures; and Public promotion programmes.

2.2.2 Legislation

Generally, actors in the Finnish national system of innovation share the notion that legislation has not played a very significant role, not negative nor positive, in relation to the intensification of industry-science relations over the past decade. Thus, IPR regulations, civil servants law and mobility regulations are regarded by most experts as having neither a positive nor a negative affect on industry-science relations (EC 2001: 102). There is an exception, however, and it concerns public science institutions. Experts mention legislation with regard to extra earnings for public science researchers and regulation on equity investment by public science institutions in enterprises as the two most important barriers to industry-science interaction (EC 2001: 102). The regulation

concerning investment by public science institutions state that "a government organisation receiving funding (even partly) directly from the state budget, may not invest in the private sector without the specific consent of the Parliament" (EC 2001: 101). Only by such specific parliamentary consent are equity investments in, for instance joint research labs, possible. Such investments are rare, and instead several universities have set up foundations, through which they are able to make equity investments. With regard to the other barrier mentioned by experts, legislation with regard to extra earnings for public science researchers, the Act on Civil Servants limits the right of a civil servant to hold secondary occupations, by which is understood any waged work or task. In practice, sporadic occupational tasks are not subject to limitations, while for instance being member of board of a company is indeed considered a secondary occupation, and thus requires that the researcher applies for a permission to hold this position. In granting permission or not, the researcher's employer must reflect on whether the researcher will be more challenged in his office or in any way be bothered in the appropritate execution of his tasks, whether the secondary occupation will compromise the confidence in his impartiality, and finally whether the secondary occupation as a competing activity may potentially damage the employer. If the researcher, on these conditions, is given permission to hold a secondary occupation, there are no restrictions as to the amount of remuneration.[1] In addition to the two above mentioned barriers, it must be stressed that actors share the view that legislation has, and does indeed still 'lag behind'. Industry-science relations have intensified enormously during the past decade, but there have been few legal guidelines for these interactions. Particularly on the university side of the relation, actors call for clearer legal ground rules for their interactions with business.[2]

The legal framework in which universities operate is defined primarily by the Constitution of Finland, which states the freedom of sciences. The Higher Education Development Act states provisions on the objectives of the higher education system, appropriations and their allocation, whereas the Universities Act ensures the autonomy of universities, prescribing their operations and objectives only in very general terms. During the 1990s, the Finnish government has reformed its mode of regulation with regard to the university system. Generally, the policy of the Ministry of Education through the 1990s was to increase the administrative autonomy of universities, and to replace budgetary and regulatory control with 'management by results', through evaluation and

[1] If a researcher in a public science institution wish leave of absence this procedure of applying to management for permission applies as well.

[2] With regard to fees for contract research, this is regulated by 'The Act of the Principles of State Fees', the basic principle being that contract research must "be provided on market conditions" (EC 2001: 101).

consultation procedures. These new principles of higher education governance were part of a general movement in the direction of 'new public management' in the Finnish public sector. These developments were reflected also in a significant change in the overall patterns of public research funding.

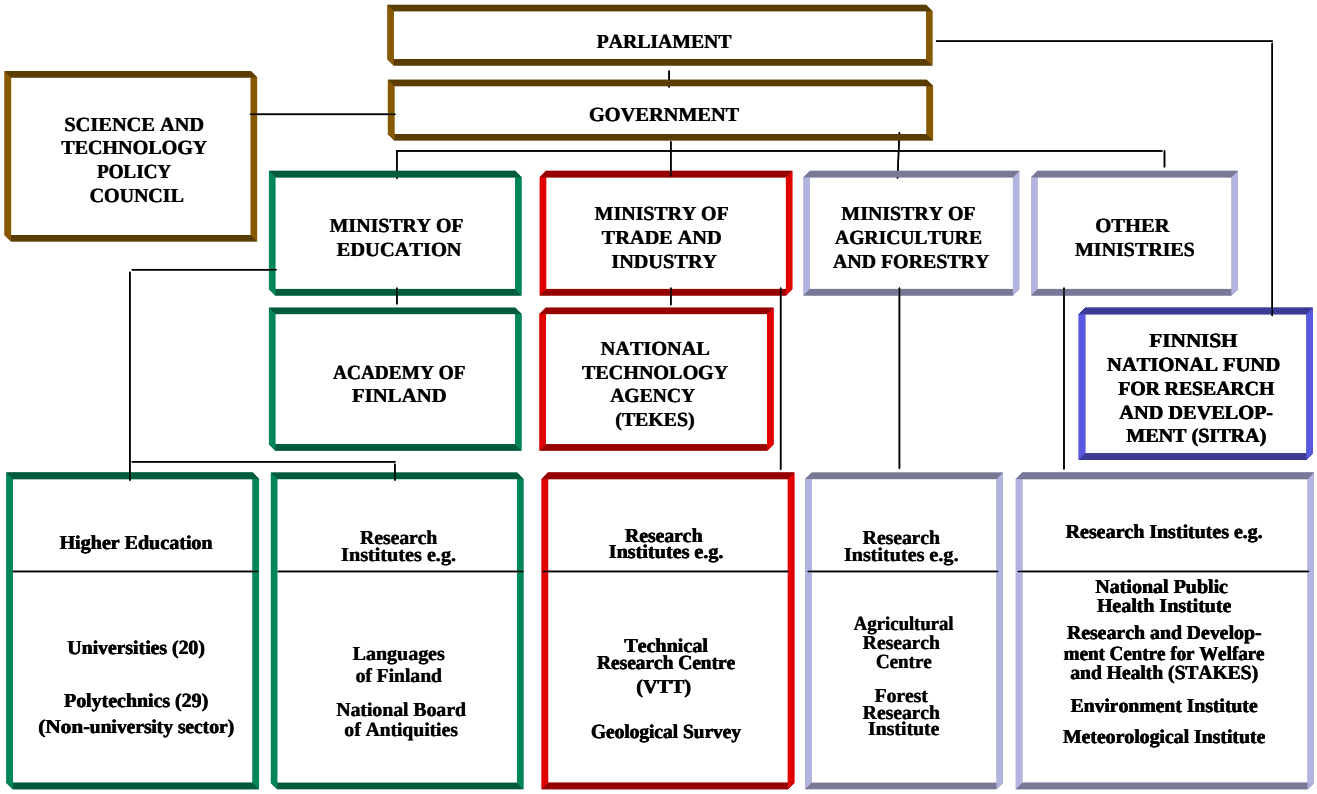
> Public funding was increasingly channeled through competitive funding mechanisms and the criteria for funding from extra-budgetary sources increasingly presupposed cooperation (cooperation within the university system, international cooperation, university industry cooperation) as a condition for funding (Nieminen & Kaukonen 2001: 32)

With regard to the regulation of universities, the increased emphasis on competition and cooperation was the two most significant changes during the 1990s. It must be stressed that the shift in the distribution of government research funding was substantial. In the period from 1990 to 1996 alone, the balance shifted dramatically. In 1990, 58 pct. of government funding was given directly to research-performing organizations (universities and research institutes), and only 42 pct. was distributed through funding organizations (Tekes, Academy of Finland, etc.). In 1996, funding distributed through funding organizations had increased to 52 pct. of total government research funding, and the share of direct budget funding to the research-performing organizations correspondingly decreased to 48 pct (Nieminen & Kaukonen: 33). By means of this shift, the relative balance between budget funding and competitive funding changed significantly in favor of competitive funding. From the perspective of the universities, this has meant a radical change in the composition of its research funding. The share of budget funding decreased from 67 pct. in 1991 to 53 pct. in 1998, with a corresponding rise in the share of competitive and other external funding from 33 pct. to 47 pct. (Nieminen & Kaukonen 2001: 38).

2.2.3 Institutional setting

The below figure gives a graphical overview of the organisation of research and its funding in Finland.

Figure 2.2 Research policy and research funding in Finland



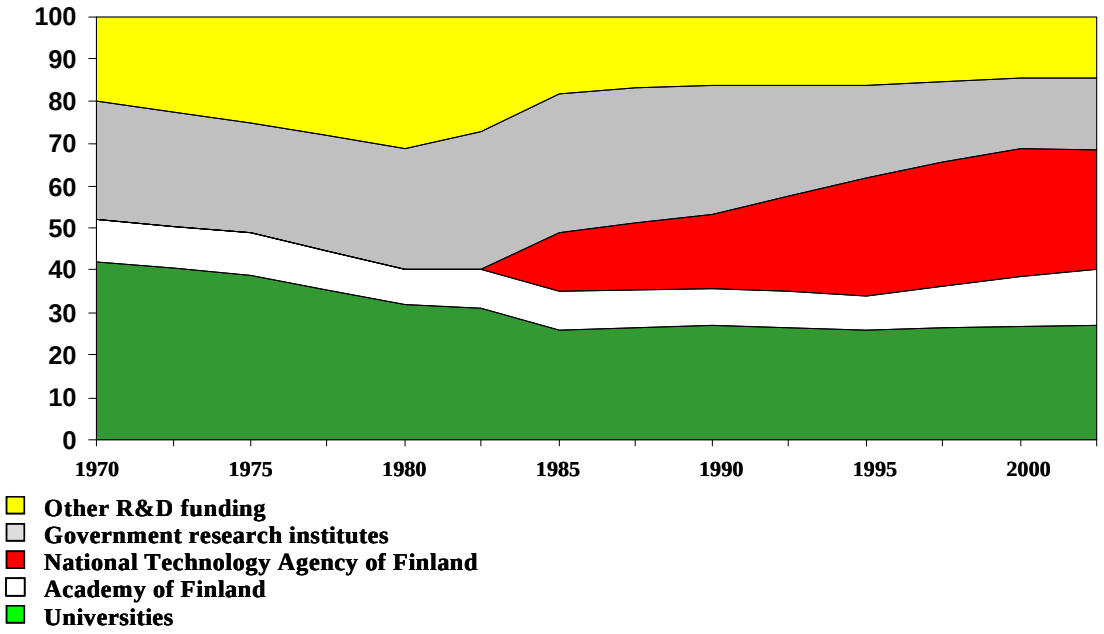
Source: Kauppinen 2002

The main public funders of R&D in Finland are the National Technology Agency (Tekes) and the Academy of Finland. As is shown in figure 2.2, these are not the only government agencies involved in public funding of R&D, however. In what follows Tekes, the Academy of Finland, and the Finnish National Fund for Research and Development (Sitra) will be described briefly. Moreover, the Centre for Expertise Programme will be described, to exemplify the involvement of ministries other than the Ministry of Education and the Ministry of Trade and Industry in public funding of R&D (see section 2.2.5). After having described Tekes, Sitra, and the Academy of Finland, follows a brief description of the governmental body that has formulated the science and technology policies of Finland since its foundation in 1987; namely the Science and Technology Policy Council.

a) Tekes

In Finland, funding has been used strategically as a change agent. This strategy has had two components: introducing new conditions and procedures for competitive funding, and increasing the overall level of funding. In this process, The National Technology Agency (Tekes) has played a particularly central role. Since its foundation in 1983, Tekes has grown to be the principal promoter of R&D in Finland. The below figure shows this development in the form of the relative distribution of government funds for R&D, in the period 1970 to 2002.

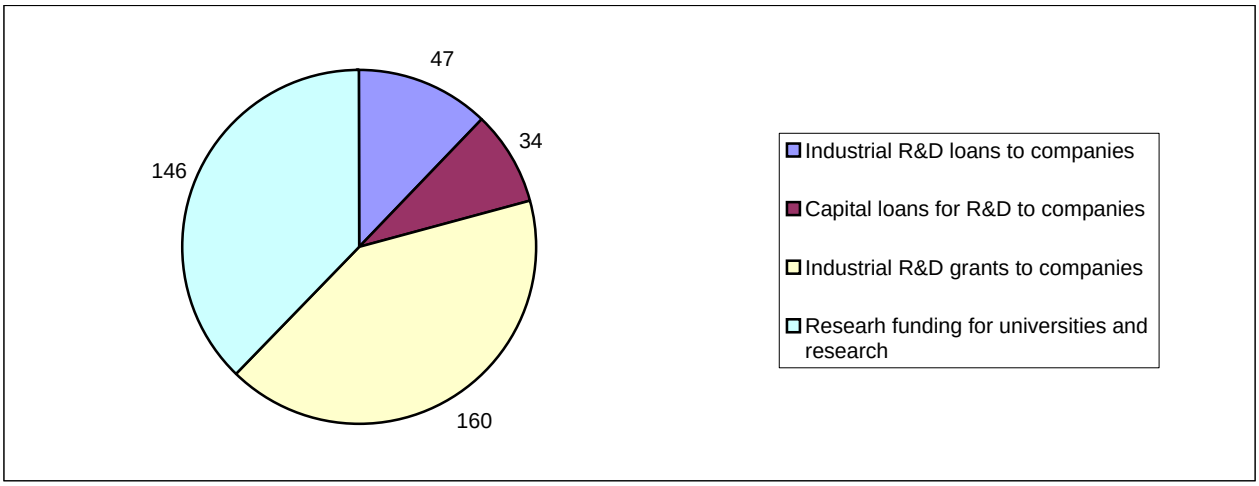
Figure 2.3 Relative distribution of public funds for R&D, 1970-2002 (pct.)



Source: Seppälä 2002

Tekes provides funding both to research projects at universities, to long-term R&D projects in companies, and to business R&D projects aiming at developing new products, production methods or services. Today, total R&D funding from Tekes amounts to 387 million euros, spread over 2.261 co-financed projects. The fact that Tekes stresses co-financing of the projects and programmes it engages in is a very central aspect of its approach to R&D funding. The overall distribution of Tekes funding in 2001 was as follows:

Figure 2.4 Composition of TEKES funding 2001 (million euros)



Source: Tekes 2001

Through its extensive funding of R&D in universities and companies, Tekes has taken a central role in strengthening the technological competencies and economic productivity of the Finnish economy. Tekes will be further described in and through some of the public promotion programmes it is in charge of (cf. discussion below). Though the focus in this report is on universities, and not public sector research establishments, the Technical Research Centre of Finland (VTT) should at least be mentioned briefly, for its close relation with Tekes. VTT employs more than 2,850 R&D personnel and has a turnover of more than 200 million Euro. VTT develops technologies in order to improve both the competitiveness of companies and the basic infrastructure of society, and to foster the creation of new businesses. VTT has eight Research Institutes – Electronics, Information Technology, Automation, Chemical Technology, Biotechnology and Food Research, Energy, Manufacturing Technology, and Building Technology – as well as an information service and a technology studies group.

b) Academy of Finland

The Academy of Finland constitutes the Finnish research council system. The Academy states that its overall function is "to enhance the quality and prestige of basic research in Finland by providing funding allocated on a competitive basis, by carrying out systematic evaluation and by influencing science policy" (Academy of Finland 2003). The Academy further states that its funding of a wide range of basic research is intended to "provide a solid foundation for innovative applied research and for using the new knowledge in the best interests of culture, welfare and the economy"

(Academy of Finland 2003). The Academy of Finland's operation covers all scientific disciplines. The Academy operates within the administrative sector of the Ministry of Education and is funded through the state budget. In 2002, over 13 per cent of all government research funding was channelled through the Academy. The objectives for the Academy's operation and the resources made available to the Academy are decided on an annual basis in talks between the Academy of Finland and the Ministry of Education.

c) SITRA

Sitra, the Finnish National Fund for Research and Development, is an independent public foundation under the supervision of the Finnish Parliament. The Fund aims to promote Finland's economic prosperity by encouraging research, backing innovative projects, organising training programmes, and by providing venture capital. The Fund was set up in conjunction with the Bank of Finland in 1967 in honour of the 50th anniversary of Finnish independence. The Fund was transferred to the Finnish Parliament in 1991. Sitra describes its aim as that of furthering the economic prosperity of Finland by the following three overall means: (i) developing new and succesful business operations; (ii) financing the commercial exploitation of expertise; and (iii) by promoting international competitiveness and co-operation. By these means, Sitra endeavours to develop new, competitive business activities and new societal models. The emphasis lies on those kinds of projects that are unlikely to be set in motion by companies or organisations independently and that do not directly constitute the responsibility of any public-sector organisation. In more specific terms, Sitra seeks to identify and help further developing Finnish enterprises that are internationally competitive and profitable. To such companies Sitra offers funding and services that will advance their progress. The focus of Sitra's corporate funding is directed towards enterprises that are at the start-up stage. Besides its funding activities Sitra follows closely trends in venture-capital investment both in Finland and on international markets. If necessary, new forms of funding together with conditions and operations may be adopted. Sitra's corporate funding activities includes PreSeed funding, and Network Development Funding. Sitra's *PreSeed service package* has been created to accelerate the emergence of new technology-based business, to improve capital management and to introduce companies to the providers of further funding. The PreSeed service has two arms: LIKSA and INTRO. LIKSA is a joint funding service operated by Sitra and Tekes that can be used to obtain knowledge and services related to the commercialisation of technology. The aim is to evolve a good business plan more swiftly than hitherto using continuous assessment.

The INTRO service takes care of the efficient presentation of start-up enterprises so that they can find both institutional and private investors who will be prepared to provide simple straightforward funding in the future. Sitra has the skills to assess start-up companies as possible recipients of funding especially in those cases where Sitra's joint investment encourages private capital to allocate resources to such start-up companies. A new form of funding for Sitra is the *Network Development and Finance* scheme. In this scheme new types and concepts of business are set up in collaboration with small and medium-sized enterprises. The aim is to combine traditional know-how with new technology. Sitra encourages SMEs to network by investing in the development of such networks. Sitra will invest mainly in existing networks and their flagship companies but may also invest in new networks. In addition to providing funding, Sitra also cooperates closely with such actors as the National Technology Agency, Employment and Economic Development Centres, and Finpro (Finnish Business Solutions Worldwide). The purpose of this wider cooperation is to agree on joint projects and measures to help traditional SMEs to develop, and go international. Sitra enjoys economic independence. Its operations are mainly financed through income from endowment investments and project finance (STPC 2000).

d) Science and Technology Policy Council

The main actor in designing science and technology policy is the Science and Technology Policy Council. The Science and Technology Policy Council of Finland was established in March 1987, to assist the Council of State and its Ministries in questions relating to science and technology. In more concrete terms, the Council has been assigned the following tasks:

- To direct S&T policy and make it nationally compatible, and to prepare relevant plans and proposals for the Council of State.
- To deal with the overall development of scientific research and education, to prepare relevant plans and reviews for the Council of State, and to follow up the development and the need of research in the various fields.
- To deal with, follow up and assess measures taken to develop and apply technology, and to prevent or solve eventual problems involved in this.
- To deal with important issues relating to Finland's participation in international scientific and technological co-operation.
- To issue statements on the allocation of public science and technology funds to the various ministries, and on the allocation of these funds to the various fields.

- To handle the most important legislative matters pertaining to the organisation and prerequisites of research and the promotion and implementation of technology.
- To take initiative and make proposals in matters under its competence for the Council of State and its ministries.

The Science and Technology Policy Council is chaired by the Prime Minister. Other members include the Minister of Education and Science, the Minister of Trade and Industry, the Minister of Finance, and up to four other ministers. In addition to them, the council consist of ten other members well versed in science and technology. These must include representatives of the Academy of Finland, Tekes, universities and industry, as well as employers' and employees' organisations. The Council has an executive committee and a science policy subcommittee and a technology policy subcommittee with preparatory tasks. These are chaired by the Minister of Education and Science and by the Minister of Trade and Industry, respectively. The Council's Secretariat consists of two full-time chief planning officers.[3]

The representation in the STP council of all key stakeholders makes its statements and proposals on science and technology policy a strong basis for subsequent policy-making. Another characteristic of the policy process in Finland is the level of decision making. The Council discusses main policy challenges in its triennial policy reviews, and makes general suggestions concerning all actors. This usually includes suggestion on how resources for public funding of R&D should be allocated. The actual implementation of these suggestions is left to the ministries and agencies. Individual research or technology programmes are not decided by the Council, nor by the ministries, but at the level of the implementing agencies. Since the key actors are few and easily contacted, a great deal of informal interaction takes place between different actors at all times. Important issues are continuously discussed in an informal way, and major documents such as the policy outline originate from these discussions. Thus, the main purpose of the outline is not so much to identify new issues, but rather to discuss and set priorities and help communicate these to a wider audience and to decision makers (Romanainen 1999).

[3] At present these are Esko-Olavi Seppälä and Kimmo Halme, both of whom were interviewed for the purpose of this study.

2.2.4 Intermediary structures

A large number of intermediaries operate in Finland.[4] The following types of intermediaries may be distinguished: Science and technology parks; technology transfer companies; industrial liaison offices and innovation centres at universities; and incubators.

(a) Science and technology parks

Science and technology parks offer premises, a technically developed infrastructure and a stimulating and innovative business environment. In addition to industrial companies and research units, different kinds of private, semi-public and public service organisations are located in the science parks. Each centre has its own general technology profile. Technology/science parks play an important co-ordinating or implementing role in various business development and regional development programmes. Shareholders of the parks are both private and public organisations. The Finnish Science Park Association (FISPA) has 10 member centres and 9 associate members, accommodating a total of approximately 1,000 enterprises, research, and education organisations, which employ more than 10,000 people. Within the National Centres of Expertise Programme, science and technology parks are used as locations for the centres. The Technology Centres implementing the programme have set up construction projects that will amount to a total volume over 150, 000 sq. m by the year 2002. These operations have resulted in new regional infrastructure (organisations, new enterprises and development units, premises and installations, equipment and service centres).

(b) Technology transfer companies

There are seven technology transfer companies located in different technology and science parks. The companies are jointly owned by university foundations and other regional organisations. The National Fund for Research and Development (Sitra) is also an important shareholder in each of them. The task of the technology transfer companies is to promote the commercialisation of research results from universities and research institutes. The companies help their customers in evaluating the new research results, the patenting procedures, licence negotiations, and also take care of the development and marketing of patents when needed. The technology transfer companies also act as co-ordinators in important national and international research projects and programmes.

[4] The following is extracted from EC 2001.

(c) Industrial liaison offices and innovation centres

All universities have industrial liaison offices and some run innovation centres. They attempt to promote research and technology transfer by helping researchers in applying for external research funding, drafting contracts and managing the research projects. Some research offices have more personnel and offer wider services. In these cases they are likely to be called research and innovation services units or innovation centres. The services offered cover a huge variety of consulting, information, training and organisation services.

(d) Incubators

At the moment, there are 12 technology incubators located at different technology and science parks in Finland. They co-operate closely together and are usually also close to universities and research institutes. There are also however, other university incubators such as the New Business Centre of the Helsinki University of Economics and Business Administration and Arabis, and the business incubator at the University of Industrial Art. Also the Polytechnics have incubators. Incubators get their backing from a variety of organisations in the public sector, organisations including large and medium sized companies, business associations and other organisations. Some incubators are so new that there are no companies in them yet. A couple of networked incubators are about to start in 2001. Technology incubators offer versatile services to companies that are just starting their activities as well as to companies that want to grow and internationalise. There are nearly 350 enterprises located in the 12 technology incubators, and between 160 and 200 new enterprises are estimated to start their businesses during the year 2001. FISPA is presently running a national project called *Technology Incubator 2001*. The main objective is to create a national business training model to support launching incubator companies as well as their growth and development.

(e) Innovation services

In the field of information services, the *Finnish Innovations* (Sfinno) project at the VTT Group for Technology Studies was introduced. It provides a unique database consisting of 1,482 Finnish innovations commercialised by 952 firms during the 1980s and 1990s. The database contains basic data on these innovations, including detailed survey data on the origin, development and commercial significance of 642 innovations.

2.2.5 Public promotion programmes

In the following the main public promotion programmes in Finland will be described. Particular emphasis will be given to Technology Programmes and Cluster Programmes.

(a)Technology Programmes

Approximately half of Tekes' funding takes the form of *Technology Programmes*.[5] These are devised to promote R&D in specific sectors of technology or industry, and to pass on research results to business in an efficient way. These programmes have proved to be a very effective instrument in promoting cooperation and networking among companies and the research sector. Technology programmes are planned in cooperation by companies, research institutes, and Tekes. The planning takes place in workgroups and open preparatory seminars. The final decision of launching a programme is made by the board of Tekes. Each technology programme will then have a steering group, a co-ordinator and a responsible person at Tekes. The duration of the programmes ranges from three to five years; their volumes range from EUR 6 million even to hundreds of millions of euros. Tekes usually finances about half of the costs of programmes. The second half comes from participating companies. It is important to understand that Tekes funding is not *either* for companies *or* for universities. Thus in 2001, companies were involved in virtually all Tekes-funded university research projects, in and through their participation in project implementation, monitoring and utilisation of results. Similarly, in 6 out of 10 Tekes-funded business projects, companies ordered research services from universities, academic institutions or research institutions. This cooperation and networking is built into Tekes operations from the initial formulation of a technology programme. Tekes technology programmes are seen as a tool with which to make strategic choices and steer research and development. In the words of Tekes, the technology programmes seek to "strengthen the key technologies and expertise from the perspective of Finland's future and provide a foundation for related business operations" (Tekes annual report 2001). These strategic choices and overall technology priorities are worked out in cooperation with industrial cooperations and unions, companies, universities, and actors un the public administration, under the leadership of Tekes. In fact, this procedure of identifying the needs of industry and society, and design technology programmes to meet those needs, may be said to be the essence of Tekes activities. The currently ongoing technology programmes are listed in table 2.2 below. A

[5] In 2001, Tekes provided EUR 185 million to financing technology programmes, out of a total of 387.

brief description of one these will serve the purpose of conveying by illustration the mode of operation of Tekes technology programmes.

The Drug 2000 Technology Programme – Biomedicine, Drug Development and Pharmaceutical Industry

The goal of the Drug 2000 programme is to contribute to the development of a strong pharmaceutical industry, operating internationally, by developing current and create new research networks, and by conceiving new international business operations for the pharmaceutical sector. The programme began in January 2001 and has been planned for implementation in two periods of three years each. The annual budget of the programme is EUR 17-25 million, of which Tekes finances approximately 60 pct. In addition to Tekes, the Academy of Finland, Sitra, Finnish Bioindustries, and a wide group of enterprises and researchers in the field have taken part in programme planning. The application process started in May 2000. More than 200 preliminary project presentations were received, of which 174 from academic institutions. On the basis of the preliminary project presentations, Tekes invited 85 and the Academy of Finland 21 projects to the second round of applications in September 2000. In January 2001, Tekes decided to fund 41 research projects and in March, the Academy of Finland announced their funding decisions for 11 projects. Eight company projects were accepted in the programme as well, funded by Tekes. There is no dead-line for companies' R&D project funding applications, and they can be submitted any time. According to the standard policy of Tekes, the projects in the Drug 2000 programme comply with a Code of Conduct. The Code of Conduct defines the objectives, organization, and activities of the programme. A brief description of programme organization may be instructive. The programme as a whole is run by a steering committee appointed by Tekes. Its members include representatives of companies, Tekes, the Academy of Finland, universities and research institutes, and observers from Sitra, Pharma Industry Finland, and Finnish Bioindustries. The steering committee meets at least twice a year. Its responsibilities relate to monitoring the programme strategy and progress, and ensuring committed and active participation by industry. In addition, the steering committee will coordinate programme assessment. Tekes has appointed a programme coordinator, who is responsible for activating the programme and its day-to-day routines, for communication between the various groups involved, and for external communications. In addition, the coordinator acts as a secretary at meetings of the Technology Teams and the steering committee. Projects submit a report on their progress to the executive committee every year by the end of January. These annual reports are made available to the steering group as a way of assessing the progress of the programme.

Source: Tekes 2003

Table 2.2 Ongoing technology programmes

Bio- and Chemical Technology	Diagnostics 2000 Drug 2000 – Biomedicine, drug development and pharmaceutical technology Innovation in Foods Life 2000 – Biological functions NeoBio – Novel biotechnology Potra – Polymers for building the future Process integration Staha – Managing static electricity dynamically
Energy and Environment Technology	Climtech – Technology and climate change programme Code – Modelling tools for combustion process development Environmental cluster research programme Ffusion 2 – Fusion energy research programme FINE Particles – technology, environment and health Process integration technology programme Promotor – Engine technology programme Streams – Recycling technologies and waste management Wood energy
Construction Technology	CUBE – Space research programme Infra – Construction and services technology programme Rembrand – Real estate management and services Value added wood chain
Information and Communications Technology	Antares – Space research programme ELMO – Minituarizing electronics EXSITE – Explorative system-integrated technologies Intelligent Automation Systems iWell – Turning wellbeing tecnology into a success story NETS – Networks of the future Presto – Future products, added value with microtechnologies SPIN – Software products, a launch pad for global success USIX – User-oriented information technology
Product and Production Technology	Clean surfaces DESIGN 2005 E-business logistics Frontiers in metallurgy Kenno – Lightweight panels MASINA – Technology program for mechanical engineering UTT – Business concepts for industries Väre – Control of Vibration and Sound

In addition to these, Tekes funds one other programme, which Tekes lists under the rubric 'Other technology', namely *ProACT - The research programme for advanced technology policy*. This programme will be described briefly in section 2.4.

(b) Technology clinics

A technology clinic is a service to help a company test new methods and new know-how quickly and flexibly.[6] Technology clinics are thus intended to facilitate and speed up the transfer of technologies from technology providers to technology users. The main goal of the initiative is to promote the adaptation of specified technologies for problem-solving in Small and Medium Scale Enterprises (SMEs) in order to introduce new technological possibilities and to raise their awareness of external R&D resources. The client of a technology clinic is a SME in need of know how and technology, and the typical assignment for the clinic is a problem that the client cannot solve alone, but which is too small to justify launching a R&D project. Thus, the typical cost is less than 20.000 euros. The core idea is to provide lines of communication between SMEs with specific technological problems, and the leading research experts in the country. An additional outcome of the technology clinics is that SMEs that use their services gain experience in cooperating with universities and research institutions. Moreover, through this interaction with a technology clinic, the external network of the company is expanded with key researchers working in fields relating to the products of the company, and with the employees of the technology clinic, which provides companies with a person-to-person relation to the public R&D funding and services system.

There are 6 different generic types of TCs: *technology-based clinics* that focus on a specific technology; *theme-based* clinics that aim towards promoting awareness and technology development in relation to a particular theme or problem; *cutting-edge clinics* that aim at keeping Finnish SMEs at the forefront of technological development in particular areas of technology; *catching-up clinics* that aim to help Finnish SMEs catch up with international standards in selected areas of technology; *methodology clinics* that aim to disseminate good management practices and methodologies in the SME sector; and *demonstration clinics* that aim to offer demonstration services to a selected group of customers in a particular sector. Four stakeholders are involved in each technology clinic: A customer SME; TEKES; a clinic co-ordinator; and the technological service provider. The latter is usually a public science institution, but can also in some instances be a private company with particularly relevant R&D expertise in the field. The role of TEKES is

[6] The following description of technology clinics are based on EC 2001 and Komulainen 2002a, 2002b.

primarily that of providing funds – up to 60 pct of the costs can be covered by TEKES, and the remaining part must be covered by the SME. SMEs do not not apply to TEKES for financing, but directly to the TC coordinator who have been authorized by contract to accept and fund assignments on behalf of TEKES. In 2002, there were 16 TCs in operation, covering areas such as Intelligent Materials; Wood Fuel; Technology Strategy Clinic for Building and Construction Industries, to name a few. The Technology Clinic initative was initiated in 1992, and by 2001 TEKES funding for TCs was at approximately 1 million euros.

(c) The Cluster Programmes

The overall goal of the Cluster Programmes was to "generate new innovations, businesses and employment", by transfering and accumulating knowledge in and across chosen fields, and by improving co-operation between authorities, public funding sources, legislators, and the private sector (EC 2001). The original iniative to the cluster programme came from the STP council. The Council noted in 1996, that successful efforts to increase collaboration in and among different actors in the industrial sectors of telecommuninications and wellbeing, should be extended to other sectors. The Council further noted that this would be best done by means of an inter-ministerial programme, which would then seek to increase not just collaboration within the targeted sectors, but also collaboration among public authorities in different policy sectors.

Thus, when the Cluster Programme came into being, a handful of different ministries were involved: the Ministry of Trade and Industry; the Ministry of Education and Science; the Ministry of Agriculture; the Ministry of Transport and Communications; the Ministry of Social and Health; the Ministry of Labour; and the Ministry of Environment.

> The novelty was to gather all the stakeholders – not only universities, research institutes, and companies, but also sectoral government research laboratories and the most relevant users – together to plan and execute joint projects aimed at increasing the competitiveness of the whole cluster (Romanainen 1999).

The Cluster Programmes started in 1997-98 and were designed to run for 3-4 year periods. They consisted of eight programmes: *the Wood Wisdom* cluster (forestry), *the Well-being cluster*, *the Food Cluster*, *the KETJU cluster* (Logistics), *the TETRA cluster* (Transportation), *the NetMate cluster* (the use of information networks in SME business), *the Workplace Development cluster* and *the Environmental Cluster*. Each programme was organised under a sectoral ministry, and each programme had its own publicly assigned and funded co-ordination. Moreover, there were several steering groups in each cluster, typically involving enterprises, public authorities, funding institutions and public science institutions. 'Earmarked' cluster-specific funds only constituted part

of the funding for the cluster programmes – other public and private financing sources have been used in all programmes.

Table 2.3 Funding and participation in the Finnish cluster programme

Name	*Number of projects*	*Number of participating companies*	*Number of participating public units*	*Cluster specific funding*	*Other public funding (million euros)*	*Private funding (million euros)*	*Grand total (million euros)*
Wood wisdom	113	12	49	2,5	17,2	14,7	34,4
Well-being cluster	17	8	22	4,4	4,9	0,0	9,3
Food cluster	12	17	12	2,0	2,4	0,1	4,5
KETJU	30	60	10	2,3	4,1	7,7	14,1
Tetra	48	29	42	1,9	7,5	1,3	10,6
Netmate	10	n.a.	n.a.	1,6	0,4	0,2	2,3
Workplace development	13	86	n.a.	5,0	8,4	0,0	13,5
Environment cluster	60	70	110	4,5	8,0	1,0	13,5
Total	303	282	245	24,2	53,0	25,0	102,2

Source: EC 2001

In addition to ministries, Tekes and the Academy of Finland were major financiers. Public resources were allocated as grants to a set of projects. Access to programme resources was based on open competitions. Each programme has its own eligibility criteria that focused on co-operation and networking, as well as scientific and industrial issues. More than 300 projects have been funded, bringing together about 300 enterprises and as many organisations from the public sphere. 110 projects are industry-driven. The total finance of all six cluster programmes is 102 Million Euro, of which 1/4 is earmarked cluster funding from the responsible sectoral ministries and 1/4 is industry money.

(d) The Centre of Expertise Programme

The Centre of Expertise Programme was created in accorcance with the Regional Development Act,[7] and started in 1994. The overall objective of the Centre of Expertise Programme is to identity regional strengths, and create economic growth by increasing the number of competitive products, services, enterprises and jobs based on the highest standard of expertise. Centre of Expertise Programmes are realised throuch cooperation between industry, local government, technology centres, universities, polytechnics, research institutes and other branches of public administration. Responsibility for leading the operations lies with the local technology centre company. A main purpose of the CoE programmes is to bring leading experts in research, education and private enterprises in a region or network into close interaction. Benefits gained from synergy will in these knowledge-intensive clusters substantially improve the environment for the emergence of new products, enterprises and jobs. The Centre of Expertise network provides enterprises with knowledge and know-how derived from national and, where necessary, also international contacts and resources. The Centres of Expertise lean on the following services provided by technology centres: project management; business development and marketing; technology transfer; enterprise incubation; patenting, licensing and financing; co-ordination of extensive research, development and training projects; and development of operating environments and models.

Initial implementation of the programme over the period 1994 to 1998 was based on eleven centres of expertise. Based on the outstanding results of this work, the Council of State extended the programme by nominating new fields of expertise and new Centres of Expertise to implement the second national programme over the years 1999-2006. Fourteen regional CeOs and two nationally networked Centres of Expertise was appointed for this purpose. In this second phase, fields of expertise has been broadened from the traditional high-tech sectors to include new media, cultural business, recreational experience industry, design, quality and environmental expertise. Programme work in the regions is co-ordinated by a National Committee for the Centre of Expertise Programme with members representing the ministries involved, the business community, research, education, culture and experts in municipal and regional administration. One of the main principles applied in implementing the Centre of Expertise Programme is *competitive tendering*. The main criteria for selecting CeOs have been of concentration of expertise of an internationally high standard, innovativity and impact for the proposed programme measures, and efficient organisation. The

[7] More specically, Regional Development Act No. 1135, 1993.

Centres of Expertise also compete annually for government basic funding, which serves as catalytic, seed-stage finance, and is matched by a contribution from the region. In the words of its main public funder, the Ministry of the Interior, "the programme has provided Finland with a strong and functional network of Centres of Expertise to meet the challenges of 21st century knowledge-based society" (Ministry of the Interior 1993).

(e) The Centre of Excellence programme

This program is funded by the Academy of Finland.[8] The aim of the Academy's Centre of Excellence Programme is to enable the emergence of research and training environments that can generate top international research with social relevance. The goal is to promote interaction between different types of research and foster a multi-disciplinary approach to research. A Centre of Excellence is a research and researcher training unit, comprised of one or more high-level research teams with shared, clearly defined goals and good prospects for reaching the international forefront in its field of specialisation. Centres of Excellence are selected for a term of six years on a competitive basis, with evaluations provided by international experts. The first 12 centres were nominated for 1995-1999 and a further five units for 1997-1999. For the period 2000-2005, a total of 26 units from different fields were granted centre of excellence status. During the first three years, the Academy will be spending 21 million Euro in direct support of the units, and 3.5 million Euro in core facilities funding. The centres also receive support from their host organisations (48 million Euro of universities basic funding and 12.5 million Euro of other funding). Tekes has been closely involved in the planning and implementation of the Centres of Excellence and supports the first three years of 11 units of the 2000-2005 programme at a cost of 5.2 million Euro. Funding from the EU is also important for many of the centres. Funding from the private sector is present in about a quarter of the centres but the amount is rather small.

(f) Other public promotion programmes

There are other promotion programmes than the ones described above. The following list provides an overview of the major public promotion programmes in Finland.

[8] The following is extracted from EC 2001.

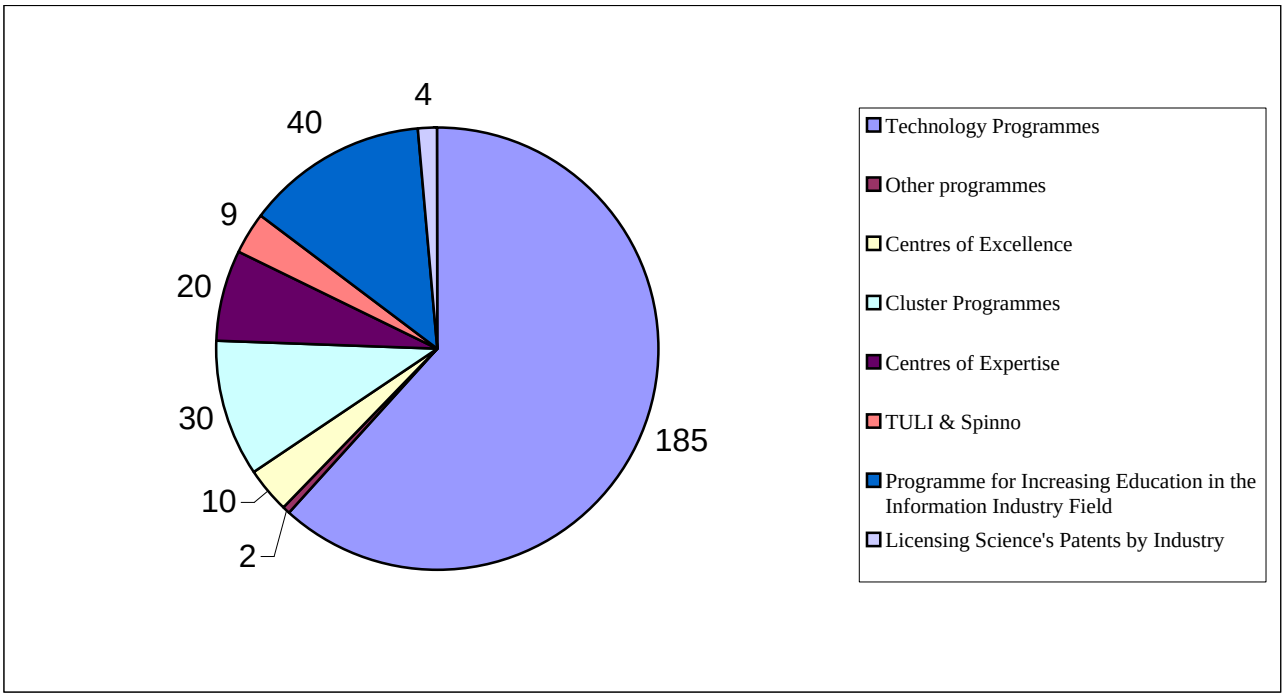
Table 2.4 Main Public Promotion Programmes

Name of Programme	*Responsible Authorities*	*Main Approach*	*Type(s) of Interaction Mainly Addressed*
Technology Programmes	Tekes	Funding for joint large research projects in 60 technology fields	collaborative research
Technology Clinics	Tekes	Funding for technology consulting to SMEs, developing a market for external technology assistance	technology transfer, consulting, training
Centres of Excellence	Mainly Academy of Finland, partly Tekes	Leading public research to top international level in selected fields of research in order to strengthen the knowledge base	long-term oriented co-operation in high-tech areas, mobility
Cluster Programmes	Several sectoral ministries, Tekes and Academy of Finland	Funding co-operative projects and networks of innovation actors in sectoral fields (research-producer-supplier-user chains)	networking, contract and collaborative research, mobility
Researcher Mobility Programmes	Tekes	Subsidies or tax relief to researchers moving abroad or coming from abroad	international researcher mobility
Centres of Expertise	Ministry of the Interior	Building up regional networks in certain fields of technology involving enterprises, universities, municipalities and intermediaries	networking, start-ups, informal contacts, collaborative research, training & education
TULI & Spinno	Tekes	Promotion of start-ups from science by providing a supportive infrastructure which actively looks for spin-off ideas	start-ups
Programme for Increasing Education in the Information Industry Field	Ministry of Education	Strengthening education relating to information industries	training & education
Licensing Science's Patents by Industry	Finnish Foundation for Inventions, Ministry of Trade & Industry	providing supportive infrastructure (consulting, negotiation, information) to inventors in public science for licensing IPR	IPR

Source: EC 2001

Figure 2.5 illustrates the relative levels of funding that are channeled through these public promotion programmes.

Figure 2.5 Main public promotion programmes: funding levels 1999 (million euros)



Source: EC 2001

2.2.6 Concluding remarks

The approach taken in Finland during the 1990s to promote industry-science interaction has very much been one of using funding as change agent. The impressive results that have been achieved using this 'funding as a change agent'-strategy, shall be further described in the below discussion of *best practices* in Finland. The less 'gloomy' side of Finnish efforts to promote industry-science interaction shall be addressed also, however. The lack of substantial reforms of the legal framework for universities, and the sparesome integration of higher education policy with science and technology policy, shall be key topics in the concluding section on *future challenges*.

2.3 University of Helsinki case study

University of Helsinki was founded in 1640, and is the oldest of current universities in Finland. The University at present has 37.300 full time students, and 61.000 students in various adult education programmes. The University of Helsinki employs 5.850 researchers and 3.540 other staff. Its overall budget is 450 million euros, with one third of this being non-core funding (Mäkipää 2003).

2.3.1 Entrepreneurial policies and support structures

In 1997 Helsinki University established a network cooperation with the task of promoting interaction between the university and business, called *Helsinki University Entrepreneurial Services*.[9] The aim of this network cooperation and its services was to speed up the transfer of research results and scientific know-how to enterprises, and especially to seek out research-based business ideas and to help researchers to protect them and exploit them commercially. The parties involved in the *Entrepreneurial Services* network were the following: (a) The Research Services Unit in the Department for Strategic Planning and Development of the Administration Office of the University; (b) Spinno Business Development Centre; (c) the Foundation for Finnish Inventions; (d) Culminatum Ltd.; (e) Helsinki Licensing Ltd.; and (f) Helsinki Science Park Ltd.

The rationale of bringing together these units and organisations in a *Entrepreneurial Services* network was to provide services and expertise which one the one hand would help researchers recognise, protect and commercialise their innovations, and on the other hand would help industry exploit research by transferring know-how and technology from the university. To realise this dual aim *Entrepreneurial Services* undertake a wide range of activities. First, it seeks out research results that may be exploited commercially, and evaulate entrepreneurial and business ideas. Secondly, it brings together enterprises and researchers, whether in relation to starting up new joint research projects, or for the commercialisation of existing research results. Thirdly, it helps providing contacts with international networks, assists in making arrangements for funding and offer training and consultation to promote entrepreneurship. In the following each of the partner units and organizations of *Entrepreneurial Services* will be described more or less briefly.

(a) Research Services Unit

The Research Services Unit was established in 1994, within the Department of Strategic Planning and Development of the Administration Office. The unit provides a full-service package to

[9] The following is extracted from Mäkipää et al 1999, and Mäkipää 2002.

researchers, including cost-free information services and personal guidance from drawing up research proposals and seeking out channels of funding, exploiting results and possibly starting up an enterprise.

(b) The Spinno Business Development Centre

Spinno Business Development Centre (SPDC) was established 1991. It's mission is to promote commercialisation of high-tech and knowledge-intensive business ideas. SBDC seeks to achieve this in and through a network of experts such as business consultants, marketing professionals, lawyers, financial advisers etc. SPDC offer a range of business development activities in the start-up, development and internationalisation phase: (i) Training activities focusing on business development, growth and internationalisation; (ii) Programmes assisting in creating well planned internationalisation strategies (iii) club activities encouraging networking between companies (iv) incubator support activities.

(c) The Foundation for Finnish Inventions

The Foundation for Finnish Inventions supports and promotes Finnish invention work and the development and exploitation of inventions. The Foundation's basic tasks consist of consultancy, evaluation and protection of inventions, funding product development and marketing as well as other promotional activities for commercialising inventions. The key criteria for funding are the market potential, inventiveness and patentability of the invention, and its level of technology. The objective of funding is to develop the inventions of private individuals, researchers and small entrepreneurs into products for the market either in the inventor-entrepreneur's own production or under a licence or other exploitation agreement. The Foundation was established in 1971 and is located at the Innopoli Technology Centre in Otaniemi, Espoo, just outside Helsinki. In addition to its staff of 22 there are 28 innovation managers in the main universities and in the regional Employment and Economic Development Centres all over Finland.

(d) Culminatum Ltd

Culminatum Ltd. Oy is a regional development company established in 1995, the principal purpose of which is to serve as a joint instrument of regional development for its owners. The company is owned by the Uusimaa Regional Council, the city authorities of Helsinki, Espoo and Vantaa, and the universities, polytechnics, research institutes and the business community of the region.

Culminatum seeks to improve the international competitiveness of the Uusimaa region and to encourage the business utilisation of the region's educational, scientific and research resources. Through its services and activities it provides a link between experts, public administration and enterprises, and enables partners and experts for various development projects to be located more easily. Culminatum achieves these objectives mainly through managing the Helsinki Region Centre of Expertise Programme, which is now in its second programme period, 1999-2006. The Helsinki Region Centre of Expertise Programme establishes channels of innovation for selected fields of know-how, whereby enterprises can take advantage of the leading expertise, research findings and technology of the region’s universities, institutes of higher education and research facilities to give rise to new, internationally competitive commercial operations. The following five regionally important expertise sectors were selected for the second period in Helsinki region:

- Active materials and microsystems
- Genetechnology and molecular biology
- Digitial media, content production and e-Learning
- Medical and welfare technologies
- Software product business.

Culminatum makes proposals and plans development projects promoting the competitiveness of Helsinki region and the utilisation in business of the expertise of its universities and research institutes. Culminatum performs investigations with a view to developing various sectors and their associated business operations in Helsinki region. In performing these investigations and implementing development projects, Culminatum seeks to link the principal stakeholders for each project effectively to investigative work and other development operations in the region. Proposals for development projects arise from the needs of regional partner networks and directly from private subscribers. Culminatum prepares a project plan, which forms the basis for seeking project finance. This finance may come from general, open funding programmes or from the subscriber's own financial sources.

Co-operation and exchange of experience with other national centres of expertise is also an important aspect of realising the aims of the Programme. Co-operation with international, and especially with European organisations involved in regional development work is vital to the development of activities. Culminatum is a member of the European Business and Innovation

Centre Network (EBN) and is through this membership involved in the Innovation Relay Centre Network (IRC).

Implementation of the Programme in Helsinki region is supervised and directed by the Centre of Expertise Steering Group comprising members of the Board of Directors of Culminatum. The members of the Steering Group are the vice-chancellor of Helsinki University of Technology; the Deputy Managing Director of the Helsinki Chamber of Commerce, the Director of Finance of the City of Helsinki; the Director of Planning of University of Helsinki; the Executive Director of Uusimaa Regional Council; and the Managing Director of Innopoli Oy.

(e) Helsinki University Holding Ltd.

Helsinki University Holding Ltd is owned by the university and SITRA, and has established three companies under the Holding to organise its business activites. These are Helsinki Consulting Group Oy Ltd; Helsinki University Development Services Ltd; and Helsinki University Licensing Ltd. *Helsinki Consulting Group Oy* is one of the largest Finnish consulting companies, measured by the number of international assignments it has undertaken. It's annual invoicing amounts to FIM 60 million, and clients include European Commission, the World Bank and Finnish as well as foreign ministries. The company's mission is to contribute to sustainable economic, social and environmental development through international cooperation projects. The company emphasises private-public partnership, assisting in public sector reform and development of human capital. The company has ongoing projects in more than 20 countries around the world. *Helsinki University Development Services* markets training and research services with an annual turnover of approximately FIM 6.500.000. Finally, *Helsinki University Licensing* is a very important company from the point of view of private entrepreneurship. Its field of specialisation is to help university researchers exploiting their research findings commercially and to assist in procuring both Finnish and international funding for this purpose. The company's services includes patenting, marketing and licensing of protected findings.

(f) Helsinki Science Part Ltd

Helsinki Science Park is located in the Viikki district of northern Helsinki, next to the university campus, home of the University of Helsinki Biocenter, the Faculty of Science and the Faculty of Agriculture and Forestry. The overall purpose of Helsinki Science Park is to promote entrepreneurial activities based on innovations in bioscience and related fields. Key areas include

biotechnology, moleculary biology, different applications of food technology and environmental technology, pharmacy, biomedicine and diagnostics. At present as much as 12 national centres of Excellence are located in University of Helsinki, covering a wide range of research fields, but with a particular strength in biotechnological and biomedical sciences. Among others, University of Helsinki have Centres of Excellence in Disease Genetics, Cancer Biology, Molecular Neurobiology, Plant Molecular Biology and Forest Biotechnology.

Helsinki Science Park and its collaborating partners provide assistance in patenting and licensing, business management, international marketing and financing. For young entrepreneurs there is a comprehensive training program Spinno in the skills needed for business - tailor-made to meet individual needs. The first business incubator facilities were established in 1999. A new and enlarged business center and incubator will be in operation in the beginning of 2003. At present, a large number of companies are presently located in the Science Park, cf. the below table.

Table 2.5 Companies in Helsinki Science Park

Consulting services	Biocid Ltd; Biofellows Oy; Bioviestintä Sirpa Pietilä; Innomedicina Ltd.; Tarjaco Oy
Environment	Ekolab Environmental Oy; Junvegroup Oy; Nordic Envicon Oy; Wood wisdom
Food & Animal Feed & Plant biotechnology	Antarios Oy; Biofellows Oy; Camelina Oy; Novatreat Oy; Omecol Finland Oy; UniCrop Ltd.
Pharmaceutical & Diagnostics	Biotop Oy; Carbion Oy; Fibrogen Europe Oy; Glomega Inc.; Karyon Oy; Ipsat Therapies Oy, Orion Oy, Spectrum Medical Sciences Ltd.
Reagents & Research and analysis services	Biotep Oy; Biovitro Oy; Conexor Oy; Genexpress Oy; Glysim Oy; Mikrofokus Oy; Stockhausen Nordic Oy; Suomen sisäilmaston mittauspalvelu Oy; Viikin Tutkimusplavelut Oy
Other	Lasse Matintalo Oy

More than 1000 research scientists and technicians working in research groups and individual companies in the Science Park. In the below box, a brief description of one of these companies is given.

University spin-out company: UniCrop

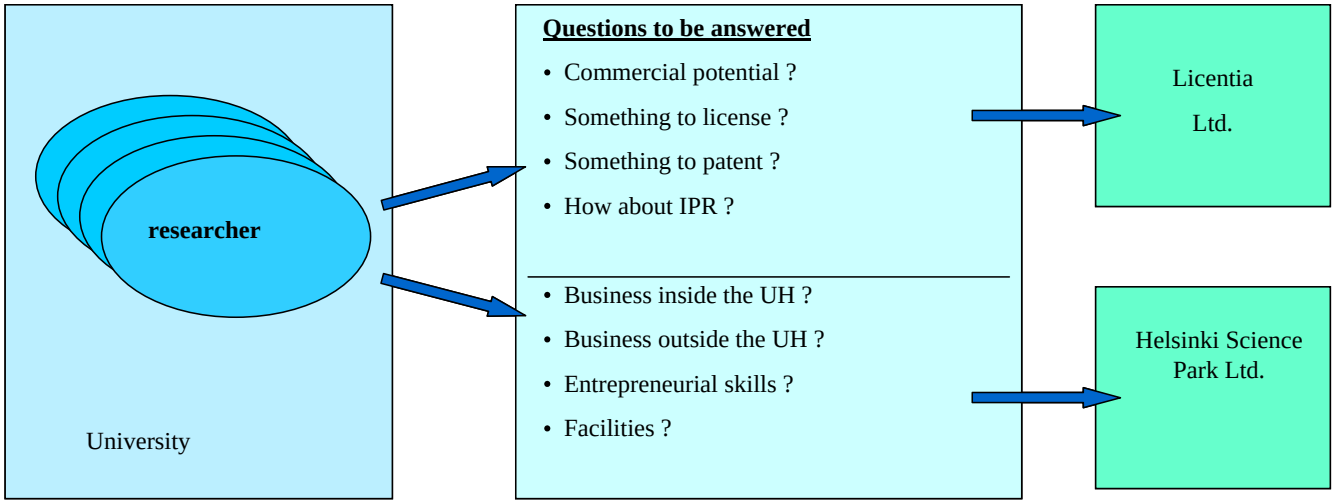
UniCrop is a private biotechnology company focused on developing a novel sprouting technology for the production of therapeutic proteins. The company was established in 1998 by Professor Eija Pehu and three molecular biologists, Anne Kanerva, Kimmo Koivu and Viktor Kuvshinov. UniCrop is located in Helsinki Business and Science Park in Viikki, Helsinki, and employs 27 people. UniCrop finalized its second investment round in the beginning of 2002. The major shareholder is Sitra (National Fund for Research and Development); other institutional investors are Biofund Ventures III Ky, Optiomi Oy and Solaris Capital Fund I Ky. In addition to institutional owners, UniCrop has four private shareholders. UniCrop Ltd is a development and manufacturing partner for the production of therapeutic proteins. The Business Strategy is to seek partnerships with companies and alliances that want to produce pharmaceutical proteins, by offering access to protein production technology that is economical and suitable for medium-volume needs. In terms of technology, UniCrop develops high-yield and low-cost technologies for the production of recombinant proteins for the pharmaceutical industry, thus meeting a growing demand for increasing the production capacity of therapeutic proteins and monoclonal antibodies. More specifically, UniCrop aims to improve the availability of a new generation of protein drugs by using its proprietary technology to express therapeutic proteins in a fully contained plant-based system.

Helsinki Science Park Ltd. is a joint venture of the Finnish government, the University of Helsinki, the City of Helsinki, Sitra, and a number of industrial federations. Helsinki University owns 1/7 of the Helsinki Science Park, the City of Helsinki 2/7, a number of private companies 1/7, SITRA 1/7, and the state of Finland 2/7.

University companies in the innovation chain

Two of the above described companies play a particularly central role in the university innovation chain; Helsiki Licentia and Helsinki Science Park. The distribution of labor among them with regard to the innovation chain may be schematically summarised as follows:

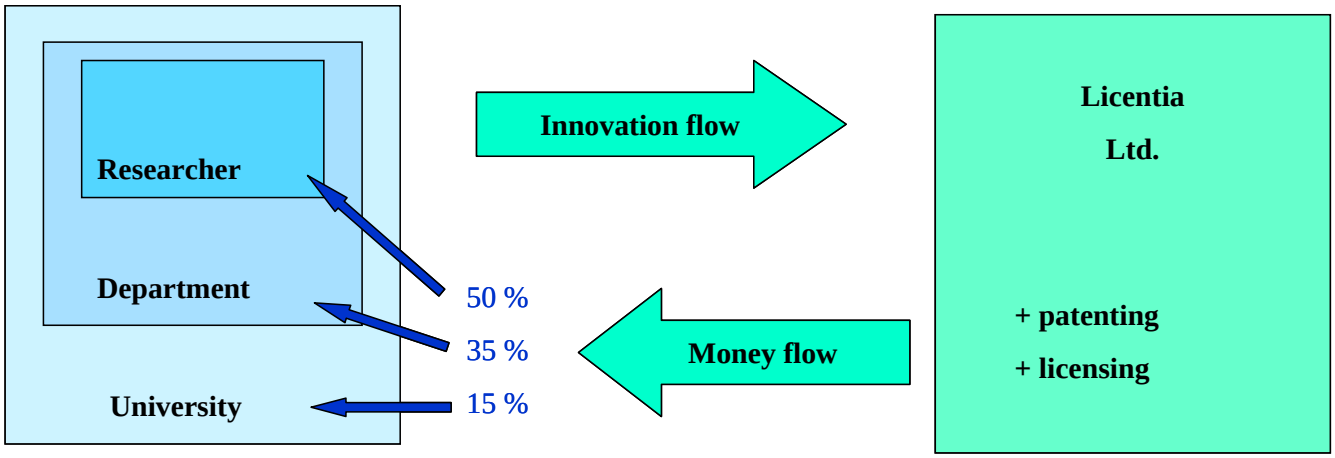
Figure 2.6 Distribution of labor in the University of Helsinki innovation chain



Source: Mäkipää 2003

The Department of Development and Planning has developed a standard model of distributing revenue generated by patenting and licensing of university research results, ensuring that incentives are in place at all three levels in the University.

Figure 2.7 Distribution of revenue from patenting and licensing



Source: Mäkipää 2003

Before making a few concluding remarks, the following section identifies a key policy issue with regard to commercialisation of university research.

2.3.2 The formation of a spin-off company at the University of Helsinki

This section will describe and discuss how a plant-biotechnology research group at University of Helsinki transformed and spun out a research-based company in the late 1990s.[10] The objective of reporting this case study in detail is to gain some key insights that pertain to the agenda of promoting commercialisation and entrepreneurship at universities. The involved issues are not specific to the University of Helsinki, nor to Finland, but express a severe tension created by two opposing rationales familiar to most European countries, though in varying degrees. This tension, created by these opposing rationales, is one of the most severe barriers to university entrepreneurship througout Europe. Policy-makers need to address and resolve it, to bring reality closer to their vision a knowledge-based society driven forward by of research-based innovations.

The research group aimed at responding to the challenges of modern agriculture by making use of various biotechnological approaches, such as genetic engineering of virus and insect-resistant crop plants. After working with such issues for eight years (1990-98), the group formed a spin-off company. The research group was founded in the late 1980s by the group leader, Prof. Monto, and her students at an agricultural experimental station in the United Kingdom. The association of the Monto group with the department of agronomy at the University of Helsinki in the early 1990s was part of an attempt to modernize the department's research tradition. The Monto group was strongly supported in its early stages by those in key administrative positions. Both the former chairman of the agronomy department and the dean of the faculty claimed that this was due to the fact that the crop science as practiced in the department was lagging behind international developments. One way to come up to the international standard was to recruit Prof. Monto's research group and, by so doing, introduce plant biotechnology into the department. The group's plant-biotechnological research program was use-oriented, basic research. The group endeavoured to understand the biology of a natural virus-resistance mechanism in the potato and, in parallel, to develop a virus-resistant cultivated potato plant. In 1993, the group extended the scope of its research. Cell and molecular-biological studies on the potato and its virus resistance were supplemented by research on insect resistance in various plants. A few years later, in 1997, the spectrum of research topics further expanded. As the group's program developed it became too application-oriented to be attractive to the Academy of Finland, and consequently the research group shifted to R&D funding

[10] The following is extracted from three articles by Juhan Tuunainen (see list of references). The name of the company as well as the names of the involved researchers and department heads were invented by Tuunainen for purposes of anonymisation.

provided by Tekes. Compared with grants from the Academy of Finland, funding from Tekes had more strings attached to it. Tekes stipulated that in order to get funding the group had to have viable industrial collaboration. The industrial network was an interesting option for Monto's group. It provided a possibility of going on with the academic research while pursuing, simultaneously, saleable commercial potato varieties. If the shift in the group's funding from the Academy to Tekes was crucial for its further development, so was also its turning to Sitra. Sitra provided long-term venture-capital investment for developing companies and facilitated the establishment of their business functions. Based on an application submitted by the Monto group in 1998, Sitra officials decided to provide seed money for the group's emergent firm. Despite the public suspicion of genetically modified crops, Sitra regarded the group, its business plan and collaboration networks as promising.

In August 1998, the biotechnology firm PlantTech was founded. Some of the doctoral students were still in the midst of their dissertation projects, and the group leader wanted to pursue both academic research and commercial application simultaneously. Although uncertain about the possibility of success of such hybridisation, the group decided to opt for it. As a result, a mixed community – a hybrid structure between public-supported science and industry – emerged. The professor and three of her graduate students became shareholders of the enterprise while remaining at the same time, members of the faculty. Although the company was founded in 1998, it did not start its operation until early 1999, when the necessary capital investment was secured by Sitra, and the chief executive officer was recruited. During the first years of operation, the firm's growth was rapid although it did not yet have real sales but depended on the investments and project funding obtained from outside sources. In October 1999, the combined human resources of the hybrid consisted of 13 persons altogether, five of whom worked in the company and eight in the academic projects at the university. A few years later the company employed 19 persons by itself.

Within the department, Prof. Monto was among the most successful scientists with a strong track record in competitive grants, students supervised and publications in peer-reviewed international journals in the fields of biotechnology, plant science and genetics. Her group was the first in Finland to apply modern biotechnology to improve field-crop plants. The group was an active and cohesive entity strongly networked with relevant plant-biotechnology research groups throughout the world. Simultaneously with the founding of the hybrid firm, the professor's term as department chair came to an end. Change in the departmental leadership had major effects in regard to the group's ability to combine academic work with business. Following Monto, recently appointed

professor of agroecology, Pekka Wilenius was elected the chair. The way of performing the administrative function within the department now altered radically: the new chairman's emphasis on correct procedures and his perception of departmental democracy replaced Monto's informal and managerial stand towards administration.

Finnish universities are public institutions governed through a number of laws, regulations and contracts. Typically, these were not constructed for universities in particular but for the state administration as a whole. Norms regulating business activities of university professors existed at three levels. First, there were the State Civil Servant Law and the Statute, which provided for all the state civil servants in every administrative branch. Second, the collective bargaining contracts agreed between the government and labour organizations defined the conditions under which professors performed their duties. At the time of this study, a new policy of total work-time planning (instead of a fixed number of, say, teaching hours) was being introduced for the sake of increasing flexibility and enhancing chances for research. Third, at the university level, the administrative regulations stated, for instance, that the general administrative authority within the department was the chair, whose task it was to lead and control its activities. More specifically, the general notion at the University of Helsinki was that commercialisation activities had to be performed in such a manner that none of the below regulative clauses pertaining to *civil servants* were violated:

- The obligation to take care of ones official duties (teaching, research and administrative tasks)
- The prohibition against taking a secondary occupation besides ones office, unless given a specific permit for it
- Leave of absence to be accorded by the employer
- Action against duties, or neglectance of them, could be subject to admonition or, in serious cases, even dismissal.

The public research was accomplished in the very same laboratory at the university as the firm's commercial development. The existence of the research group–firm hybrid soon became a contested issue in the department. Although economic development and commercialization of the research results were considered issues of great importance in the university policy, no clear-cut rules and regulations existed in relation to managing start-up companies at departments. Instead, determining the conditions for the business activity became an issue of a heated battle between the group leader and those in administrative positions. The university administrators wanted to make sure that there existed a fine line between the hybrid community's academic work and its commercial projects. They also wanted to secure that the group leader performed her teaching duties in the department

diligently. Thus, administrative reports and plans concerning the group leader's allocation of working time were called for. The administrators believed that she was neglecting her duties as a university professor, by confusing the boundary between her official duties and business activity. Prof. Monto had a different point of view. She underlined the ambivalence of the entire university policy. In her viewpoint, the university favoured commercialisation in the abstract, but prevented people from doing it in the concrete. She was perplexed and irritated by the requests for accounts that questioned her academic freedom. Moreover, she regarded the start-up company as an entirely private issue with no other relationship to the university, except a temporary rental of laboratory space. Additionally, she held that she had done excellent work in accomplishing her departmental duties, teaching and research.

The situation aggravated and, after a couple of months, the professor and the chair were in the midst of a heated conflict focusing on the boundary between the professor's official duties and her private businesses. The chair claimed that the crux of the matter was the department's teaching. According to him, the professor had refused to teach, and since some other teachers complained about their excessive workload, he started pushing her to become more active in teaching. Recurrently complaining about not having received the requested accounts, he referred to what he regarded as proper conduct: 'according to the law (…) the professor, who has business activities close to his or her branch must notify them to secure that things won't get all confused'. In sum, accounts were requested for two reasons: 1) to police the boundary between the official duties and the private business and 2) to manage the department's teaching.

The professor had a very casual attitude toward administration. Instead of respecting bureaucratic correctness she managed her extensive personal networks through frequent trips, acted dynamically and spontaneously and focused on the outcomes of the research, such as publications. She believed that not everybody else was expected to give accounts; that the new chair treated her differently. In consequence, the situation developed into a personal fight for power: the professor regarded the chair's actions as expressing mistrust, overenthusiastic administration, 'bullying' and 'micromanagement', exercised at the expense of the department's academic performance and applied mission. She also maintained that the situation was polarized and believed that plant biotechnology was being expelled from the department in favour of agroecology, which was the chair's discipline.

The professor decided to draw a boundary between the department and the hybrid firm: she did not give any information on the private business to the chair. In her view, the important issue was the fulfilment of her academic duties, which she believed she had done outstandingly. She maintained

that she was accountable only to the highest executive, the rector; he was the right administrator with whom to discuss because the company was going to relocate into the university's science park. This viewpoint was in a sharp contrast to the chair's perspective. In his viewpoint, a concern for accounts was a central preoccupation. He held that there was only one legitimate reporting line, which went through his position. He also stressed that he was not interested in the firm, as such, but only as far as it was related to the professor's duties: 1) how the professor, as a dual affiliate, would take care of them and 2) how the firm would organize its relationship to the department. To him, the boundary was permeable: the firm was a collective affair and the department should benefit from it financially through merit points.

In November 1998, the professor informed the chair about the enterprise and her intention to take a partial leave of absence. She had the idea of working part-time in the firm while continuing her academic research. The head approved the leave. The professor also expressed her hope that the firm could rent laboratory space from the department until the university's business incubator was completed. The chair answered that this appeared to be possible. However, the professor was still uncertain about the possibility of combining the two modes of activity. Could she really divide her time between the firm and the department? Would the transfer to the business incubator result in a breakdown of bonds with the university? These were questions she wanted to discuss with the university rector when he came to visit her laboratory. The professor did not see any need to inform the chair about the rector's visit but regarded it as being related to a private business with no other ties to the department than a temporary rental of space. The chair felt badly about that. He sent a letter to the rector regretting not having known about the visit and expressing that the department approved the professor's partial leave and the rental of the laboratory. Because he was aware of the cautious attitude towards commercialisation within the administration, he also avowed that the firm was a positive event and asked for the rector's support. The professor objected to the chair's intervention and sent an e-mail to him drawing a strict boundary between the department and the enterprise:

> Hi, my meeting [with the rector] was entirely private, and I do not want you to intervene in it in any manner. (…) If any of my meetings with the university management, or other, are connected to the department I shall inform you properly. I do not want you to mention [the firm PlantTech] in any occasion either, least associated with this department or your own 'support'… We are arranging our affairs fully legitimately, and we shall contact the department properly.

The chair believed that the professor did not see the department as a partner in collaboration. He was perplexed about it and reacted strongly

> On account of this [e-mail] I have changed my attitude in such a way that I regard the forthcoming negotiation [on the leave] as extremely difficult. On the basis of this, I conclude that she has something like – aggression, something like – belligerent sentiment towards this department. Just like we had, or some of us had, done something against her (…)

This exchange was a turning point in the process of insisting upon and resisting accounts: it expressed the grave difference in viewpoints between the two actors. By way of talking with administrators they both tried to figure out how to proceed further. The chair had more powerful position compared with that of the professor, and he decided to tighten up his attitude. Trying to normalize the situation through administrative means he intervened in the professor's work by sending her a severe letter requesting her 1) to give a report on her use of working hours, 2) to draw up a work-time-table and 3) to adopt a constructive attitude towards the department.

A total annual work-time plan was a new administrative guideline where academic staff reported their contributions to teaching, research and administration. Neither the chair nor the professor knew exactly how to best fulfil this obligation. Its aim was to serve for a neutral coordinating mechanism to accommodate for strengths and interests of the faculty, securing their contribution to departmental activities but allowing for more freedom of choice. As such, it provided for the possibility to negotiate working hours. It was not designed as a tool for dictating the issue, but in this case the chair made it a coercive implement: he used it to push the professor to teach undergraduate courses that, in his view, were neglected.

> For months I advanced that matter very softly, like 'Could you, please, make the work-time plan?' that would make it apparent that [she] doesn't teach and why [she] doesn't teach etc. No. The work-time plan, the insistence of it, was an infringement of intellectual freedom although it is a guideline given by the central administration.

The chair also sent another letter to the professor stating that her leave would be approved only if she realized her official duties. To normalize the situation and to make the professor comply with the administrative routines, the chair admonished her with a severe letter, which was examined and revised by the dean, the university lawyer and the director of personnel affairs. It stipulated two regulations: 1) the professor should start diligent teaching and 2) she should apply for a permit for business activity. These regulations were case-specific; they were based on the general provisions stated in the law but expressed in terms of the issue at hand. As a result, the university's liberal stance towards university – business boundary grew restrictive:

> You are still more a professor (…) than a private entrepreneur: the society pays you expecting that you use the most of your time and energy for achieving the goals of your subject and those of our department. Teaching undergraduate students is the most important part of your duties. (…) I urge you to apply for a permit for entrepreneurial activity during working time immediately. (…) I urge you to renew your work-time plan and start energetic teaching.

To justify the regulations the chair piled up a number of ‘serious faults and failures’ he believed the professor had committed. He also expressed lack of confidence in the professor’s group, since the researchers occupied positions both at the department and the company. Such hybrid roles were difficult to control, given that trust and mutual collaboration was not in place. From the professor’s perspective, the letter and the chair’s related oral statements were groundless and erroneous. The chair had said that she had ‘embezzled the pay of six weeks’, ‘been away from work with full salary and misappropriated taxpayers’ money’, ‘made a serious mistake and acted illicitly’ and that the university administration was investigating her actions. Shocked by these accusations the professor examined their validity and tried to get them corrected. She got to know that no investigation had been initiated and no malpractice had been recognized.

The chair sought to manage the boundary by referring to the professor’s teaching duties, to the administrative necessity of acquiring a permit for private businesses, and to the professor’s perceived malpractice. The administrators consulted by him also took a restrictive attitude towards hybridising university research and business. This state of affairs became evident in a meeting called together by the rector. In her summary of the discussion, the professor said that the atmosphere was accusative, emphasizing the interest of the university. The hybridisation was now considered illegitimate.

Despite the conflict, the research group and the hybrid firm worked at the department until the company’s laboratory was completed at the business incubator building in the university’s science park. As the Monto group’s academic projects were relocated to the university’s biotechnology research institute, a collaboration agreement between the institute, the research group and the start-up company was made. The primay focus in the science park was on high-quality academic research and postgraduate education and, as a new objective, commercialisation of research results. Thus, the leaders of the institute considered entrepreneurship in a positive light, provided that it was practically accomplished elsewhere than in the confines of the institute and that it did not affect working hours, or employees’ ability to carry out their academic duties. As the institute did not have any undergraduate teaching responsibilities to fulfil, one of the most complex issues related to preceding boundary work was removed from the start: the allocation of teaching loads. Yet, the collaboration agreement proved complex. A major function of the agreement was to bifurcate the hybrid community by creating a boundary between its academic projects and private business activities. From the group’s perspective, this was highly problematic. It worked in the field of applied plant biotechnology and tried both to reveal fundamental scientific questions and to develop agriculturally useful end products. For the researchers, the hybrid firm was a way to make their

university research applicable in the wider society. They had also developed a manner of working flexibly across the border of commercial and academic projects: 1) they used to help each other and solve experimental problems collectively; 2) they held it possible that PlantTech might commercialise some of the results achieved by the academic projects; and 3) the professor went on leading the academic projects although on a 100 % leave from the university and being employed by the firm.

The stance taken by the institute's head of administration was that public and private sector research should not be combined in such a way that the administration would lose its ability to control the use of public funds. In his view, such problems were likely to emerge if the roles of an academic and an entrepreneur were confused and the public and private research was performed in the very same place:

> The roles [need to] stay non-blurred. And, of course, these kind of mixed communities further their confusion. But there should be established such a kind of balance that this can be taken care of otherwise than only by trusting in people's ethics (…) Where does the boundary between university and entrepreneurial activities lie, especially when the university and the entrepreneurial activities are accomplished in the same premises? (…) [She] could have established that firm within the university but she would have faced the same issue, that is, to make an account of how responsibilities and duties are allotted between them. One can do nothing in such a way that one sits on two chairs. (…) Within the university, entrepreneurial activities can be engaged in by hiring equipment, by paying for premises, instruments, service. (…) But in that case, one can't have a kind of dual role of being simultaneously engaged in the firm and at the university. Instead, it is definite: you are on either side.

To make this policy effective, the collaboration agreement was agreed between PlantTech, the research group and the institute. In that contract, an attempt to 'deconstruct' the hybrid was made, that is, its public and private parts were separated from each other. In this connection, two specific boundaries were instituted: social and spatial. The social boundary concerned the roles of the professor and two PhD students of her group. Because of possible 'conflicts of interest', the mixed roles of researchers-entrepreneurs were abandoned. The head of administration insisted that the academic projects needed to have a leader who was in an employment relationship to the university, and that 'this firm should not become involved in those projects'. On these grounds, the professor (now working for the firm) resigned from the position of the project leader and two graduate students were named as new principals. The professor's role was defined as being 'not responsible leader of the projects but only a scientific expert'. The contract also named the researchers and technicians working for the academic projects separating them from those working for the firm.

The spatial boundary defined in the contract highlighted the importance of the physical location from the perspective of the changing relationship between public and private in the research practice.

While the hybrid firm sought to keep its laboratory as a kind of a ‘trading zone’ between academic research and corporate development, the university administration tried to separate the two from each other. In particular, the contract specified the rooms where the academic projects could be performed, thus, separating them from the corporate activity. In practice, the public – private division inscribed into the contract was called into question and redefined by the research group, which had established the firm. In result, the contract did not provide an efficient means to control the use of space and, thus, remained curious from the point of view of both, the head and the professor. The head admitted that the separation between the working spaces was made only to give an impression that the issue was properly handled. In this respect, he admitted that the boundary remained not only rhetorical but illusory as well. In fact, the hybrid firm had customized their lab space to fit their particular needs by pulling down the partitions in the research group’s area. Instead of being composed of many individual rooms, as implied in the contract, the area now comprised two large rooms with workstations and desks for all of the researchers arranged in an unsystematic manner. What the head, however, regarded an important issue was to control the use of the group’s public research grants: they should not be used for the benefit of the private firm.

The professor held that the boundaries had the dysfunctional effect of breaking off the continuum from academic research to the society – the link of central importance to the group’s applied mission. In realizing this purpose, the hybrid firm was instrumental: it was a mechanism used to transfer the results from the research laboratory to agricultural practice. She noted also that bureaucratic solutions, like administrative boundaries, did not hinder the informal intellectual interaction, communication and collaboration between the researchers of the hybrid community. According to the group members, the boundary nonetheless was strict in specific sense: the firm’s projects did not make use of instruments acquired with public funds. However, the researchers worked the other way around; they used the company’s expensive facilities, laboratory chemicals, equipment and computers to support their academic projects. In this way, they could both preserve the legality in regard to the regulations, while maintaining some of the flexibility provided by the hybridisation.

In PlantTech’s chief executive’s perspective, the spatial boundary served as a means of allocating renting expenses between the firm and the academic projects. The researchers of the firm and the academic group had also drafted a reciprocal confidentiality agreement and concurred mutual prohibition against the use of each other’s results. He remarked that the academic group and the firm worked, in fact, in different fields of research: The academic projects studied the virus and insect resistance of transgenic plants and developed the quality of foodstuffs by using genetic engineering.

The firm, on the other hand, concentrated on the production of medical proteins and industrial enzymes in plants and was not interested in commercialising the results of the group's academic projects, after all.

The fact was that the boundary between public academic research and the corporate activity remained ambiguous. In a similar vein as in the department, the institute was part of the university organization and followed the principles defined in interaction with the central administration. The head of administration pursued to define the boundary by consulting the very same officials as the department chairman had consulted. Nonetheless, the boundary problem was not really resolved. Instead, it remained permanently at risk as the head found it necessary to sustain monitoring the group's finances to secure that public grants would not flow from the university to the private company. The group soon decided to cease its academic research projects altogether and become a fully independent private entity. At this stage, some of the researchers left the community, while PlantTech hired others to work in new commercial projects. The professor transferred to work on a large multinational economic organization in the United States of America.

2.3.3 Concluding remarks

In this case study all the elements for a successful commercialisation of research results were present. National policies were favorable, public funding for R&D, as well as for capital investment was provided. The central management of University of Helsinki was keen to promote commercialisation of its research and had started already in 1997 formulating its policies and creating entrepreneurial support structures. Finally, an internationally renowned academic had developed a research program with strong commercial potential, and a had a dedicated group with her, determined to bring their research to market. Yet, the process of spinning out the company was everything but smooth. The difficulties and conflicts described in the case study should not be seen as exceptional; as merely an incidental conflict between two individuals with dislike for eachother. On the contrary, the two persons embody each their rationality, and their conflict is the conflict of those two rationalities, played out in the everyday life of a university department. It is the rationality of academic entrepreneurship against the rationality of academic purity. At present, they each have their own policy patron: science and technology policy on one side, and higher education policy on the other side. Policy-makers need to resolve this opposition. Fundamentally, policy-makers need to rethink the rationality of academic purity. Why is it that an entrepreneurial researcher should not

use university resources and thus indirectly taxpayers money to establish a spin-out company? What's the moral difference between using taxpayers money to fund industrial R&D (through Tekes), and using them to fund the commercialisation of research in universities? Why is the latter inappropriate and the former not? We talk so much about the knowledge economy, about research-based innovation etc., but how are these ideals and visions to materialise, when the only actors whom we seemingly cannot permit to benefit from it – the universities and their researchers – are the ones we expect to run with the ball?

2.4 Best practices in promoting university interaction with industry

The discussion of best practices in Finland will emphasise the following four characteristics of Finnish science and technology policies: (i) commitment; (ii) clarity and coordination; and (iii) continuous, clever assessment. The discussion of these characteristics of Finnish S&T policy will be illustrated by referring to (i) the additional research appropriation programme; (ii) the common conceptual matrix of public promotion programmes; and (iii) the use of research and evaluation in the formulation of science and technology policies.

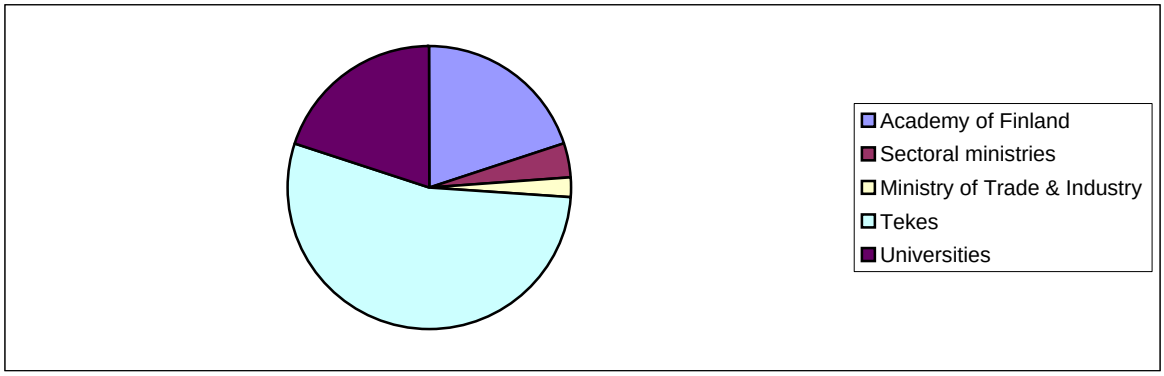
2.4.1 Commitment: the additional research appropriation programme

In the section above on the history of science and technology policy in Finland, the commitment by Finnish policy-makers to the strategic importance of science and technology policy in the difficult economic situation of the early 1990s was emphasised. Though the Finnish economy recovered from the economic crisis by the mid-1990s this commitment was not abandoned. On the contrary, in 1996, the government of Finland decided to allocate 3,35 billion FIM in proceeds from state property sales, to further increase the level of public funding for research and development.[11] The purpose of this additional appropriation, disbursed between 1997 and 1999, was to intensify the operation of the national innovation system for the benefit of the economy, the business environment and employment alike.

The STP council drew up a plan for the appropriation whereby the bulk of the funds were to be allocated to research and development through the appropriate channels in the science and technology administration, notably by increasing the resources allocated to Tekes and the Academy of Finland by means of competitive tenders.

[11] The following is based on Sitra 2000 and EC 2001.

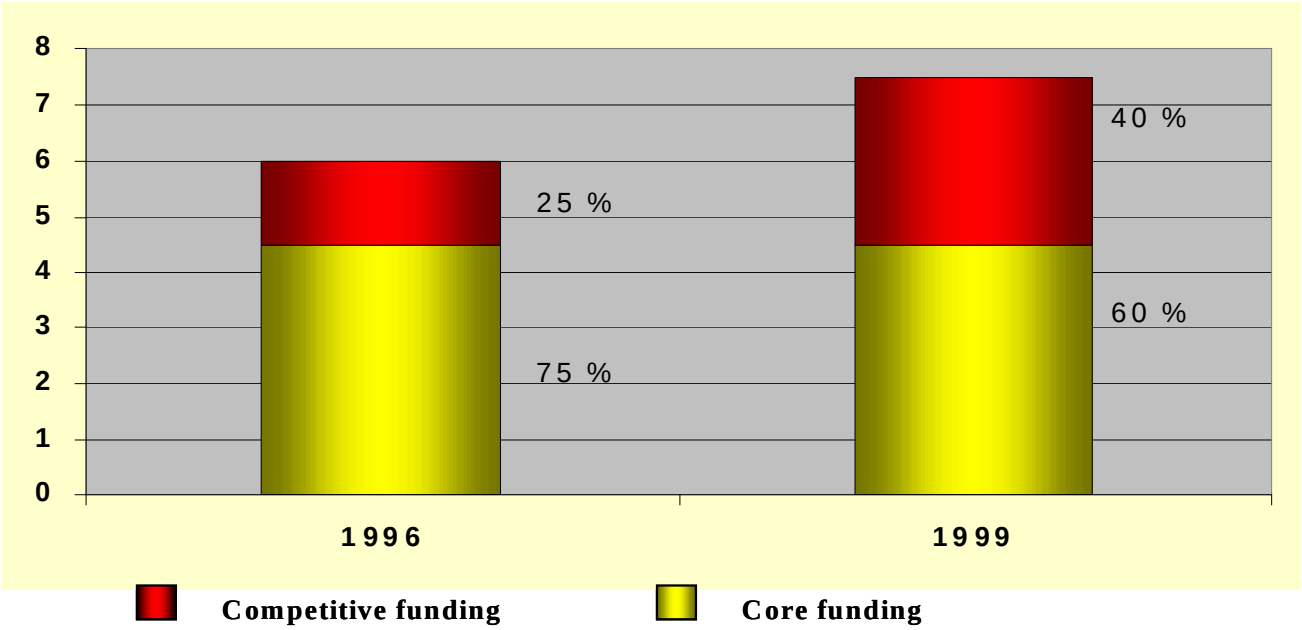
Figure 2.8 The additional appropriation for research



Source: Prihti et al 2000.

The vast majority of the funds were allocated on the basis of competitive bidding, for which cooperation in and among industry and science actors was explicit key criteria. As is shown in the chart below, the additional appropriation has significantly changed the overall level and composition of public R&D funding.

Figure 2.9 Public R&D funding in Finland 1996-1999 (billion FIM) [12]



[12] This chart is provided by Esko-Olavi Seppälä, Science and Technology Policy Council, Finland.

The original target in the additional appropriation programme was to raise the national investment in R&D to 2,9 percent of GDP by 1999. This goal was reached and surpassed in 1998. In 1999, an appropriation increment of FIM 1,5 billion was introduced on a permanent basis.

The policy throughout the 1990s of promoting university interaction with industry through continuously increasing the amount of funding available for different modes of collaborative research and development through competitive bidding, has been a core element in Finnish science and technology policy, and it certainly justifies the term *best practice*. The commitment to this strategy was recently affirmed in the triennial policy review by the Science and Technology Policy Council:

> With a view to strengthening innovation and favourable conditions for it, measures will be taken to enlarge the resources of the Academy of Finland and Tekes to enable them to take care of their growing responsibility for the development of new growth fields, research-based innovation and innovation environments (STPC 2003: 37).

2.4.2 Coordination: common conceptual matrix of public promotion programmes

The Finnish strategy in promoting industry-science interaction has been characterised by a high degree of coordination and clarity. Finnish economic performance in the 1990s has taken great advantage of an unusually clear understanding among different actors of the overall objectives and strategies of the programmes launched to promote industry-science cooperation in research and development. There seems to have been a clear sense of mission among the different actors, which involved also a clear understanding of the different roles that the respective actors were expected to take up in relation to this common mission. Such a common understanding did not develop by chance. The collapse of the socialist markets and the economic recession in the early 1990s created a sense that the country would have to *fight* to recover and to prosper in a new, increasingly integrated Europe. Without an extremely well-coordinated, strategic science and technology policy, this sense of urgency would never, however, have led to a sense of *mission*. The paramount importance of the Science and Technology Policy Council with regard to this coordination is emphasised by all oberservers (cf., for instance, Ormala 2001).

Finnish efforts to promote industry-science relations have been characterised by a very strong focus on concrete targets – whether a specific *cluster*, a specific *technology*, or a specific *expertise*. Moreover, Finnish efforts have been characterised by making *networking* an integral element of all programmes and projects. The way in which the different stakeholders are involved from the very

first exploratory phases, preceding the launching of a technology programme, is an excellent example hereof.

Though the term itself was not always used explicitly – in industrial policy the preferred term was 'cluster policy' – the thinking, planning and implementation of Finnish policies and programmes throughout the 1990s were all more or less explicitly patterned on the concept of a *national innovation system* (NIS).

> 'NIS thinking' had been gradually entering into policy discussions over the course of the late 1980s. It was taken up a few years before the cluster approach was introduced in industrial and economic policy. Since both the NIS and cluster approaches are characteristically systemic, one is relatively easy to adopt once the other has been adopted. Therefore, the early adaptation of NIS thinking supported the adaptation of a cluster approach. In fact, not only did it support the approach, it also strongly influenced the way in which the cluster approach was introduced into policy making (Romanainen 1999).

This existence of a common conceptual matrix for policy-making no doubt contributed crucially to the clarity of objectives and roles in relation to the promotion of industry-science cooperation. This has been all the more important for the involvement of universities in this cooperation since when *not* convened in and through these public promotion programmes, great confusion prevailed in universities and other higher education institutions with regard to the rules of the game of seeking to become a more entrepreneurial university (cf. the case study).

2.4.3 Use of research and evaluation in formulating S&T policies

Many observers point to *evaluation* as a key element in Finnish science and technology policies. In its 1990 policy review, the finnish STP council declared "increased evaluation in all parts of the research system and in different sectors of science and technology policy" to be a key objective (STPC 1990: 62). The Finnish policy on evaluation as a core element of its science and technology policy was outlined in a separate statement by the STP council in 1991. Here, the STP council stressed the need to "extend evaluation to the whole national system of innovation". Three years later, the STP council noted that few of its objectives had "come true as fully as the recommendation for increased evaluation" (STPC 1993: 28). The role intended for evaluation was to continuously inform "objective-setting and selection within the innovation system" and further develop "the knowledge-base which supports decision-making on the improvement of the system" (STPC 1993: 28). Thus, in the Finnish approach, evaluation is an integral element in the ongoing effort to identify and further strengthen the comparative advantages of Finnish economy through R&D, rather than merely an instrument of public control of the correct use of public funds. This applied for the recently completed evaluation of biotechnological research; *Biotechnology in*

Finland – Impact of Public Research Funding and Strategies for the Future (December 2002). This evaluation, funded by the Academy of Finland, evaluated "the current status of the Finnish biotechnology innovation system", and proposed "improvements as appropriate", all in order to "serve as a basis for drafting the next national biotechnology development programe" (Academy of Finland 2002). The evaluation combined an external assessment by an international expert group with an internal self-assessment exercise, and on the basis hereof formulated recommendations directed to the academic sector, the funding organisations and to industry.

> The purpose of the evaluation is two-fold: first, to evaluate the impact of public research funding and second, to advise funding organisations, universities, research institutes and industry how to develop and focus biotechnology and life sciences research in Finland. The mission of this exercise is to improve the competitive ability of the Finnish innovation system in biotechnology (Academy of Finland 2002: 91)

The fact that evaluations are used in this strategic and policy-developing manner is but one expression of the practice in Finland of formulating science and technology policy on the basis of a comprehensive system of continuous policy research and assessment. Another notable example hereof is the launching by Tekes of a technology programme aimed specifically at informing the development of advanced technology policy; namely *ProACT – the research programme for advanced technology policy*. To give an indication of the scope and magnitude of this programme, the individual projects that make up this programme are listed below in table 2.5.

The director of Tekes has motivated the practice of basing the formulation of science and technology policies on research and evaluation in the following manner:

> Policy design and implementation must be innovative and able to experiment with different approaches and tools in order to meet the challenges of the changing innovation environment. This is possible only if the theoretical framework and methodologies continue to evolve and are able to provide a better understanding of the complex interactions and linkages within the innovation environment. Understanding how the system works is the key to successful policy design and implementation. (Romanainen 1999).

Examples testifying to the fact that research and evaluation in the field of science and technology policy are in fact taken seriously, and do in fact strongly influence policy-making are numerous. One classic example is the study on industrial clusters by the Research Institute for the Finnish Economy which preceded and heavily influenced the National Industrial Strategy 1993, and later generations of cluster programmes. A more recent example is the evaluation of Biotechnology in Finland. The biotech evaluation report stressed the need to "modernise University organisational structures… so as to achieve more flexibility" (Academy of Finland 2002: 76), and this was a key focus area of the very recent policy statement by the Science and Technology Policy Council (STPC 2003; see further discussion in section 2.5.3).

An important element of the Finnish approach to the formulation and implementation of science and technology policy is the division of labor between the STP council, the Ministries and the funding and implementing agencies, such as Tekes and the Academy of Finland. That policy-making in this field is extremely well-coordinated, does not imply that everybody are involved in everything. On

Table 2.5 Overview of the research programme for advanced technology policy

Challenges facing Finland's innovation system	Innovation processes and innovation networks of firms in rural areas and small centres The role of social capital in the innovative process Innovation system in action: an analysis of tecno-economic developmen in the Oulu region The international dimension of the Finnish science and technology system Multinational enterprises and the Finnish innovation system
New perspectives on innovative activity	Challenges and oppportunities for the utilization of research results Informal ways to protect intellectual property in SMEs Value creation and renewal of the knowledge base of the corporation Dynamic patterns of innovative activities among Finnish firms R&D patterns in input-output structures
Technology policy and civil society	Technology policy, citizenship, and every-day life A rhetoric of innovation in the case of welfare clusters Toward a multi-purpose technology policy Communicative order in the age of information technology DIGITAL HUBRIS – on the mental and moral dimensions of the computerized network-society Information technology in Finland after World War II: The actors and their experiences
Co-operation and interaction in innovative activity	Producer-user collaboration and new forms of innovation activity Technologies, strategies and women's business activities within the new economy Public-private partnership in market construction Increasing eco-efficiency: an analysis of factors generating innovations Processes and boundary conditions for embedded foresight in innovation networks
Biotechnology and society	Managing transepistemic innovation processes Biotechnology as part of the national innovation system Acceptability and interaction as a challenge for technology projects Rights and responsibilities in biotechnology

Source: Tekes 2003

the contrary, a substantial degree of autonomy with regard to policy implementation have been delegated to the funding agencies.

> Individual research or technology programmes are not decided by the Council, nor by the ministries, but at the level of the implementing agencies. This makes it possible for the system to react relatively quickly to new industrial and societal challenges as they are identified (Romanainen 1999).

Tekes employs staff with research experience and significant understanding of those technological fields that they are involved in evaluating and further developing. This enables Tekes to provide scientifically high-quality mediation between public science researchers, industry partners, and other players in the innovation system. This system of basing science and technology policy on research and evaluation, and of basing policy implementation on scientifically high-quality mediation certainly qualifies for the term *best practice* in promoting university interaction with industry.

2.5 Future challenges in Finland

In the following three main challenges facing Finnish policy-makers with regard to the promotion of university interaction with industry will be discussed. These are: (a) Commercialisation & Internationalisation (b) Integration of higher education policy and science and technology policy (c) Shaping up the university for third mission

2.5.1 Commercialisation and Business excellence

Observers stress that much of the Finnish economic growth over the past decade has been based on business-to-business product development and sales. The core competences of the Finnish growth success have been technological. There is widespread recognition that Finland is underperforming when it comes to business management competences of an international standing. This was noted, most recently, in the international evaluation of the Finnish biotechnology sector:

> Competent and experienced manageres are in short supply; a national effort to train managers and business development specialists for biotech would be very beneficial (The Academy of Finland 2003: 77).

The Helsinki School of Economic recently launched a new degree programme in Biotech Management. Without going into detail on the profile of this programme, one can appreciate that this well illustrates the mutual responsiveness in and among the different actors of its national innovation system that Finland in recent years has become so famous for. Key agents in the Finnish national innovation system are discussing, at present, the possibility of creating a national centre of excellence in business management (Seppälä 2002, Romanainen 2002). Generally, an increased focus on internationalisation in the Finnish national innovation can be noted, reflected also in the title of the recent policy review from the Science and Technology Policy Council, *Knowledge,innovation and internationalisation*.

> The national line of development, which has proved successful, will be continued and further strengthened. In keeping with that, input will be made into the production of technological and social innovations and into *the expansion of internationally successful business* built on it. The set of measures thus determined will form the core of the future national strategy (STPC 2003: 35, italics added).

In the Finnish approach to strengthening its national innovation system, the focus has previously been on stimulating co-operative research in technological fields closely related to its key industrial clusters. *Commercialisation* of university research results *as such* did not enter the policy agenda in Finland until the latter half of the 1990s, and is only recently being considered a policy agenda in its own right. One may expect the Finnish innovation model to broaden in the coming years, in terms

of seeking to mobilise universities to contribute to economic development in other ways than through co-operative research. This is very likely, however, to accentuate the tension between the rationales of Finnish higher education policy on one hand, and the rationales of its science and innovation policies on the other hand.

2.5.2 Integration of higher education policy and science and technology policy

In the section on best practices above, it was stressed that a key component of the Finnish approach has been a high degree of integration of policy-making across a number of key policy areas, including science, innovation, industrial, and economic policies. There is, however, in this coordinated policy-making, a missing link: namely higher education policy. This was noted in a report evaluating the role of universities in the Finnish national innovation system:

> It has to be noted… that [overall] developments in the realm of higher education policy did not have any (visible) links to science and technology policy. For historical reasons, links between these two policy realms have been weak, even though the target institution of the policies has been the same (Nieminen & Kaukonen 2001: 33).

The tension between these two policy agendas was illustrated in the case study on the process of spinning out of a plant-biotechnological company from the University of Helsinki in the late 1990s. A working group under the Finnish Ministry of Education has recently developed a set of guidelines for how universities should promote research-based entrepreneurship. There are ten such guidelines a few of which (italized) strongly exemplify the fundamental ambiguity with regard to the entreneurialisation agenda:

1. Universities should promote research-based entrepreneurship, that is (i) compatible with university's mission and objectives, (ii) compatible with strategy and main activities, (iii) not in conflict with main purposes.

2. University's funds should not be used for the development of new business activities.

3. University's liabilities and guarantees should be clearly defined in contractual agreements.

4. Attention should be paid to possible interest of conflicts between researcher and entrepreneur.

5. Attention should be paid to possible disqualification due to conflict of interest of a researcher/entrepreneur in specific research topics/projects.

6. Entrepreneurship activities should not compete with the teaching and research as the prime activities of universities.

7. The procedures of permission for secondary occupation/ perquisite position should be followed.

8. Confidentiality aspects in contract research needs more attention.

9. University employees or students as participants in entrepreneurship activities should not receive any monopoly rights.

10. University name and logo should not be used in entrepreneurship activities by private researchers/entrepreneurs.

Source: Mäkipää 2003

The message of these guidelines is ambiguous. University entrepreneurship is on one hand encouraged, and on the other hand illegalised: university funds should not be used for new business activities and entrepreneursip activities should not compete with teaching and research as the prime activities of universities. Univerisities are encouraged to promote research-based entrepreneurship, but are also made clear that any substantial allocation of funds and/or resources in terms of working hours, is illegal. This construal of a fundamental opposition and conflict of interest between the traditional missions of universities – research and education – and the new third mission – promoting the utilisation of new knowledge and contributing to the economy – is highly problematic. Framed in this manner, university entrepreneurship seems to be alienated from the outset, rather than being taken up as truly a new *mission* for universities.

In recent months, the Committee on University Inventions have been working on a proposal for defining the "third mission" of the universities in the University Act (Kauppinen 2002). The contents of this proposal are not yet known to the public. It is expected, however, that the proposal will be put forward after the upcoming general elections.

2.5.3 Shaping up the university for third mission

The Science and Technology Policy Council (STPC) in Finland recognises that introducing to universities the third mission of promoting the utilisation of new knowledge demands a commitment from policy-making, both in terms of increased funding and in terms of a revision of the legal framework within which universities operate. The recent policy review from the STPC

explicitely states that “the implementation of the national strategy entails that university core funding is increased” (STPC 2003: 20). Moreover, it is recognised first, that changes taking place with regard to the universities’ mission is shaking up the university as its core, and secondly, that this requires, on the part of policy-makers, that universities are correspondingly *shaped up* to its new mission, by addressing the involved legislative issues.

> Ever since education and research – knowledge and know-how – took centre stage in the development of societies, systematic input has been made into their development. The quality, quantity and right targeting of education and research pose a challenge to all industrial countries … Various research, studies and pilots are being conducted to find out the measures needed to obtain the best results from the inputs made into education and research and the best impact from outputs in terms of both efficiency and quality-based productivity. One major question is how the *university as an institution* will be able to manage the pressures and growing expectations directed at it with regard to social, cultural and economic development – whether the university has the internal capacity for renewal needed to lighten its work load in the face of constant new challenges. The traditional mission of the university is to promote free research and scientific education and to provide higher education based on research. The burning question in today's debate how to include the duty to *promote the utilisation of new knowledge* in the Universities Act the as the university's third mission. This question arises from both the growing expectations directed at universities by the users and from the legislative issues involved in efforts to reconcile the university's administrative culture, business and research ethics. The need to address these questions is tangible, because the change taking place in universities' mission and funding structure is systemic, shaking up the institution to its core (STPC review 2003: 19).

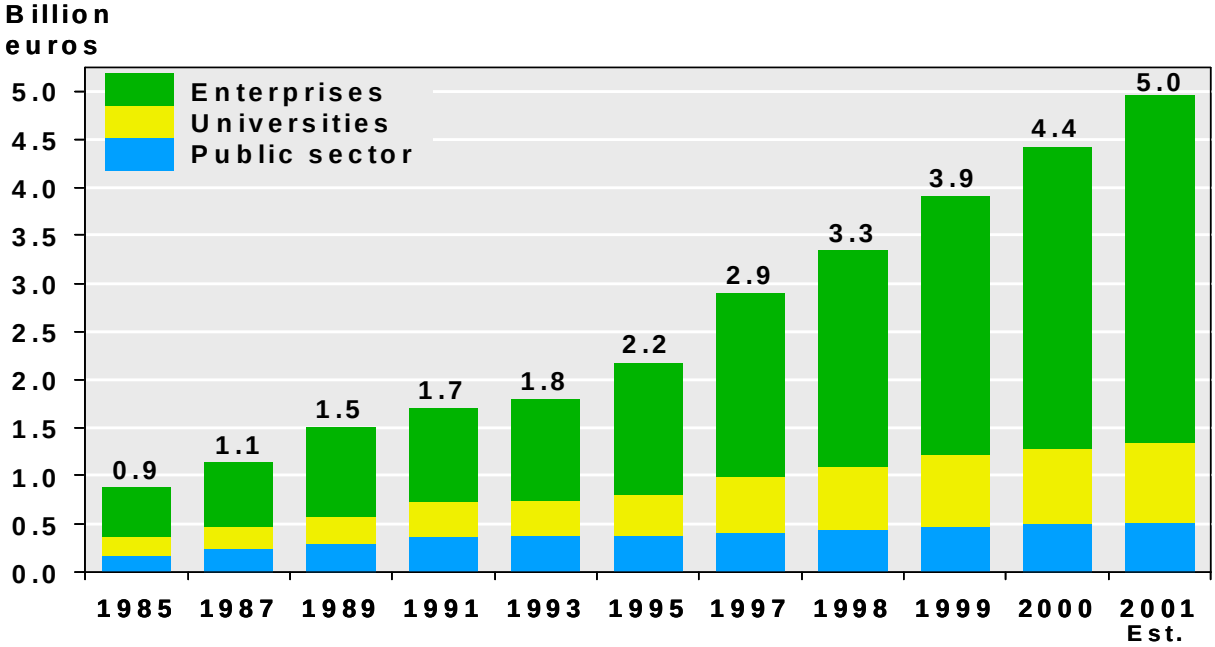
It shall be exciting to see how Finland, in coming years, will deal with this task of adapting the legal framework for universities to its new mission. As noted by Erkki Ormala, the director of technology policy at Nokia, at present university regulation is not aligned neither with the development of the Finnish national innovation system as such, nor with the changing role of universities in the wider global economy (Ormala 2003). Ormala argues a strong case for increasing the basic budgets of universities, but he also argues that such increases in funding streams to universities should not me made without prior structural changes of university regulation and administration. In its concluding sections with policy recommendations, the Science and Technology Policy Council clearly indicates its approach to these issues:

> Universities meet the full force of expectations for social, cultural and economic development. The growing expectations involve open legislative issues concerning ways and means of reconciling administrative cultures, research ethics and business activities in universities. The ongoing transformation of the university mission and funding structure is systemic; it challenges the whole institution to its very core. A new challenge for universities and the whole research system is to be able to combine in-depth specialised knowledge with versatile expertise for the benefit of users and in contract research and in joint projects with them. A question partly relating to this is the future of higher education on the whole: how its different parts will take shape jointly and separately. Universities must have the possibility and capability for organising their economy and administration in a way which will enable their actual operations to develop flexibly (STPC 2003: 38).

2.6 Concluding remarks: funding as a change agent

All observers agree that the additional research appropriation programme and the massive emphasis in Tekes' funding on promoting research and technology networks, has been a crucial factor in the developmental succes of Finland. Observers agree that it is primarily in and through Tekes technology programme activities – in and through the networks, and the concerted effort and action thus generated – that a veritable R&D boom has taken place in Finland. The below figure conveys the magnitude of this boom.

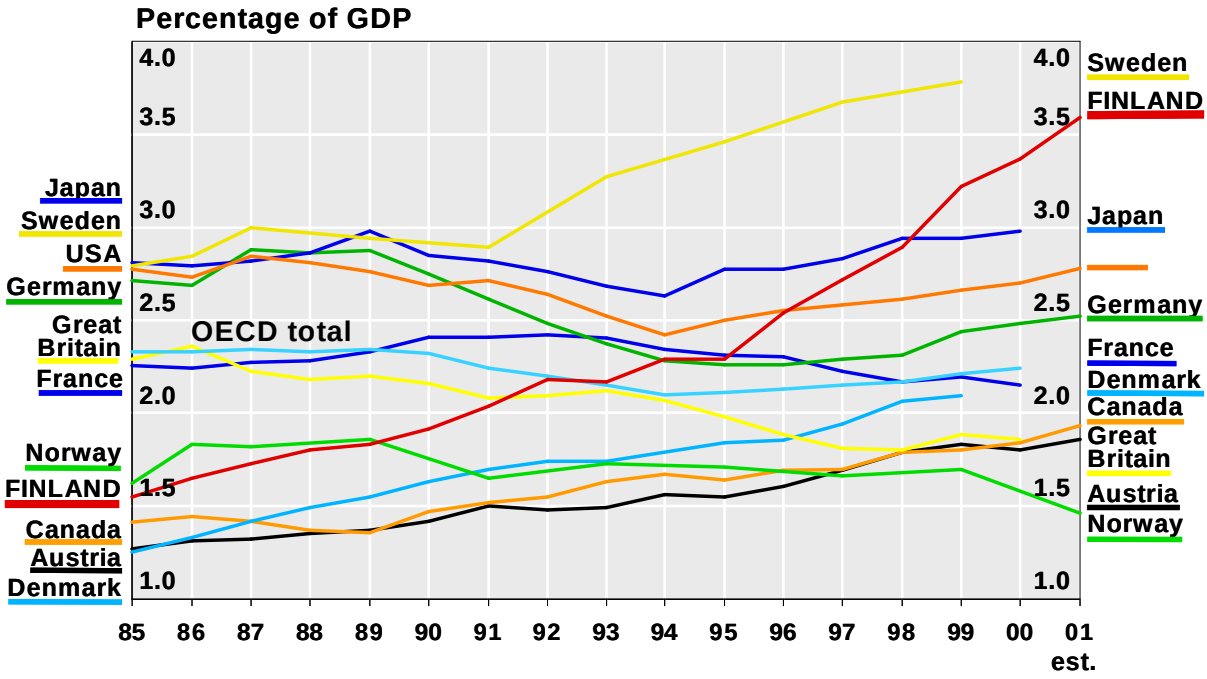
Figure 2.10 R&D in Finland, 1985-2001



Source: Romanainen 2002

This R&D boom has taken Finland from a position in the lower of end of OECD-countries when it comes to R&D spending, to the absolute top, cf. figure 4 below.

Figure 2.11 R&D in OECD countries



Source: Romanainen 2002

In 2001, Finland was given top ranking in terms of economic and technological competitiveness in five independent international comparisons, and academic scholars has begun speaking of a 'finnish model' (Castells & Himanen 2002). Finland is widely renowned for its impressive transformation from being an economy in crisis after the collapse of the socialist markets in the late 1980s and a severe banking crisis in the early 1990s, to being a front-runner economy in terms of innovation and competitiveness. The central element in 'the finnish model' is the very well-developed networks in and among companies and universities, and their strong orientation toward R&D cooperation. Just to mention one aspect of this, Finland has achieved a level of cooperation among innovative firms, universities and public research institutes that is truly extraordinary: 70 % of finnish innovative firms cooperate with other firms, universities or public research institutes. In comparison, the EU average is 25 pct.[13] All obervers agree that public funding in general and Tekes in particular has been a crucial change agent in promoting this transformation of the finnish economy.[14]

[13] Indicators for benchmarking of national research policies, Key Figures 2001, European Commission.

[14] Some might argue that the role of Nokia should have been stressed. I disagree. Nokia was of course important, but the growth of Nokia should not be seen as external or exogenous to the developmental strategy of Finland, quite the contrary. Though the success of Nokia certainly benefited from the ICT boom, and though the rest of the Finnish economy benefitted from Nokia's growth, one should not reduce Finnish achievements to a coincident ICT boom, but rather be impressed that Nokia better than any of its competitors survived the ICT crash, a fact that perhaps more than anything testifies to the fact that Nokia's growth had a solid grounding in R&D and thus to a large extent was yet another a powerful example of the success of the Finnish developmental model.

CHAPTER 3 SWEDEN

3.1 History of science and technology policy in Sweden

Up until the late 1960s, the Swedish university sector was fairly small and like most other European university systems dominated by an educational and intellectual agenda that was suited to the elite of the society. This bias was removed through a combination of policy directives as well as gradual erosion due to the massification of higher education and later research. The period beginning in the late 1960s saw a rapid expansion of the Swedish higher education system. The student revolts in 1968 stimulated another set of reforms mainly in the nature of degree structure. While the education function of the university was undergoing major transformation during this period, there was not much happening by way of policy innovation in research policy. Like most other OECD countries, Sweden was following a Vannevar Bush inspired model for science policy. This implies that the agenda for research was determined by researchers themselves with few guidelines from the state. Although the emphasis was on researcher autonomy in determining his/her research agenda, there were certain expectations. One of these is the widespread belief that Swedish universities and university colleges would function as society's research institutes. This view would become more entrenched during the 1970s when the Swedish state made a slight departure from the 'laissez faire' or Vannevar Bush type research policy. During this period, a new research policy doctrine was introduced to which commentators of Swedish research policy refer as sektorsforskning. The main point of sectoral research policy in Sweden is that the state will determine, formulate, initiate the research needs of each sector as well as meet the costs. The research so defined should develop the knowledge and methods needs to achieve a specific goal.

A concern that the research funding sector was all too fragmented, the onset of an economic downturn, the election of a conservative government to power in Sweden and preparations for Sweden's entry into the European Union all coincided to bring about a shift in policy doctrine. Sweden began to slowly outline a new science policy direction in the early 1990s (Ruin 1991; Odén 1991). The first significant act in this was the creation of a number of strategic research foundations with funding that was not tied to annual budget allocations but based on stock market earnings from an initial capital outlay. The creation of the wage earner foundations as they are called was a controversial moment in the history of Swedish science policy for several reasons. The most important from the point of view of this document was the fact that these foundations were all oriented towards funding research of a strategic cut that had hitherto not been common in Sweden.

The original intent with forming the wage earner foundations was to provide an *additional* capital injection to Swedish research. The second is that the foundations were supposed to be independent of the government and current state research policy doctrine. Thirdly, they were supposed to work directly for promoting collaboration between universities and firms and for the commercialisation of academic research. Once the social democratic party regained control of the government, they devoted a great deal of time and effort to trying to disband the wage earner foundations and it was only in 1998 that they were officially accepted. In the meantime, the government has become more influential in many of the foundations and through a policy of reducing public research budgets it has managed to dilute the potential effect of the wage earner foundations. A classic example of this was the severe reduction of the research budget of the Swedish Environmental Agency (Naturvårdsverket) to the point where this agency had to rely on MISTRA (the wage earner foundation for strategic environmental research) to fund projects to which the Swedish Environmental Agency had already committed.

After the initial act of introducing the wage earner foundations, a series of policy and institutional measures have been taken between 1994 and 2002 all geared towards the reorientation of the public R&D system towards more strategic goals. One of the more significant components of this policy for reorientation is the set of policy and institutional measures designed specifically for the promotion of university interaction with industry.

Briefly the policy for reforming the university sector has three pillars:

(i) Promotion of the development of an entrepreneurial culture at universities and university colleges;
(ii) Reform of the institutional framework for competitive research funding
(iii) Expansion and upgrading of the regional university colleges while integrating them in regional strategies for economic development.

Throughout the described period – starting at the same time as the sector research policy doctrine – a number of measures have been introduced to facilitate the transfer of knowledge from universities and university colleges to the society at large. Many of these mechanisms are still in place and relevant to the issue of university-industry interaction although they are not specifically focused on the theme of commercialisation of knowledge. The following sections will briefly describe how each of the mechanisms were intended to function.

3.2 Framework conditions in Sweden

3.2.1 Introduction

Two initiatives are seen by observers as having had a particular impact in promoting a cultural attitude favorable of university interaction with industry. The announcement by the Conservative government that technical universities and regional colleges could compete for the right to be privatised and the formalisation of the Third Task as a law in 1997 may be regarded as the two critical initiating acts which signalled that times were changing for Swedish universities. Both of these initiatives will be described in further detail in section 3.2.2 on the legal framework for university interaction with industry.

The remainder of this chapter describes the framework conditions for university interaction with business in Sweden. The description is divided into the following four sections: Legislation; institutional setting; intermediary structures, and public promotion programmes.

3.2.2 Legislation

This section will describe recent key changes in the legal framwork for university interaction with industry in Sweden. Focus will be on the following three areas: University privatization, Entrepreneurial organizing, and Third mission legislation.

University Privatisation

The attempt at university privatisation was a limited experiment that did not survive the Conservative government's fall from power but the universities' that won the right to become private still exist in that form. The history behind their privatisation is interesting from the point of view of framework conditions for U-I collaboration in two respects. The first is that the approach to privatisation was a policy innovation and the second is that privatisation gave the universities in question opportunity to be entrepreneurial on an organisational level that is rare in the Nordic context.

The policy innovation was initiated by the then education minister Per Unckel (Conservative) announced that he would like to try to privatise a Swedish university. Some of the major reasons for this decision include a previous state decision to increase the number of student places at Swedish universities and in particular at engineering universities. Further, it was decided that it would be a good idea to ascertain whether diversity of ownership could improve quality in the higher education sector. In a government proposition entitled Universities and Colleges: Freedom for quality

(Universitet och högskolor: frihet för kvalitet) a number of guidelines were given for structural reform of Sweden's universities and colleges of higher education which were to be implemented in parallel with the proposed increase in number of university educated. It was decided that technical universities and regional university colleges would be the ones eligible for this privatisation. A number of universities competed but none of the major research universities such as Uppsala and Lund was eligible for participation in this competition. The eventual winners were Chalmers University of Technology and Jönköping university college.

The two universities became private foundations and each received a large sum of money as its capital base which it got the legal right to invest on the stock market. In the case of Chalmers, a fifteen year agreement was set up and the university received 1,5 billion SEK as base capital. This base capital is not to be used but only the interest earned from investment of the capital, after the fifteen year period is up, it is expected that the base capital sum will revert to the state. The organisation structure which has been used to make room for the changed status is that Chalmers is a private foundation (Stiftelsen) which owns the university. This foundation is run by a Board of Directors which is comprised of a number of actors from the industrial, public and university sectors[15]. Like other universities, in Sweden, Chalmers has a rector who is elected by faculty (See case study on Chalmers in this report for further details).

From the point of the view of the state, the differences between the privatised universities and university colleges and other universities and colleges are:

(i) privatised universities and university colleges have a high degree of autonomy with respect to planning and organisation of their activities relative to that enjoyed by other universities and colleges in the country
(ii) the relation between the state and the privatised universities and university colleges is regulated by an agreement between the state and the university or college.

The university still enjoys all the privileges of other Swedish universities and the agreement between Chalmers and the Swedish state explicitly states that the university should not be penalised in or treated differently because of the changed status. Privatisation has meant certain freedoms as well. One of the more important of these is the right to recruit and lay off staff without being governed by the civil service act. One of the reasons for Chalmers entering the competition was that it saw privatisation as a move that would give the university more control over its hiring policy. While, the university has taken quite a bit of initiative in using this freedom for building its infrastructure for innovation, the deadly combination of poor management on the departmental level

[15] It should be noted that this board structure is not unique to Chalmers as all Swedish universities are required to have a diverse board membership.

and academic conservatism have meant that there has been less innovation in the area of recruitment. Even some of the goals that Chalmers set itself in the initial argument for privatisation have not been realised. This is in part because of a general lack of knowledge among departmental leaders and those who work with management of education and research within the university about the great potential for flexibility written in to the foundation's charter. Although the new organizational formats at Chalmers have been in existence for less than ten years, several different types of evaluations and investigations of the activities of these organisations' and they have all reported positive results. Nevertheless there has been no demand from any of the other universities for privatization and neither has there been any move on the part of the state to extend this policy innovation. The National Audit Office has recently proposed to conduct an evaluation of the foundation universities with a view to assessing whether the ownership structure makes any difference in how the university operates on several different levels.

Entrepreneurial organizing

The coupling of privatization and entrepreneurial organizing in this report is a hypothesis; there is still little evidence to evaluate the validity of this argument. A further problem in this regard is there is no standard definition of entrepreneurialism with regard to universities. A survey of the evidence reveals that different universities have the potential to be entrepreneurial in different respects. What may be gleaned from the evidence available through the yearly reports and different evaluation documents prepared over the last eight years about the Chalmers and Jönköping foundations is a marked improvement in efficiency in the following areas:

a. Overseeing and general internal management of the organisation's activities;
b. Attempts to develop more effective recruitment policies; and
c. The development of an infrastructure within the university for commercialization of knowledge.

While it may be argued that all three of the above may be attributed to the general policy shift at the macro level, the most noticeable difference is in attitude.

The Third Task

The Third Task (Tredje uppgiften) is a convention which has existed in Swedish university governance since the mid 1970s which holds that in addition to their two main tasks- research and education- universities have a responsibility to communicate their research results with the surrounding society. In 1997, this convention was made a law. Despite this formalisation, the actual

law about the Third Task or mission of universities is not very specific as to how universities should go about fulfilling this mission. Further as many universities have been eager to point out, no additional funding was made available for this mission. In retrospect, one might argue that the Third Task was an effort to signal the beginning of a concerted policy effort to change the culture of Sweden's universities. The cultural value that was to be encultured was that of 'entrepreneurship' or enterprise culture. In order to achieve this a number of items were added to the list of mechanisms for promoting collaboration. What distinguishes these from the first generation of collaboration mechanisms is that these are more specifically oriented towards commercialisation. A quick overview would reveal the following mechanisms:

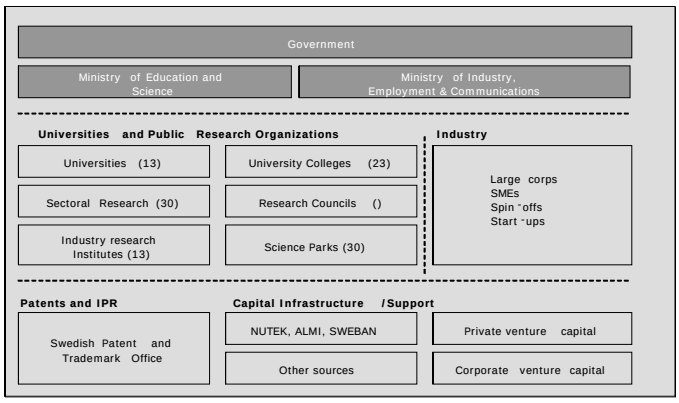
- University holding companies
- Research patent companies
- Competence centres and material consortia

Each of these will be described in further detail in section 3.2.4 and 3.2.5, respectively.

3.2.3 Institutional setting

The public R&D sector in Sweden is distinguished from that of other Nordic countries by its size and nature (see figure 1 below for a graphic representation of the R&D organization). According to the OECD, Sweden has the largest expenditure in relation to Gross National Product (3.8%) of all OECD countries. More than 70% of this is however corporate R&D and there is a high probability that development work accounts for a significant portion of this figure.[16]

Figure 3.1 Organisation of R&D System in Sweden



[16] According to Heyman and Lundberg (2002) an analysis of OECD data shows that Sweden lags behind other OECD countries in terms of the university sector's share of R&D resources. Heyman, U. and Lundberg, E. (2002) Finansiering av Svensk grundforskning, Uppsala: Vetenskapsrådet

A second peculiarity of the Swedish public R&D sector in relation to that of other Nordic or even OECD countries is that the majority of publicly financed R&D is conducted within the university and consequently the public institute sector is relatively small. This particular characteristic is a result of a policy commitment to following a Humboldtian model of keeping research and education together institutionally. Thirdly, even discounting for the facts that: (i) Sweden has the largest population among the Nordic countries (circa 9 million persons) and (ii) the dominance of the university in the public R&D sector, the number of universities (13) and university colleges (23) in Sweden is larger than in any other Nordic country. A recent report produced by the National Audit Office estimated state expenditure on higher education for 2000 at SEK 43 billion (including student loans)[17].

There are about 30 or so sector research organizations which have a budget larger than 0.5 mkr. The sector research landscape is a diverse one with considerable variation in principles and routines. Some sector research organizations are small and very specialized agencies while others are large and cover broad subject areas. In keeping with the doctrine of sector policy research many Swedish ministries were given substantial R&D budgets and became procurers of research. Apart from this funding, there was also research council funding. The research council structure was a very heterogeneous one with a large number of small to medium sized councils, some of which were so small that their budgets that sometimes barely allowed them to maintain a credible research portfolio. With the exception of a few significant private foundations such as the Wallenberg foundation, the bulk of the money available in this sector was public money allocated by the state on an annual basis.

As previously mentioned, a key innovation and change agent in Swedish science and technology policy was that of the wage earner foundations. The main characteristics of the funding policy of these foundations include:

(i) A preference for program funding and large grants spread over a substantial period of time (usually 4 years at a time with the possibility of renewal)
(ii) Emphasis on collaboration across universities and between universities and industry or public sector organisations
(iii) Evaluation of eligibility for funding and evaluation of outcome of the programme in terms of scientific quality and relevance with the latter being given equal weighting as the former
(iv) Involvement of targeted stakeholders in the design and management of the research program

[17] Figures taken from National Audit Office 2001 Audit Proposals in Higher Education, Stockholm, Sweden. Also available from www.rrv.se

The wage earner foundations represent a total capital base of about 10 billion SEK (see table 3.1). This money is invested in the stock market and as a result of successful investment strategy many of the foundations had doubled their initial capital base by 1999. Benner (2001) provides an extensive overview of the debate surrounding the introduction of the wage earner foundations.

Table 3.1 Wage earner Foundations and their budgets

Name of Foundation & Purpose	Budget (billions SEK)
Stiftelsen för miljöstrategisk forskning - MISTRA www.mistra-research.se Funds strategic environmental research	3,9
Stiftelsen för forskning inom områden med anknytning till Östersjöregionen och Östeuropa Östersjöstiftelsen Finances research on Baltic countries conducted at Södertorn University College	2,5
Stiftelsen för vård- och allergiforskning - Vårdalstiftelsen	0,7
Stiftelsen för internationella institutet för industriell miljöekonomi vis Lunds universitet	0,3
Stiftelsen för internationalisering av högre utbildning och forskning - STINT www.stint.se Funds researcher mobility- Inviting foreign researchers to Sweden as well as funding research visits by Swedish researchers to other countries	1,6
Stiftelsen för kunskaps- och kompetensutveckling – KK Supports the use of information technology; funding research at middle size universities and colleges and supporting exchange of knowledge and competence between industry and public R&D institutions	3,6
Stiftelsen för strategisk forskning - SSF www.stratresearch.se Funds research in medicine and the natural and technical sciences mainly	6,0

According to the Ministry for Trade and Industry, the primary framework structure for promoting the interaction between university and industry consists of five organisations: Vinnova, the national agency for energy, the industry research institutes, the engineering science academy and the technology bridge foundations. Here a short summary of the main functions of Vinnova, the National Agency for Energy, and the Industry Research Institutes. The technology bridge foundations will be described in section 3.2.4.

Vinnova - Agency for Innovation systems (Verket för innovationssystem)

Vinnova was inaugurated on 1 January 2001. The agency formally took over the responsibilities of three agencies that already existed. These were: the Research council for Communication Kommunikationsforskningsberedningen (KFB), the part of the National Board for Industrial and Technical development (Närings- och teknikutvecklingverkets) NUTEK that financed research and development and parts of the research council for working life research (Rådet för arbetslivsforskning) RALF.

STEM - The National Agency for Energy (Statens energimyndighet)

The national agency for energy was formed on 1 january 1998. Its responsibilities are to coordinate and implement the main part of the actions needed to restructure the energy system. The energy agency is a central actor in research, development and demonstration of new energy technology.

Industry Research Institutes

The industry research institutes are financed jointly by the state, the knowledge and competence foundation (KK-stiftelsen) and the corporate sector. They conduct research within a particular industry or area and function as an important resource for the transfer of knowledge to among others the small and medium sized companies.

With the exception of the industry research institutes and the engineering sciences academy, all the organisations charged with directly promoting U-I interaction have been introduced during the course of the 1990s. While these organisations may be regarded as the frontline of U-I interaction, in order for them to be able to have any impact on the system as a whole a series of other interventions had to be made. It is these interventions which we intend to sketch out in the rest of this report.

3.2.4 Intermediary structures

This section will focus on three categories of intermediary structures, all of which relate specifically to the commercialisation agenda and the third mission legislation discussed above: Competence centres, University holding companies, and research patent companies. In addition, a brief description will be given of industrial research institutes, technology bridge foundations and the emergence of science parks.

University holding companies

A total of 64 million SEK has been invested in establishing university holding companies at eleven universities. this means that the actual sum invested per university is quite small. The holding companies are an institutional innovation that was born out of two necessities: (i) the need to provide a mechanism which would allow universities to be able to accumulate and own capital, patents, etc. while still keeping universities as part of the public sector and (ii) the need to create an infrastructure within the university which would at once signal that entrepreneurship was institutionally condoned and provide a support structure for entrepreneurial ventures. The holding companies have not been as effective in reality as forecasted by the policy vision for a number of reasons. These include the fact that they are under resourced (finance and competence) and as a

result of this they are for the most part dependent on the various technology bridge foundations[18]. The emphasis on patents and licenses that seems to be the main focus of all commercialisation efforts may also be an obstacle for the holding companies finding their full role in the system since patents and licenses are among the most demanding forms of commercialisation in terms of resource investment.

Research patent companies

The first research patent company was founded in 1993 at the University of Linköping since then the practice has extended and research patent companies may now be found at most if all universities and university colleges. The research patent company takes responsibility for all costs associated with applying for a patent including legal advice, negotiation, etc. The current practice is that in the case of a profit, there is a three way split between the researcher, the department and the patent company. None of the research patent companies has been especially successful and none showed a profit in the first seven-eight years. This result is consistent with international experience even for US universities.

Although much has been mentioned about patents and licences in a general way, little specific information has been given here about arrangements for patenting at Swedish universities. The reason for this is that this particular issue is still under review and as yet no policy measures have been taken. The latest investigation conducted in 1996 concluded that even if the teacher exception law were to be changed there would not be any real change without further adjustments to the legal structure. The loosely structured framework represented by the technology bridge foundations, university holding companies, research patent companies and science parks provide a means of facilitating the commercialisation of research while raising the level of awareness among researchers, students and university administrators about science based entrepreneurship in general. Although as yet there is no formal change to the policy on researcher patents there are several local initiatives at different universities which show that the informal practice is tending towards a three way split with the researcher, the university and the firm sharing the profits of the patent.

Industrial research institutes

The industrial research institutes are probably the oldest of the mechanisms introduced to promote U-I collaboration and the first such institute was introduced in the 1940s. There are about 30

[18] A recent report by the National Audit Office provides an appraisal of the Technology Bridge Foundations and the university holding companies, RRV 2001 Från forskning till tillväxt- statligt stöd till samverkan mellan högskola och näringsliv, Stockholm, Sweden

industrial research institutes and many of them have a broad mandate e.g. (environment, optics, corrosion). The main tasks of the industrial research institutes are:

- Industry related research
- Innovations and problem solving
- Technology transfer
- Collaboration and coordination of larger research programs with higher education institutions, industrial research institutes and industry as partners
- Contacts with foreign firms, institutes and other knowledge centres
- Development of new standards
- Assisting with the recruitment of research trained people to industry

Technology Bridge Foundations

In 1995, seven Technology Bridge Foundations located in major university cities became operational. Together they received capital of about 110 million euros, the return on which, they may use to increase commercial benefit from university research and to encourage co-operation between industry and academia. The overall objectives of Technology Bridge Foundations are:

(i) to facilitate patenting, licensing and commercialisation of knowledge and research results from the universities

(ii) to facilitate firms and single innovators to search for knowledge in the universities

(iii) to develop common research between firms and universities and finally

(iv) to stimulate co-operation between SMEs in joint projects.

There are Technology Bridge Foundations in seven university or university college areas from Luleå in the north to Lund in the south. The foundations contribute to increased knowledge exchange between universities, university colleges and industry so that companies can get access to the knowledge produced in universities and university colleges. The Technology Bridge Foundations were established with money from the Swedish wage-earners funds.

Science Parks

The first science park was Ideon in Lund (1983), after which a number of science parks were established at other universities and university colleges. The purpose of the science park was to offer a good working environment for R&D intensive firms. There are two main types of activity that can be found in science parks: (i) R&D departments of large firms for the purposes of networking and recruitment and (ii) spin-outs from the university or university college. Initially science parks were limited to providing physical facilities (offices and practical service), later the functions of science parks were expanded to include support for patent application, venture capital, etc. In recent years the number of science has burgeoned to 30 and have been organized in an

umbrella outfit known as Swedepark. As of last year (2002) they boasted a membership of 30 science parks and circa 1700 firms with about 50 000 employees.

3.2.5 Public promotion programmes

In the following the most important public promotion programmes in Sweden will be described. Particular emphasis will be given to Competence Centres, VINNVÄXT, and the Technopole Programme.

(a) Competence Centre Programme

The Swedish Competence Centre Programme is an effort to build bridges between science and industry in Sweden by creating excellent academic research environments in which industrial companies participate actively and persistently in order to derive long-term benefits.[19] The basic idea underlying the Competence Centre concept is that active involvement from industry in academic research brings about mutual benefits. Active collaboration between research groups and companies in joint R&D projects is seen as the most effective way of achieving good agreement between academic research and industrial needs and an effective transfer of knowledge and technology. The complex needs and problems of industry offer new and exciting challenges to the universities. This translates into a demand for active participation by all the industrial partners in research collaboration and not only a commitment to pay in cash. From 1998 to 2000, the budget for the competence centre programme was about 53 million euros, i.e. around 1 percent of Swedish R&D expenses. NUTEK/VINNOVA, participating universities and enterprises are each contributing one third of that amount. Each centre is closely connected to the activities, long-term priorities and plans of a host university. The university has the responsibility for the centre administration and contributes to their financing by providing a base organisation and other resources.

The programme started in 1995 after an initiative by NUTEK. The Competence Centres were patterned after similar centres in the USA and Germany. The main purpose of the competence centres is to collect, exploit and further develop specific research areas where the prognosis for further progress has been evaluated as good. Financing of each of the competence centres is a tripartite arrangement consisting of: a group of companies; the university or university college and NUTEK. Each competence centre has approximate 9 firms involved and a few firms are involved in several centres. During the initial phase 1995-1996, the total capital input for the centres was 532

[19] The following is extracted from EC 2001.

million kronor. The costs are divided among the different financiers according to the following formula:

- Firm capital input: 198 mkr (37%) on average 7,1 mkr per centre
- University and university college: 168 mkr (32%) on average 6,0 mkr per centre
- NUTEK: 166 mkr (31%) on average 5,9 mkr per centre

Every competence centre is run by a board that is selected by the different partners. The operational leader is selected by the university.

At present the Programme comprises 28 Competence Centres at 8 universities and about 220 participating industrial companies (EC 2001). The programme is run as a joint venture between NUTEK (now: VINNOVA) and the Swedish National Energy Administration, STEM, which is the governmental financing partner in five energy-related Competence Centres. NUTEK/VINNOVA and STEM intend to contribute to the Centres for up to 10 years. The Competence Centres are specialised in specific research fields within the following areas: (i) Energy, Transport, and Environmental Technology (8 Centres), (ii) Production and Process Technology (7 Centres), (iii) Biotechnology and Biomedical Technology (5 Centres), and (iv) Information Technology (8 Centres).

From the very beginning, Swedish industry has shown a great interest in the Competence Centres and played an active role in their build-up. Many enterprises, especially the large international groups based in Sweden, are engaged in several centres. About 20 % of the industrial partners are small and medium-sized firms, here defined as companies with less than 250 employees and not belonging to large groups.

A first round of evaluations was carried out in 1997-98 by an international team of experts on this kind of university-industry collaborative effort, focussing on reviewing the introductory efforts to develop Competence Centres. A second round of evaluations is currently underway. This time, the evaluation teams are constituted of the same experts as in the first evaluation, as well as 2-3 scientific experts in the field of the Centre. The Centres are reviewed with respect to their development as Competence Centres (their Added Values), their technical and scientific achievements as well as the industrial relevance and benefits. The first report of the second round of evaluations included state ments such as:

> We were impressed by how many times during the visits we were told by the scientific subject experts from their respective technical areas that the intellectual calibre of the work performed to date was world class or first class.

> The involvement of industrial personnel in the Competence Centres Programme, from both large corporations and SMEs (small and medium enterprises), is phenomenal and exemplary. It ranges from project participation all the way to serving on the Boards in strategic roles

The concept of the Swedish Competence Centre Programme has served as a basis for the development of an initiative of similar kind in Austria, called the K+ Competence Centre Programme.

(b) VINNVÄXT

To contribute to the overall objective of developing effective innovation systems in the regions, VINNOVA recently launched a new programme with the title of "VINNVÄXT - Regional growth through dynamic innovation systems". I[20]n the words of the General Director of VINNOVA, Per Erikkson:

> Innovative capacity is crucial for achieving growth in Swedish regions. This requires world-class research and education, as well as effective innovation systems for these regions. This initiative is both a 'facilitator', allowing innovation systems to function more efficiently, and a means of a support for research in areas of future growth in the regions (VINNOVA 2003).

Innovation takes place within the framework of complex processes as a result of a variety of participants learning from and interacting with one another. Experience and research show that the innovation system's capacity for producing this type of result is a decisive factor in promoting growth. Geographic proximity has the potential to create competitive advantages in terms of interaction, learning, access to skills and cooperation in development and business. Regions which have recognised this can consciously develop their own competitive advantages. Increased growth and international competitiveness in the regions will also contribute to growth in the country as a whole. The concept behind the programme is the promotion of effective cooperation between companies, research and development organisations and the political system (the triple helix) within each region, with the aim of developing dynamic regional innovation systems, which will allow the region to be competitive at an international level within specific areas of growth. One of the guiding principles of the programme is that the regional processes, which VINNOVA will support, will be selected on the basis of a competitive "call for proposals". This has the following benefits:

- higher quality applications
- funds are allocated to the regional teams/strategic ideas which are judged to have the best potential for growth
- regional and local initiative, driving force and knowledge are exploited to the full

[20] The following is extracted from VINNOVA 2003.

This requires a well-planned assessment and selection process. A great deal of care is put into developing this process. The "call for proposals" process will consist of several stages. In January 2002 applicants where initially invited to submit project outlines. After the first selection phase, the applications will be developed further during the planning phase. Following this, the applications will be carefully evaluated and a decision will be made about the strategic ideas and processes to be implemented. The best proposals may be awarded up to SEK 10 million (approximately EUR 1 million) a year over a ten year period.

In addition a range of support activities will be provided, for example: (i) seminars for communicating concepts and ideas, (ii) analysis and process support for the planning and implementation of projects in the region, (iii) Training for innovation system participants and facilitators, and (iv) forums for the exchange of experiences.

The programme planning and design process included pilot projects implemented in five different regions. The pilot projects where focused on different fields, to ensure that they would result in a wide range of experiences. The projects had two overall objectives: (i) to be a learning experience (for VINNOVA and for the participants), (ii) to be a prototype, or demonstration project. The five pilot projects supported were:

- A bio-innovation system in the Uppsala region
- An IT services innovation system in the Karlstad region
- Development of subcontractors for contract manufacturing in the Jönköping region
- Innovation training and company development in the Halmstad region
- Inter-regional cooperation (northern Sweden and Finland) within the field of applied IT

During the programme planning and design, efforts have been devoted to learn in several different ways from the experiences of other countries in the design and implementation of similar programmes. This, together with the experience gained in Swedish development projects, has allowed VINNOVA to identify a number of factors which are crucial for success. These factors were an important starting point for the design of this programme. The key success factors for the programme are as follows:

- the existence of strong regional leadership which promotes renewal and is based on a shared vision or strategic concept within a specific area of growth. This forms the basis for regional profiling and prioritisation.
- a functional definition of the region. The administrative bodies which become involved will be determined by this definition.
- the development of robust research and innovation environments.
- the development of strategies and resources for learning

- knowledge and insight into business and development logic within the specific area of growth
- strong commitment on the part of the companies.

The Swedish Agency for Innovation Systems is allocating SEK 400 million (approximately EUR 40 million) for a period of ten years to promote growth in the Swedish regions.

(c) The Technopole Programme

The Technopole programme is a demand-led initiative from NUTEK aiming towards fostering the process of commercialising research results through stimulating the foundation of new technology based firms (NTBFs) and fostering the growth of NTBFs. In 1998, 24 Technopoles received funding. Technopoles may be units of universities or part of a science park structure. The Technopoles are centres that promote a business-like and supportive environment for start-ups. They are also targeted towards stimulating growth in small technology-based enterprises based on commercialisation of research findings. They supply technology-related services (R&D projects, patent services, technological consulting and search for R&D partners), market-related services (market analysis, search for business partners, marketing assistance and contact with other firms), finance-related services (EU schemes contact with financiers and financing of projects), software (seminars, training and education, general consulting and law consulting) and founder-specific services (offices, internet access, reception desk etc). Public funding is around 1 to 1.5 million Euro per year.

There are, of course, other promotion programmes than the ones described above. The following list provides an overview of the major public promotion programmes in Sweden.

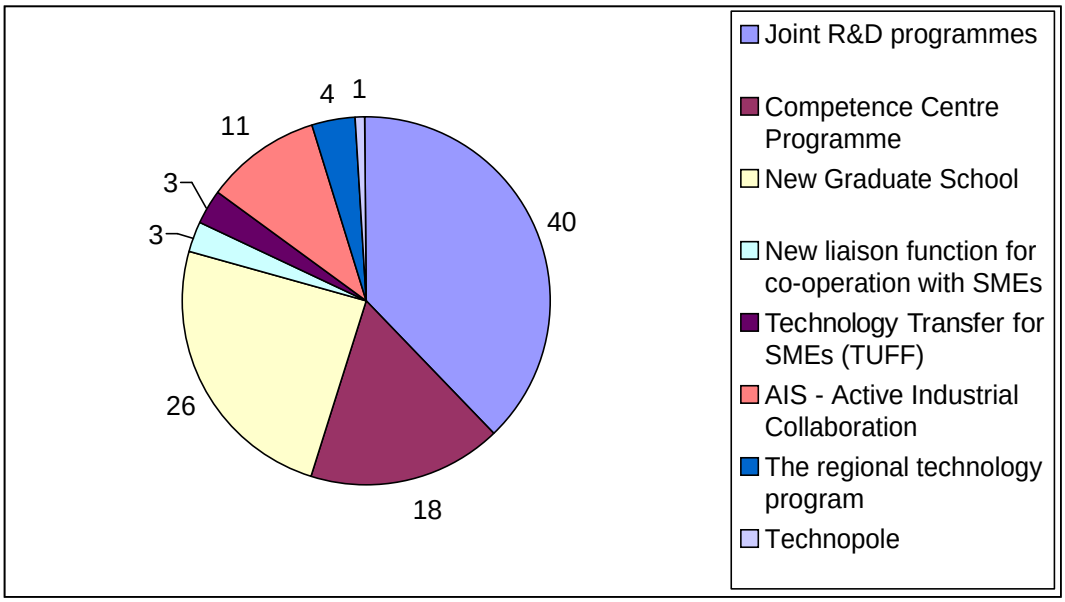
Table 3.2 Main public promotion programmes

Name of Programme (responsible authorities)	*Main Approach*	*Type(s) of ISR Mainly Addressed*
Joint R&D programmes (VINNOVA)	Establishing joint R&D between HEIs and business aimed at increasing industrial relevance of HEIs research	Research collaboration between HEIs and business
Competence Centre Programme (VINNOVA)	Establishing large scale research consortia between HEIs/PSREs and business enterprises	Research collaboration between HEIs, PSREs, business enterprises
New Graduate School (The Knowledge Foundation and the Swedish Foundation for Strategic Research)	Education of graduation in scientific fields with strategic importance	University-industry collaboration in education
New liaison function for co-operation with SMEs (NUTEK, VINNOVA, and the Knowledge Foundation)	Increasing the interaction between universities and industry focusing on a regional level	Mobility of researchers; technology transfer
Technology Transfer for SMEs, TUFF (VINNOVA)	Enhancing absorption capacities of SMEs, facilitating the trade between SMEs and HEIs/PRSEs	Technology Transfer; co-operation in the innovation process
AIS - Active Industrial Collaboration (VINNOVA)	Establishing consortium of research institutes; university institutes and business enterprises; Focussed on IT, life sciences, manufacturing and processing, sustainable development	Research collaboration between HEIs, PSREs, business enterprises
The regional technology program - "SME consortia" (NUTEK)	Establishing networks between universities, research centres, local actors, SMEs, and partly large enterprises	Co-operation between firms and HEIs/PRSEs in the innovation process
Technopole (NUTEK)	Commercialisation of research results gained at universities	Creating and supporting spin-offs
Technology Bridge Foundation;	Commercial exploitation of university research	Co-operation between industry and academia
CapTec (NUTEK)	"Meeting place" between NTBFs and investors	Supporting spin-offs and NTBFs
Provision of management support for various technology and science parks	Providing management assistance	Creation of spin-offs

Source: EC 2001

Figure 3.3 illustrates the relative levels of funding channeled through these public promotion programmes.

Figure 3.2 Main public promotion programmes: funding levels 1999 (million euros)



Source: EC 2001

The figure above does not include the Technology Bridge Foundations; see section 3.2.4 for details on their funding.

3.2.6 Concluding remarks

The Swedish research landscape has undergone a period of rapid change over the last ten years. Prior to the 1990s, which may be said to mark a watershed in Swedish research policy, the Swedish research context was dominated by university based basic research with a few independent state funded industrial research institutes. With very few exceptions organisations charged with directly promoting university interaction with industry were all introduced during the course of the 1990s. As will be apparent in the below sections, key barriers to university entrepreneurship continue to impede interaction with industry, even in a univerisity that has committed itself so highly to this agenda as in the case of Chalmers University of Technology.

3.3 Chalmers University of Technology case study

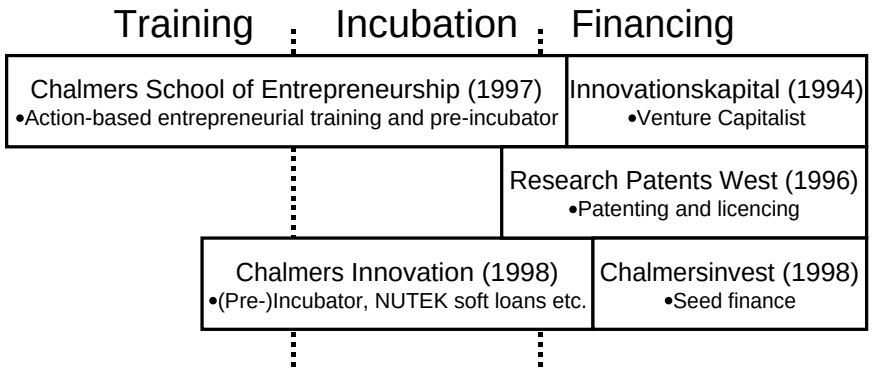
Chalmers University of Technology was founded in 1829 after a donation from William Chalmers, a Swedish industrialist. The school is located in the second largest city in Sweden and has a population of 10,200 including students and faculty. The university was operated as a private venture until 1836 when it became a state institution. This period of integration into the public university sector came to an end in 1994 when the university became a private foundation again.

3.3.1 Entrepreneurial policies and support structures

The evolution of the family of institutions that together may be said to comprise the basic infrastructure for the commercialization of knowledge at Chalmers can be dated from about the 1970s with the introduction of a number of initiatives aimed at facilitating the emergence of technology-based start-ups. Together, these initiatives constitute a system of loosely connected structures all directed at the commercialization of new technology. This system, which is illustrated in figure 3.3 may be divided into venture capital and intellectual property facilities (Chalmersinvest, Innovationskapital, Research Patents West,[21] incubators (Chalmers Lindholmen and Chalmers Innovation) a research park, entrepreneurship education, (Chalmers School of Entrepreneurship) and consultancy and further education programmes (Chalmers Advanced Management Programs – Champs).

[21] In 2001, Chalmers became the sole owner of Research Patents West and renamed the facility Chalmers Technology Licensing.

Figure 3.3 The principal components of the Chalmers Innovation System



Source: Jacob et al. 2003

From the late seventies and to the mid-nineties innovation research on and support at Chalmers were focused around the Chalmers Innovation Center (CIC). At this center, inventors, innovators and entrepreneurs could receive advice and support, for instance in the form of office space. CIC and the entities that replaced it indicated in figure 1 have during the years provided a close network to the 225 (1998) direct Chalmers spin-off companies and its 3000 employees (1998). In parallel with the development of CIC, in the 1970s and 1980s, several other initiatives were taken regarding cooperation with established industry, such as Chalmers Industrial Technique and Chalmers Science Park. 1994 may be said to have been a watershed year not only for the Swedish science and technology system as a whole but also for Chalmers in particular. In July of 1994, the university won the right to revert to being a private foundation and one of three universities of this type in the whole of Sweden[22]. In outlining its bid to become a private foundation, Chalmers put forward three main arguments which it felt distinguished the university from its major competitor, the Royal School of Technology (KTH). These were: (i) the Chalmers' spirit which was characterized by a strong alumni network that linked both staff and former students, open and trust based relations; (2) a long tradition of organizational innovativeness flexibility, service mindedness in administration and a flexible appointments system; and (3) the importance of Chalmers to the region of Gothenburg. With regard to the third point, it is significant for the reader to note that Chalmers

[22] The decision to become a privatised university again came about as a result of an offer by the then ruling conservative party offering the opportunity to privatise one of Sweden's technical universities. In this regard a competition was initiated and Chalmers University was the technical university that won. Chalmers received a capital grant of approx USD166 m. It is allowed to invest this money on the stock market and use the interest for university development. The initial capital sum has to be repaid after a period of 15 years. There is one other privatised higher education institution and this is Jönköping University College.

made two specific sub arguments here both of which were very much in the spirit of what was at that time the coming new orthodoxy in national research policy. The first of these sub arguments was that Chalmers bid for privatization had the support of economic actors in the region and the other was that a privatized Chalmers would create opportunities for strengthening already existing collaboration between Chalmers and the state run Gothenburg University. This new phase of collaboration was framed as a public-private partnership. Thus by appealing to its well established relations with the region's industry as well as the other major university in the area, Chalmers was able to frame itself in terms of the new rhetoric of public spiritedness, collaboration and entrepreneurial intentions.

With privatization, management of Chalmers passed from the state to a new foundation – a limited company called Chalmers Ltd. The new statutes, which replaced the previous ordinance, gave Chalmers greater freedom of action and more scope for exploring new paths, without sacrificing the current standard of education and research. In the agreement drawn up between the Swedish government and Chalmers Ltd. on commissioned education and research for the period 1997-1999, it was stated in a special paragraph that:

> The university corporation should strive to promote recruitment from groups with a weak tradition of study and in regions where people less frequently go on to higher education

The wording is reminiscent of that of the will of Chalmers founder, William Chalmers in which there was a stipulation that the school should devote itself to the education of "poor children who have learned to read and write". However, the School of Arts and Crafts, which opened in 1829, had not in fact made any particular effort to recruit its pupils from among poor children. Notwithstanding, the new Charter's espoused dedication to bringing education to the marginalized groups of Swedish society, privatization was seen as a move which would afford Chalmers much longed for autonomy in its teaching and research but more importantly in developing its innovation infrastructure. In keeping with this, a number of initiatives were launched which were designed to capitalize on Chalmers new autonomy and more importantly its ability to accumulate capital from the various entrepreneurial initiatives that had been part of the university's landscape over the last two decades. The legal right to accumulate capital which came with privatization, the existence of an embryonic infrastructure for entrepreneurial activities combined with the new spirit of the times as represented in the macro research policy initiatives meant that Chalmers was at least formally better equipped than most of its counterparts to transform itself into an entrepreneurial university. Most other Swedish universities including the other privatized university, Stockholm School of Economics had little interest or history in organization wide entrepreneurialism.

The relative short history of university based entrepreneurialism in Nordic countries combined with the overwhelming publicity that successes at Silicon Valley have received has meant that most efforts to build an entrepreneurial university use Silicon Valley as a role model. Chalmers is no exception to this rule and the institution building since 1994 have been for the most part framed as inspired by this approach. Despite the considerable efforts that had already been underway to change the national research policy system, when Chalmers began to focus more intensively on promoting entrepreneurship at the university, the Swedish university system was by no means a buzzing hive of entrepreneurialism and there were few support structures within the universities as a whole or outside. Table 3.3 provides a time map of the institutional development of the infrastructure since 1994. This development is concentrated in four areas: venture financing, patenting, entrepreneurial training and venture incubation.

Table 3.3 Development of the Infrastructure for Supporting Entrepreneurship

1994	Innovationskapital – a venture capital company which is partly owned by Chalmers was founded
1996	The Gothenburg Foundation of Technology Transfer, Chalmers and Gothenburg University jointly started Research Patents West Inc.
1997	Chalmers School of Entrepreneurship
1998	Opening of Chalmers Innovation (a high tech incubator) at Stena Centre. This Centre was built with money from a USD 5 million endowment from the Sten A Olsson foundation
	Chalmersinvest – a wholly Chalmers owned seed venture capital company was started. This company provides funding for the early stages of starting up a business.

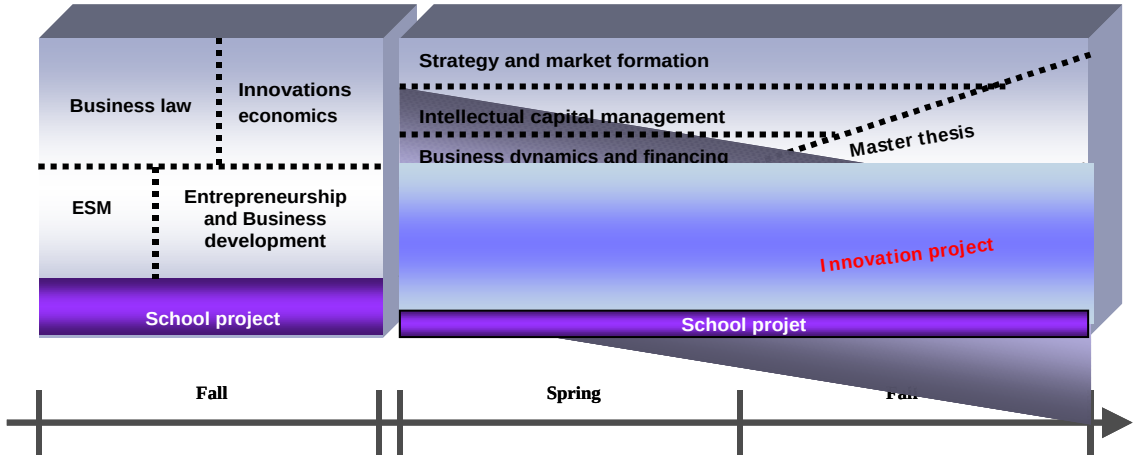
Source: Jacob et al 2003

In order to legitimate its early efforts at transforming itself, Chalmers administrators and academics looked to US universities for models particularly Stanford and MIT. However, there are considerable differences between the US and Swedish environments and cultures in higher education. It should come as no surprise therefore that while a great many speeches and debates from proponents of Chalmers' entrepreneurial efforts draw on US models for rhetorical support,

little actual borrowing of models and practices can be found in practice. Nevertheless, the structure that Chalmers resembles many that may be found elsewhere including in US universities although it is radically innovative in its own context. The Chalmers-owned venture capital fund Innovationskapital that was initiated in 1994 is a good example of this in so far as the idea of a university owning a venture capital company was completely new to the Swedish context. Likewise, the foundation of the Chalmers School of Entrepreneurship (CSE) in 1997 was the first of the type in Sweden. The mission was to increase the degree of commercialization of new high-technology through an action-based final-year program for M.Sc. students.

Chalmers University of Technology is quite unique in assuming that the researcher/inventor and the entrepreneur are not the same person.[23] Whereas most other universities rely on having entrepreneurial researchers with a drive to exploit, Chalmers focuses on finding the right entrepreneur for each new technology product or service. As part of this matching exercise, Chalmers School of Entrepreneurship fits well into this broader scheme to encourage commercial exploitation of university research. Chalmers School of Entrepreneurship aims to 'teach' entrepreneurial skills to final year Masters students.

Figure 3.4 Masters Programme in Innovation and Entrepreneuship



Source: Lundqvist 2003

The course has been heavily oversubscribed since the outset, and has had to be designed to accept only the strongest, most driven students selected according to the results of external psychometric testing, and extensive interviews with the School's board. The School had 12 students in its first year, and has added another three students to its intake in each subsequent year. The students are grouped into teams of three, and matched with a new technology and its university inventor. The

[23] The following is extracted from EC 2001.

students then undergo a year of intense real-time, live case study, in which they must develop an appropriate strategy for the new technology to be developed into a start-up firm by the end of the training. Teaching is done as modular workshops that are relevant to the position of the business to date. Groups meet their other peers to discuss successes and assess their strategies for 'their' businesses; although the students are actively discouraged from having any ownership stake in the company until they have completed their course. The School has had a good rate of success with the course and has only this year had to build in an element to discuss failure in a positive way. Another feature of good practice in Chalmers is the facility for start-up firms to be helped at each step of the process. The School of Entrepreneurship only captures a small number of the technologies available for development/exploitation. In general though, the process of commercialisation is as follows. Once a researcher has an invention, he/she can approach Chalmers Innovation (Chalmers Foundation owned unit) to discuss whether this idea should be patented or developed as a spin-off company. If patenting is the chosen route, Chalmers Innovation has links with a group called Research Patents-West (partly owned by Chalmers Foundation and Göteborg University). Research Patents-West will assess the invention to determine the return from patenting, and should it go ahead, will direct the inventor toward a specific patent attorney. If it is decided that a start-up company should be formed, Chalmers Innovation has links with Chalmers Invest. This organisation, owned by the Chalmers Foundation, has 30 million SEK at its disposal for early, equity investment in start-up companies (although the maximum investment per company is 1 million SEK). Chalmers accept that it would be better if other actors were available to provide funds at this early stage, and that its lone role at this stage may be a weakness. However, this early stage investment is only for a very short period (generally, one year), in which time the firm must develop a business plan to attract venture capital. If firms fail at this stage, the funding from Chalmers Invest is not repaid to the Foundation. This therefore encourages Chalmers Invest to back only those companies that will succeed. Firms are encouraged to approach external venture capitalists for funding. However, the majority of firms from this system approach *Innovationskapital*, a venture capital company which participates in newly-established, high-tech companies. This private finance concern aims to build growth in the early years of these firms, which can then be returned from the sale of its shares in the firm at a later date. Throughout this process, Chalmers Innovation provides low cost services and equipment to the start-up companies. It also provides advice and training throughout the build up of the firm.

By May 2000, 45 students had graduated from the Chalmers School of Entrepreneurship, and a total of 12 new companies were created from this group. These companies together raised more than USD 10 million in venture capital and created 136 new jobs.

Although Chalmers is fairly well off financially in comparison to many of its counterparts in Sweden, the costs of developing the above could not be sustained by the university itself. Thus, the entities listed in table 3.3 bear the prefix Chalmers in their names and are either fully or partly owned by Chalmers but the source of the start up and/or operational funding is a curious mix of public and private money. Another example of the university interaction with industry at Chalmers University of Technology is long term collaboration with large national and mulinational companies.

Chalmers University of Technology has a well-established science park, Chalmers' Science Park, situated adjacent to the university campus. One measure of the success of Chalmers Science Park is that it already has a number of companies vying to be situated on the, as yet unbuilt, extension to the facility. However, the majority of the facilities based at the science park, are the research units of large national and multinational firms like Volvo (see below), Ericsson and SKF. Chalmers has a range of schemes to facilitate industry collaboration as well as the exploitation and commercialisation mechanisms. These include: continuing professional development programmes; technology support schemes for SMEs; high-tech firm collaboration mechanisms; and university firm spin-offs programmes. Volvo needed a flexible and skilled workforce that had specific competencies that were relevant to Volvo's technology requirements and approached Chalmers to provide this training. These specific competencies were in the fields of: aerodynamics, sheet forming, automated assembly, noise reduction, tribology, combustion, exhaust catalysis, corrosion control and use of light alloys. As an initial way to tap into this expertise, Volvo agreed to invest in equipment, personnel and laboratory space that would allow Volvo staff, together with Chalmers academics, to work jointly on the study of surface technology and develop training courses for work into this field. Such work particularly focused on tribology and mechanical and corrosive wear. Laboratory space was taken at Chalmers' Science Park, microscopes and other laboratory equipment was purchased, together with the hiring of Chalmers' graduates to man the operation. A number of staff work for Volvo and Chalmers on a 50:50 basis. The co-operation has benefited both parties, aside from just the specific collaboration.

For the university, the collaboration has generally allowed:

- staff to use equipment bought by Volvo to work on other research projects which Volvo is not involved in

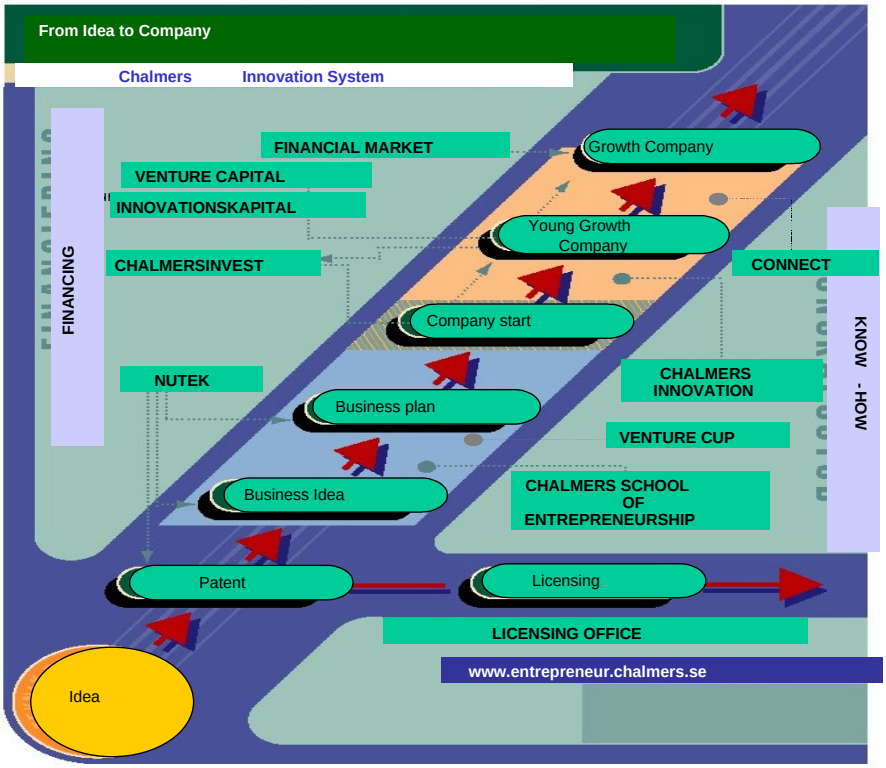
- feedback by Volvo on the quality of its graduates
- Volvo personnel to work with university staff and students
- use of direct examples from Volvo of modern engineering design problems and issues as teaching tools

For Volvo, in turn, it has allowed the firm to:

- to obtain preferential access to the university's research base more generally
- use of other specialist equipment and instruments housed in Chalmers
- to use the university as a 'listening post' for wider developments in science and technology related to Volvo's activities

As it appears from the above description, the Chalmers Innovation System is multi-faceted. Figure 3.4 provides a graphical overview:

Figure 3.5 Chalmers Innovation System: From Idea to Company



Source: Lundqvist 2003

Though the establishment of the Chalmers Innovation System has never followed any strict plan a set of oveall characteristics can be identified as a result a gradual transformation process. Among the special features developed at Chalmers are:

- integration of innovative research, entrepreneurial students and action-based training
- increased focus on pre-incubation support, i.e. on the subtle processes resulting in the start of a compelling growth venture,
- cooperation between training and support function on one hand and soft (loans and grant) and hard (equity investment) financing on the other,
- The purposeful building of a learning entrepreneurial community of young graduates from CSE, and promotion of working with start-ups as a viable alternative career choice.

In section 3.3.2 below, a set of key policy issues will be identified by means of a summary of the main results of a recent research on Chalmers' experiences with entrepreneurialisation.

3.3.2 The problem of bringing entrepreneruship from the margins to the centre

The research referred to above (Jacob, Lundqvist & Hellsmark 2003), investigating the different actors involved in building the infrastructure for supporting entrepreneurship, revealed a number of issues describing the difficulties in creating the entrepreneurial university: transparency; organization of the infrastructure for entrepreneurship; integration and the commercialisability of the research. These issues, as will become apparent in this section are tightly coupled to each other and may be further reduced to two broad themes: the organization of the infrastructure and the integration of the entrepreneurship function with the primary tasks of research and education in the Chalmers.

Transparency

As mentioned above, many of the structures for supporting innovation at Chalmers have been in existence for several years, yet the majority of researchers at Chalmers are often not aware of their existence and/or function. Although all of the interviewees were involved (either directly or indirectly) with different parts of the infrastructure for promoting entrepreneurship and commercialisation activities at Chalmers, their knowledge of this infrastructure varied considerably. Some persons reported that they met the different actors involved in this infrastructure frequently and many of them had good working knowledge of the different components of the infrastructure. Despite this overall knowledge, many displayed some degree of ignorance as to how to use the different components of the system. One interviewee described it in the following way:

> I know all the people in CIS [Chalmers Innovation System] and I meet them regularly, but I still don't know who is who and who does what …. I meet them all at different occasions representing different things…If I had an idea with commercial potential, I wouldn't really know where to begin. But I would probably look up the Technology Bridge Foundation's homepage and try to orient myself in the system.

Almost all of the interviewees pointed out that most researchers are unaware that Chalmers has an infrastructure for innovation. The general feeling is that no more than a few researchers currently employed at Chalmers would be able to name one or two entities in this infrastructure and most would not think it was relevant to them or their research. This ignorance and lack of transparency is also reflected in the fact that few research based companies have been started within the Chalmers infrastructure for innovation and entrepreneurship.[24] The exceptions to this general rule, all share one feature and that is the researcher with the commercialisable idea knew someone who was able to guide him/her through the system. One such researcher when asked how he made the move from idea to company stated that one of his colleagues had received a grant to start a school of entrepreneurship and needed some projects to get his students started. In this regard he was approached and asked if he had any research results that he felt had commercial potential that the students could build a start up around.

The Chalmers infrastructure for innovation and entrepreneurship has been an ad-hoc experiment with little or no directions and guidelines from the main administration. This has meant that the different components of the structure are 'owned' by a few strong individuals and each component has its own legal structure and board of directors. Apart from contributing to the problem of lack of transparency cited above, many of those interviewed stated that the current structure is prone to several other problems. Among those most commonly cited were fragmentation and uncertainty about the appropriateness of the mission.

Fragmentation

Each element of the system is constructed to optimize its own performance and not to create and derive synergies from others. This creates a certain amount of tension and frustration throughout the entire system particularly since the attempt on the part of Chalmers to create an entrepreneurial university has meant that all the different entities are now being subjected to new pressure to perform as part of a well developed system. One actor in the system described it in this way:

> I think that we have to clarify the roles and dimensions (of the different components of the infrastructure) so that we do not have all these different boards of directors ….

Additional consequences of the fragmentation of the structure mentioned included the need for one part of the system to pay huge taxes on profits while at the same time having to declare huge losses for another part of the system. The interviewee who reported this argued that had these entities been

[24] This finding fits well with other studies which also included the Chalmers system cf. Lindholm Dahlstrand, Å. 1997 Growth and inventiveness in technology-based spin-off firms, Research Policy 26(3) 331-334

part of one legal body, this would not have happened. A third way in which fragmentation has become a feature of the system is that Chalmers has several different interfaces with external actors and this multiplicity not only makes it difficult to coordinate but also contributes to making the system even more opaque to potential users.

> Chalmers needs one interface to the world outside and not the multitude that we have today. It would be better if Chalmers created a single corporate identity for its innovation system and a common entry point so that it is clear where one should take one's project. This would even facilitate and make it easier to market the system.

Although the infrastructure discussed above has been developed explicitly for commercialising and commodifying knowledge from Chalmers, the university's administration has not been a driving force and has not until very recently attempted to integrate these structures. One director involved in building up the innovation system commented on his experience and the relation to Chalmers as the following:

> It was not that they resisted these efforts. That was not at all my experience. They (Chalmers administration) thought that it was a very good idea. But it was a little 'strange bird' and one did not really understand what the different units were and what they did.

Many of the interviewees directly involved in managing this infrastructure pointed to the fact that the university administration has however recently begun to take a more active interest in their activities. The recent appointment of a vice principal with responsibility for coordinating university-industry relations is taken to be one sign of this new interest. All those involved expressed the view that it was about time that Chalmers administration got involved in this aspect of the university's life and provide some direction for the system.

While there was a general consensus among those interviewed that the intervention of Chalmers administration in the role of coordinator was imperative, researchers who have had some prior experience with this infrastructure pointed to other gaps in the structure. Among these was a low level of awareness at faculty level about the infrastructure. It was further argued that many members of faculty did not even possess the most rudimentary knowledge necessary for engaging in entrepreneurship. The ability to evaluate the market potential of a prospective innovation or what kind of knowledge is necessary to operate a start up was cited as areas where education was urgently needed.

In general one may conclude that while fragmentation is perceived by many actors to be problematic and even unnecessary particularly given the small size of the operation, it is a logical outcome of the spontaneous way in which the system developed in its earlier stages. A second contributing and not unrelated factor is university culture. Chalmers prides itself on being a

university where individual initiative on the part of students and/or faculty is highly valued. This is also seen as one of the reasons that it was so easy to develop an entrepreneurial culture however; this individualism may explain the fragmentation to some extent. The proliferation of different initiatives was according to the university's own narrative of itself an indicator of the innovativeness of its students and faculty. That fragmentation is now perceived to be an obstacle is a consequence of the attempt to transform from an organisation with entrepreneurial individuals to an entrepreneurial organisation.

Uncertainty about the appropriateness of the mission

One of the central tensions in the emerging discourse about entrepreneurial universities is that between those who see research as a public good and those who focus only on the need to integrate university based knowledge production with the rest of the economy. This tension is particularly strong in university cultures where public money is still the largest source of funding. For this reason, it should come as no surprise that those involved in the development of the infrastructure for promoting innovation and entrepreneurship at Chalmers are ambiguous and in some instances doubtful about the wisdom of trying to upscale the university's entrepreneurial activities. Although the interviewers did not raise these issues, they cropped up persistently in a number of different ways. Some of the interviewees pointed to the difficulties involved in commercialising research and others stated that exploiting university research was still a controversial stance to take. Others expressed the view that since Chalmers was a non-profit corporation it was important not to be seen to be too good at profiting from research since this could result in a loss of the benefits of being a non-profit company. Despite this fear that too much profit would be bad for the university's image, there is no consensus among those responsible for commercialisation as to its potential worth. Some of those interviewed were very optimistic and stated that there is a big business potential hidden in university research, and it is just a matter of finding the right tools for exploitation. Others (mainly positioned slightly outside the innovation infrastructure) thought that the potential in university research is quite small. They pointed to the difference and distance between discovery and industrial application and the time lag and costs involved in moving from research idea to innovation. Still others argue that Chalmers research is not very innovative. One of the interviewees stated that:

> It is a very small portion of research that is relevant and innovative enough to make it worthwhile to start a company around it. One problem within traditional research areas is that every researcher looks only at such a small and well defined area that it is unlikely that knowledge in that area only would give rise to a new product. The newer research fields such as computer science and computer technology can therefore be a larger source of new companies….

Further, the interviewees outlined a number of potential problems that could be encountered along the way to an entrepreneurial university. These included that the university may suffer if it is perceived as being too profit oriented. For example, some actors feared that companies that were traditionally the sources of endowments and other types of donations would view an entrepreneurial Chalmers as a competitor. They felt that it was not reasonable to expect that it would be possible to approach a company for a donation one day and then sell them a patent or a license the next. Another issue which was tabled was that there was no discussion as to what should be Chalmers' strategy to build an entrepreneurial university: should the university restrict itself to selling patents licenses and selling consultant services to companies or should it extend its activities to include starting companies?

Even the issue of the university selling patents and licenses is not a straightforward one since up to the present time; researchers in Sweden like in most other Nordic countries have sole ownership of any intellectual property that may accrue from research in which they engage. The new interest in the commercialization and commodification of knowledge has led to this convention becoming an issue of intense policy focus not only in Sweden but in other Nordic countries as well. There is no legal obstacle which prevents Swedish universities from exerting rights as employers and negotiating directly with researchers on the issue of intellectual property ownership. Further evidence shows that researchers are not in principle opposed to a three way split on the proceeds from intellectual property. There however remains a major financial obstacle from the side of the universities who for the most part have very little money or expertise to invest in ownership of intellectual property.

In summary, the above points to a number of issues that universities such as Chalmers encounter in the effort to transform an institution designed in the first instance to train engineers and do innovative research. In what follows we shall extract a number of implications for university managers as well as for science and technology policy from the Chalmers case. In general we argue that these policy implications fall into two broad categories:

- Designing an integrated structure for supporting science-based entrepreneurship; and
- Communicating and implementing value changes

Designing an integrated structure for supporting science-based entrepreneurship

After more than two decades of laissez-faire policy towards structures for promoting science-based entrepreneurship, Chalmers is now on the brink of developing a more comprehensive and coherent institutional framework for this activity. The results presented above may be taken as a snapshot of the attitudes and views of a selected sample of the actors who have traditionally been involved in what has hitherto been a peripheral area of the university's life. It should be noted that while these activities have been peripheral, there is and always has been a general positive attitude among students and faculty to commercialisation and commodification activities particularly if one compares Chalmers to other Swedish university cultures. That being said however, the results from the study may be read as illustrative of the problem of bringing entrepreneurship from the margins to the centre of university life in Sweden generally.

Universities have traditionally viewed the transfer of information and industry collaboration as a fortuitous event, which usually came about through alumni networks or through meetings between professors and industry representatives. Chalmers, being a technical university, has had a somewhat more active policy in that many areas of its research and education have been traditionally linked very strongly to industry. This profile is however not in any way to be taken as representative for the entire university and was like in most other universities filtered mainly through alumni and individual researcher networks. One of the prerequisites for an entrepreneurial university is that there must be some formalisation of these types of contacts without overly bureaucratising or alienating researchers and/or alumni networks. Moreover, even in areas where industry linkages have been organised and traditionally strong, the attempt to shift to a more entrepreneurial culture implies changes in the nature of these linkages and ultimately in the way research and development activities are viewed. One example of this is the implication of an intensification of the promotion of university based start ups for research and traditional relations with large companies. One interviewee pointed to the fact that the way in which research was presently conducted at Chalmers did not fit well with what he perceived to be the requirements of commercialisation while another pointed to the need for researchers to be knowledgeable about what is a marketable invention. This is a manifestation of what might be termed the two cultures problem as it relates to university and industry culture.

Despite the conventional policy wisdom that science and technology are growing closer and that lag times are rapidly decreasing between an invention and its commercialisation, there remains a considerable difference between what comes out of a university laboratory and what is regarded as

a potentially marketable. Further, Mansfield (1998) has in an update to his seminal paper provided a number of important caveats that suggests that caution is necessary in terms of interpreting the time lag between invention and commercialisation. The continued uncertainty about this aspect of innovation policy may to a certain extent be explained by the qualitative difference in how innovativeness is defined in research and how it is defined in industry. The prevailing value in university based research is that innovation is measured in terms of criteria such as: (a) an advance in knowledge; (b) providing new means for further research; and (c) improving or deepening understanding of processes (know why, how and what). Commercial innovation is defined however in terms of: (i) added value; (b) new application and (c) relatively short financial payoff lead times.

These two definitions of innovation are not necessarily mutually exclusive but they are often difficult to reconcile particularly when we include the fact that publication is still the main performance indicator for researchers and that commercialisation or commodification of research results is invariably a time consuming process. Some workers have expressed the view that there may be a hard limit to the degree of commercialisation and commodification that universities can pursue without compromising the complementary relation between open and commercial research (Dasgupta & David 1993; Lee 1996). In this respect, Liebeskind et al. (1996) recently argued that the social norms of science, including the emphasis on priority, might actually provide more protection to innovations than legal methods such as patenting and trade secrets. Although this has so far only been substantiated to a limited extent for bio and information technologies and mainly in the USA, there are some problems in applying this on the European level because of differences in the European and US patent regimes. One such difference is the US insistence on a first to invent rule versus the European practice of using the first to file.

To the above, may be added the issue of how to balance the research interests and needs of small start ups which are usually short of cash to spend on research and those of large companies who are the traditional customers of the university's research. If government and European Union policies continue to miss the research needs of the growing category of university based start ups, universities like Chalmers may well find themselves having to finance this activity out of existing funds or having to take more and more equity in such firms in order to be able to justify this expenditure.

Communicating and implementing value changes

The problem of accommodating the values of commercialisation and commodification in a context of the Swedish university system where the social function of the university had been previously seen as part of a general social welfare ethos is one of the main issues to be confronted when building an entrepreneurial university. The doubts expressed by those involved in building and managing the different entities for promoting innovation reflect this tension. It is significant that even though the top down (i.e. government) policy signals seem to favour a shift towards entrepreneurial values, the interpretation from the bottom is that this value shift should be approached very carefully. This particular attitude is not surprising and is a direct outcome not only of the historical role of Swedish universities as part of a welfare state apparatus but should also be seen as indicative of the sensitive issues raised by efforts to transform largely public investments in knowledge creation into wealth.

Additionally, the potential tension between fundraising for research and other types of activities and selling patents, licenses and other types of services pointed to by some interviewees may also be connected to this history and the situational context of Chalmers. Swedish universities unlike their US counterparts do not exist in a culture where fundraising activities are taken for granted aspects of university management and there is no perceived conflict between this and other more commercial efforts on the part of the university to raise income. This implies that efforts to achieve a value shift towards a more entrepreneurial culture within universities will have to be accompanied by a re-education of the population generally and alumni in particular as to the changing realities of university funding. At the level of government policy, this may also imply that policy ideology will have to be mindful of the fact that not all universities have the potential to become entrepreneurial, thus a common policy for the university sector such as that which now obtains in Sweden may not be the most appropriate steering instrument for national science and technology policy. Likewise, university managers in Sweden will also have to recognise that efforts to develop and market the entrepreneurial university will have to be modelled not on Stanford, Colombia or MIT but that a middle way between the public and private university has to be carved out both with respect to faculty and students as well as to the external public.

3.3.3 Concluding remarks

Since the beginning of the 1990s, Sweden has been transforming its national research policy into policy for innovation. One of the bottom up responses to this top down initiative has been an attempt on the part of some Swedish universities to transform themselves into entrepreneurial institutions. This section has studied the transformation process one particular Swedish university; Chalmers University of Technology. The case confirms existing knowledge in that it shows that creating an entrepreneurial university takes several years as both infrastructural and cultural changes are necessary to achieve success. The case also shows that despite the long history of public-private in Sweden, the new emphasis on commercialization and commodification of knowledge creates some degree of 'role uncertainty' for universities. It can be concluded that a key element required for Swedish innovation policy is flexibility and diversity both at macro (policy vision and implementation) and micro (university organization) level.

3.4 Best practices in promoting university interaction with industry

Three best practices in Swedish science and technology policy will be stressed: (i) Third mission legislation, (ii) Reform of the structure for competitive research funding, (iii) Focus on regional development.

3.4.1 Third mission legislation

Sweden made an important step in 1997, when the notion that universities have a responsibility to communicate their research results with the surrounding society was defined as the 'Third Mission' (Tredie Uppgiften) and formalised in university law. Critics have emphasised that no additional funding was made available for this mission. Yet, observers all agree that this law has contributed significantly to setting a new agenda of promoting entrepreneurship in universities.

3.4.2 Reform of the structure for competitive research funding

At the same time as Swedish policy began to focus on the issue of harnessing the power of the university for national innovation, it became clear that neither the current academic system nor its main institutional source of alternative research funding, research councils was well equipped for the new challenges. The reform of the research council system began with the conservative government of the early 1990s and continued with the Social Democrats. The process was often controversial and took a period of a little more than a decade. The restructuring of the Swedish research funding system has contributed crucially both to allowing an increased focus on collaboration and commercialisation and to a increase acceptance of the third mission agenda in universities.

3.4.3 Focus on regional development

Although Sweden has a number of regional university colleges, it was not until the switch to innovation policy was made that the regional university colleges became part of a concerted strategy for regional economic development. Once this particular policy direction was taken a number of other changes were introduced. This included increasing the number of university colleges and a deliberate state policy of upgrading these institutions to the level of universities once they have achieved certain pre determined criteria. Another element of the attempt to strengthen the role of universities in promoting regional economic development was the launching of public promotion programmes such as the Technology Bridge Foundations and, more recently, the

VINNVÄXT programme. Observers have identified this regional focus in Swedish science and technology policy as a key comparative strength (Erikkson 2002, Lundqvist 2002). Some have argued that this regional focus could be considerably strengthened if the national agency for innovation systems (VINNOVA) established regional offices with funding authority (Lundqvist 2002).

3.5 Future challenges

In the following five main challenges facing Swedish policy-makers with regard to the promotion of university interaction with industry will be discussed. These are: (a) Revision of top-down approach; (b) Coordination of public and private R&D; (c) Avoidance of unintended consequences of university dependence on competitive funding; (d) Fund organisational restructuring at universities , and (e) Adopt more holistic approach to commodification.

3.5.1 Revision of top-down approach

It is important to understand as an initial point of departure that Sweden has chosen to promote collaboration between universities and industry with top down policy initiatives. This is a very complex approach and a review of the last ten years of policy in this area will reveal that there are several different strings that needed to be orchestrated in order to achieve the policy portfolio that exists today. Further, it is still an open question whether this particular approach is the best for the policy area in question. A casual glance at the stakeholders in question i.e. universities and firms would necessitate that one adopt a very cautious approach to top down steering. The reason for this is that in Sweden, the large number and size of the universities makes them relatively powerful actors even if they are completely dependent on the state. Put together with the fact that the interaction between organisational factors such as management, funding, etc and knowledge production remains a densely opaque issue even for those who have devoted their lives to studying universities, top steering of such institutions is an approach that is rife with opportunities for producing unintended consequences.

3.5.2 Coordination of public and private R&D

The fact that the Swedish economy is dominated by a small number of large multinational firms means that the relative autonomy of the industrial sector is quite high. Further, as mentioned earlier, these firms account for the majority of the national expenditure on R&D and they also do a considerable share of this R&D themselves. This would imply that some effort at coordinating public initiatives with the R&D effort would be necessary to ensure that collaboration is not used opportunistically. For example, firms may decide to collaborate with universities in order to access public funding to support R&D projects in which they either have little immediate interest or they may lack the motivation to commercialise the results.

3.5.3 Avoidance of unintended consequences of university dependence on competetitive funding

Swedish universities are merely one actor in a knowledge market that is global. In other words, Swedish researchers have to compete internationally with other researchers for the opportunity to collaborate with Swedish firms. This implies that their comparative advantage will have to be built on proximity as well as internationally strong research reputation. This implies that performing well on the basic indicators such as international publication; attractive education programmes, etc. continue to be important even for collaboration. There is a danger that the initial policy efforts at promoting collaboration in Sweden may have been over zealous. For instance, the rule of reducing fixed budgets for research to 50% in order to promote more dependence on competitive research has affected resource planning and development for the future. The dependence on soft money has meant that Swedish universities are limited in developing proactive hiring policy to deal with the shifting competence profiles needed both for research and education demands.

The emphasis on competitive research funding has also encouraged a herd mentality in that everyone chases after the same money and therefore does the same types of research. In some areas where there is a need to develop critical mass, this policy performs well; it does however draw money and personnel away from other areas. The danger here is that Sweden may be gambling away its future inheritance by not betting on ensuring that there is broad competence in order to maintain a certain level of absorptive capacity.

Finally, there is a growing concern that the pendulum may have swung too far to the extreme in so far as collaboration and third mission activities at Swedish universities are now overly focused on industry. Strömberg and Tydén (1999) pointed to the lack of attention to the public sector research needs and development of infrastructure at universities for supporting such collaboration.

3.5.4 Fund organizational restructuring at universities

One important area that has been overlooked in Swedish efforts to reposition the university is the need to support and promote the reorganisation of the structure of universities in order to ensure that they are structurally capable of meeting the new demands. The result of this is that most if not all of the new tasks assigned to universities have to be met by academic staff while the administrative part of the organisation becomes marginalised to a few functions. In many instances, it is not even clear that there is any attempt on the part of the administrative units to even strive to develop routines and functions that would support the newly emerging activities at universities. The result is that despite

the fact that the numbers of administrators keep growing, the percentage of academic time spent on administration is also growing rapidly.

3.5.5 Adopt more holistic approach to commodification

Cursory sampling of science policy literature alone would reveal that university based entrepreneurship encompasses both commercialisation (e.g. custom made further education courses, consultancy services, extension activities) and commodification (e.g. patents, licensing, faculty or student owned start-ups). Further requirements for displaying an entrepreneurial disposition are those mentioned earlier such as entrepreneurialism at the organisational level (active recruitment policies; technical administrative infrastructure that supports and promotes the organisation's main objectives, etc.). Much attention is given both in the Swedish discourse and internationally to innovation infrastructure within universities. This discourse is unfortunately overly focused on structures such as technology transfer offices, patents and licences. Evidence from Sweden and elsewhere shows that these are very small sources of income for universities generally. In the USA it is merely a small handful of universities that have actually harvested great benefits from this infrastructure, most technology transfer offices at universities are operating at a loss. The most important sources of incomes to universities particularly in the Nordic countries continue to be research contracts and grants either from research councils or private companies. Ironically, when discussion about entrepreneurial organising and infrastructure is introduced, it is almost always overlooked that many universities could actually increase their current earnings by actually building an infrastructure to take care of these particular contracts rather than leave it up to chance.

3.6 Concluding remarks

The Chalmers case is an instructive one for Swedish science and technology policy as well as for Europe. For Swedish policymakers, the above provides some insight into how top down steering affects processes on the bottom. A critical observer may remark that Chalmers' efforts to transform itself into an entrepreneurial university may be seen not as a policy outcome but as an internally driven process that may be better explained by the culture of an engineering school rather than responses to top down steering. The above will support this view to a large extent; however this does not imply that policy plays no role in this scenario. In fact, the general consensus among those interviewed was that the shift in research policy focus on the national level was significant in that it created a climate which legitimised what had been taking place within Chalmers for nearly two decades. This legitimacy in turn made it possible for actors within Chalmers to make further and more radical moves that they would not have contemplated otherwise.

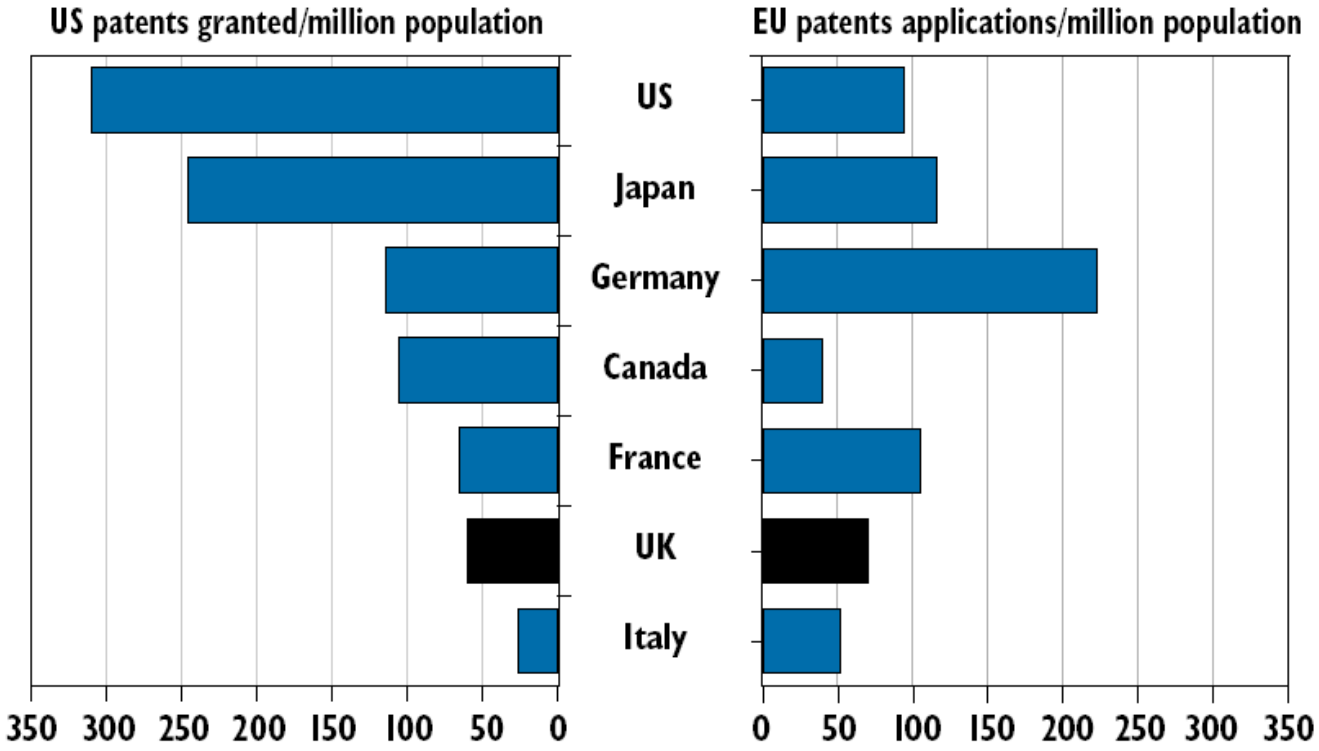
While on one level the shift from a research to an innovation oriented policy has brought this legitimating aspect, on another it has also made Chalmers more aware of the need to balance its knowledge exploitation activities with a strong culture of exploration and knowledge creation. This insight ironically enough has come as a result of trying to leverage itself as an entrepreneurial university. In this sense national science and technology policy has not been an enabling factor in so far as funding for this type of research and education is severely limited. This funding scarcity is first and foremost a result of a longstanding structural flaw in the Swedish system to which other studies have pointed and this is that its highly centralised nature makes it very difficult for the system to be agile enough to achieve the goals it purports to pursue. This is not only a problem for Chalmers but for other Swedish universities where a simple task like recruiting a new faculty member can take at least a year. Thus, even with the recent spate of reform it is clear that Swedish science and technology policy still needs to be overhauled one more time- this time with emphasis on introducing flexibility. The Chalmers case may be taken as an indication that more top down reform may not be the answer. This conclusion is based on the fact that the university still suffers from considerable inertia in spite of privatisation and quite generous provisions in the charter for organisational initiative. There may therefore be a need for further investigation at the organisation level as to what are the factors that contribute to organisational inflexibility at Swedish universities.

CHAPTER 4 UNITED KINGDOM

4.1 History of science and technology policies in UK

In the United Kingdom, the relationship between science and economic performance has been a key concern in the formulation of science and technology policy for more than a century (Georghiou 2001). However, UK performance in science-based industrial innovation at the end of the century doesn't match the high standing of the nations's scientific record. There is, in other words, a persistent problem in transferring a seemingly internationally excellent scientific performance into high levels of industrial innovation and science-based economic growth. One aspect of this is a low performance in regard to patents. International comparison of patents applied for or granted to firms may be used as an indicator of success in converting knowledge spending into new products or processes.

Figure 4.1 Patents granted and patent applications, 1999



Source: DTI 2002

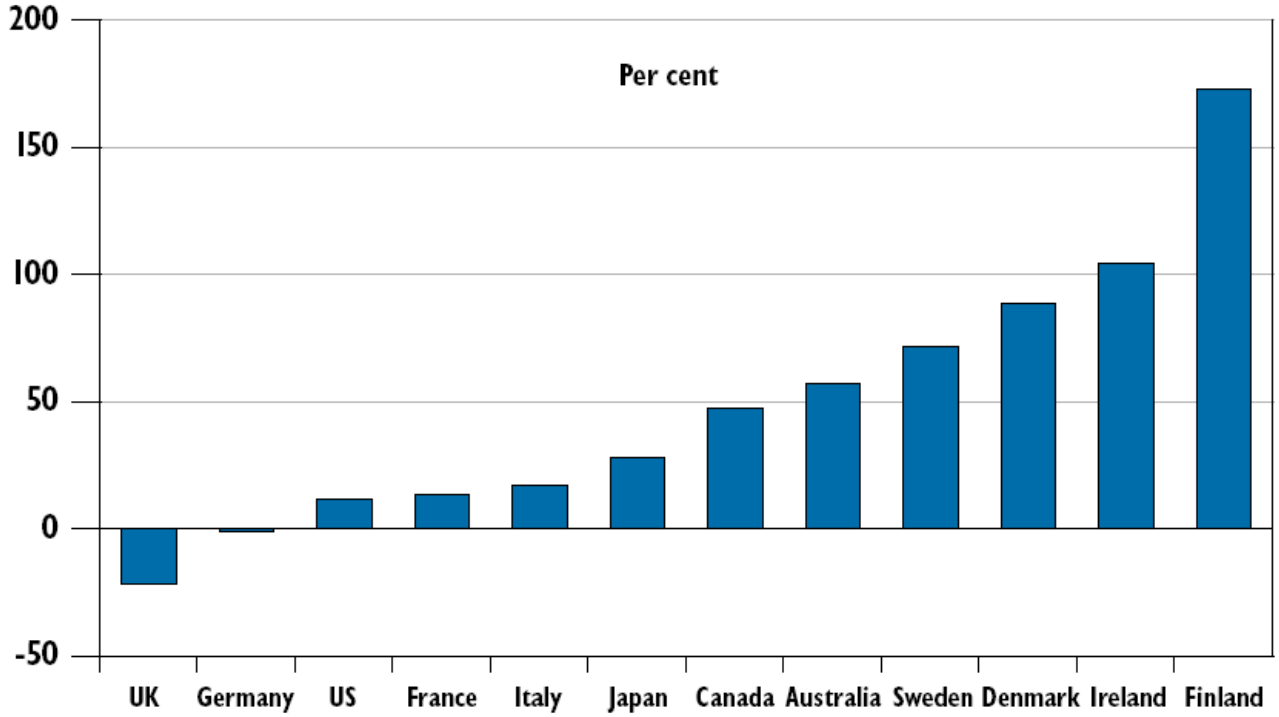
A number of studies have addressed this problem over the years. One of these identified four "persistent reasons for the erosion of the UK's industrial standing" (Georghiou 2001: 254): the short-term outlook of capital markets; under-resourcing of education and training; weakness in co-

ordination; and the loss of a strong technological culture in which engineers are accorded high status. These will be more or less central themes in the following discussions. Some emphasis will be given, however, to a fifth element: the rather strong disincentives for innovative research and third mission activity that the UK funding system seem to inadvertently produce.

The 1990s has been a turbulent period for UK science and technology policies. The history of the Office of Science and Technology (OST) brings this out very clearly. The science budget was a responsibility of the Department of Education and Science (DES) up until 1992. The Department of Education and Science provided core funding for research in Higher Education Institutions and hosted the Secretariat of the Advisory Board for Research Councils which allocated funds for the autonomous, non-departmental Research Councils. It was UK policy at the time, that co-ordination of matters relating to science across government departments did not require a Minister of Science, but could be handled by the Prime Minister, as part of her general responsibility for trans-departmental issues. All this meant that the DES had a very central position in the formulation of UK science policies. During the course of the 1990s, this strong position has been somewhat weakened. In 1992, the new Prime Minister (John Major), announced the formation of the Office for Science and Technology (OST) in the Cabinet Office. Further, he appointed the first Cabinet level Minister for Science since the 1960s. OST was created by combining the Cabinet Office Science & Technology Secretariat with the Science Branch of the Department for Education and Science. Thus, key areas and responsibilities relating to science and technology policy were taken out of the Department of Education and Science, and made the jurisdiction of the Prime Minister in the Cabinet Office. Only three years later, however, the OST was moved out of the Cabinet Office and into the Department of Trade and Industry (DTI). The new Science Minister thus assumed the position of a junior minister within DTI. Though science had thereby lost its dedicated Cabinet Minister, the argument in favor of this change was that it would bring science closer to industry.

Policies throughout the 1990s focused on the stimulation of the relationship between the science base and industry. Despite the stated priority given to science, all public sources of income other than the Research Council budgets declined, however, under the Conservative Government from 1979-1997.

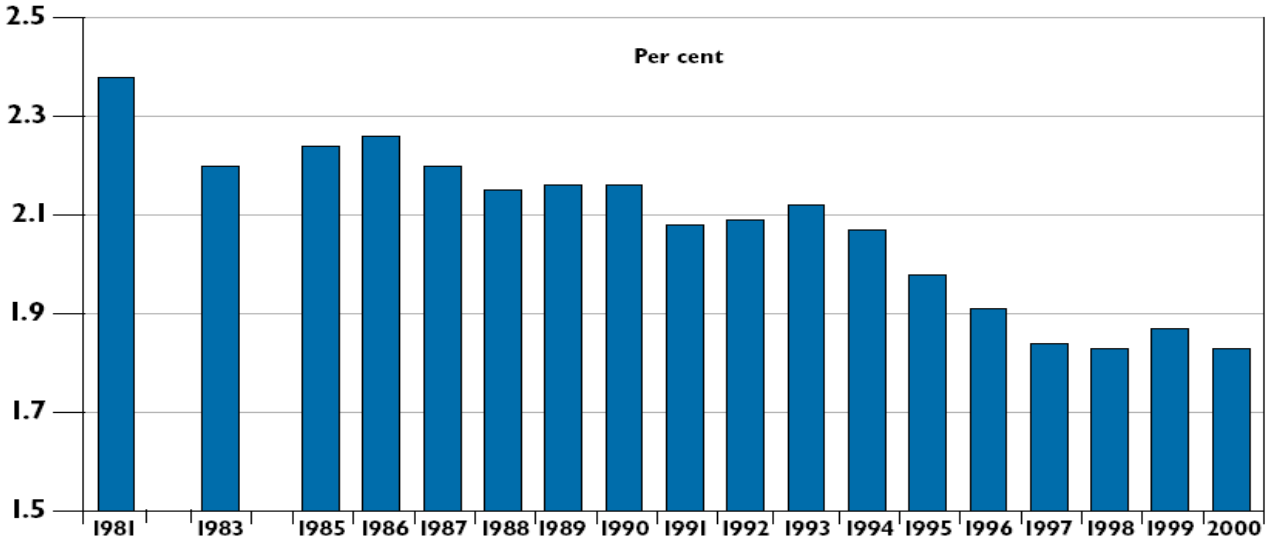
Table 4.1 Growth in R&D spending as a share of GDP, 1981-1999



Source: DTI 2002

Already in 1986, a pressure group of several thousand scientists concerned with the declining infrastructure in universities and other public sector research institutions was launched, under the name, *Save British Science*. Yet it was not until 1998, one year after the election of the Labour Government, that public funds were provided to alleviate this problem of deteriorating infrastructure. In its first year in Office, the Labour Government undertook a Comprehensive Spending Review of all public expenditure, and as a result of this, science emerged as a major priority for increased public funding. More specifically, an additional public spending on science of £700 million was announced, and to be accompanied by a further £400 million from the Wellcome Trust. Hereof, £600 million were to be spent on renewal of equipment and buildings. This change of government policy has contributed crucially to bringing to an end a 20-year long period of more or less steady decline in R&D spending as a percentage of GDP:

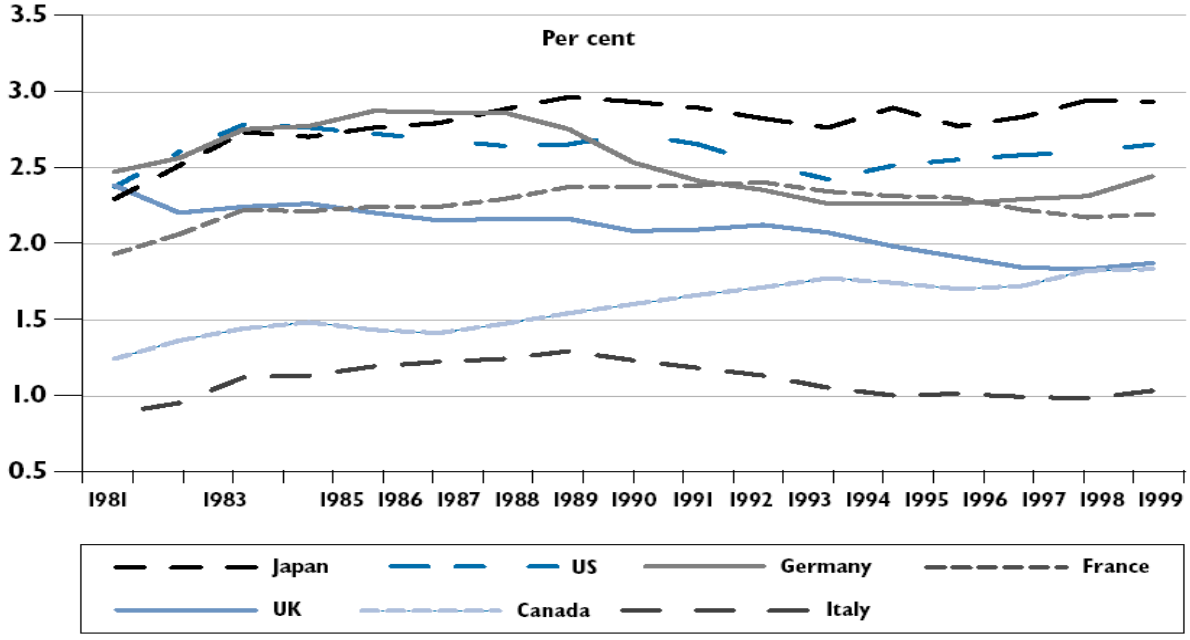
Figure 4.2 R&D spending as a share of GDP



Source: DTI 2002

Though ending this decline was certainly an important achievement, the UK still faces the challenge of redressing the balance. By the early 1980s, the United Kingdom was fully on par with the world's most R&D intensive economies. At the turn of the century, UK had lost this lead position:

Figure 4.3 R&D expenditure as a share of GDP in G7 countries



Source: DTI 2002

By the end of 1998, the Labour Government published its Competitiveness White Paper, *Our Competitive Future: Building the Knowledge Driven Economy*, which was followed in March 1999 by an implementation plan. A key element of the new Labour Government policy was the provision of a new stream of funding, specifically seeking to promote industry-science relations in general, and commercialisation of research results in particular. This new stream of funding was made available through new public promotion programmes, such as University Challenge Fund and Higher Education Reach Out to Business and Community (HEROBAC). By providing what is now termed ‘a permanent stream of funding’ for a wide range of third mission activities, the UK has taken a lead in Europe in this area of science and technology policy. Critical observers argue, however, that as long as UK policy-makers do not address the fundamental weakness of its national innovation system, the impact of such promotion programmes will be severely impeded, producing modest changes at best. To these issues, we shall return in the section on *future challenges*.

4.2 Framework conditions in UK

4.2.1 Introduction

The overall cultural attitude toward university interaction with business is generally favorable in the UK. In the recent EC benchmarking study on industry-science relations this was noted as one of UK's key comparative advantages. One expression hereof is that a very large share of UK universities consider technology transfer to industry to be a major mission, and thus operating industrial liaison offices and commercialisation units at universities is a much more common practice in UK than in most other European countries. Despite the generally favorable cultural environment and a relatively high degree of institutionalization of commercialisation efforts in UK universities, the UK national system of innovation is as previously mentioned still characterised by "unsatisfactory performance in industrial innovation" (Georgiou 2001: 254). High performance in science is simply not adequately transformed to high performance in innovation and commercial development. Observers point to a vast number of possible explanations to this, including under-resourcing of education and training, and the uni-dimensional incentive structure created by the Research Assessment Exercise (RAE) upon which a large share of university funding is based (EC 2001). The RAE does not reward university interaction with industry, and UK policy-making are increasingly recognising the rather strong disincentives thereby created for individual researchers to engage in such interaction. Furthermore, concerns have been expressed that the RAE promotes research excellence in conventional research areas, at the expense of more innovative research (Georghiou 2001: 271). Recent policies have tried to counter-balance the disincentives for third misson activities by providing separate funds particularly for the promotion of such interactions; for instance the *Higher Education Reach Out to Business and the Community* (HEROBAC) program. The remainder of this chapter describes the framework conditions for university interaction with business in UK. The description is divided in the following four sub-sections: Legislation, Institutional setting, Intermediary structures, and Public promotion programmes.

4.2.2 Legislation

Generally, the legal framework for higher education institutions is considered to have little impact on industry-science relations in the UK. Policy initiatives and promotion programmes are widely seen to be more influential than legal regulations. This was emphasised most recently in the OECD benchmarking report on ISR issues (OECD 2002: 130). One must bear in mind, however, that the absence of a barrier to university entrepreneurship may not be felt and noticed by observers, who are accustomed to its absence. But from a comparative policy perspective such 'absent barriers' are extremely important. Two areas of legislation will be discussed briefly: IPR regulation, and Employment regulation.

(a) IPR regulation

Up until 1985, the National Research and Development Corporation (NRDC) had a monopoly in the exploitation of publicly funded research in the UK Higher Education sector. The Conservative government brought this monopoly to an end, and launched instead a policy of decentralised ownership of intellectual property. The notion was that only if universities themselves could take ownership of intellectual property, would proper incentives for commercialisation prevail. However, up until 1992, universities were required to commercialise their IPR through the British Technology Group (BTG), a restructured version of the NRDC. In 1992, the BTG became a public company quoted on the Stock Exchange, and universities were now free to decide whether and how to use their IPR. During the period when universities had their IPR commercialised by the BTG, the universities were nevertheless entitled to royalties from their work. By the mid-1980s, many universities started setting up technology licensing offices, specialised in intellectual property management. These were set up within, or parallel to, existing industrial liaison offices. Today, these offices support university researchers in making use of IPR. In UK, the question of how to organise efforts to commercialise research results have thus over the course of the past 20 years increasingly been left to the universities themselves to decide upon. This includes the question of incentive schemes. The distribution of royalties to staff is thus carried out though different arrangements at different universities. Taking the University of Newcastle as an example: The university is the owner of a patent, revenues are shared between the university and the inventor(s). After subtracting legal costs, the first £ 5,000 of IP income goes to the inventor(s), the next £ 200,000 of IP income is split - 50 % goes to the inventor(s), 25 % to the department(s) of the inventor(s), and 25 % to the university. In the case of IP exploitation via a university-owned start-

up company, the inventor(s) can take equity in the company, the inventor(s) involvement being subject to the university's company directorship policy.

(b) Employment regulation

As observed in the EC benchmarking report, in UK universities no specific employment regulations which may impede ISR activities apply. There were, however, for long a crucial difference between researchers employed in universities, and researchers employed in certain Public Sector Research Establishments (PRSE). In some PSREs scientists were bound by the civil service management code and thus had no incentive schemes for commercialising research results until the government revised the code in 2000. Until the reform of the code in 2000, the presence of incentives for researchers in PRSEs to commercialise IP was dependent upon whether the scientist worked for a government department or for a non-departmental public body (i.e., research council institutes). Those scientists who were employed in research council institutes were subject to incentive schemes, whereas those who were employed by government departments were bound by the civil service management code which forbade the use of incentives. After the reform of the code in 2000, all researchers employed in the public sector are subject to incentive schemes for commercialisation. The below table gives two examples of such incentive schemes in UK public sector research.

Table 4.2 Incentive schemes in UK research council institutes, 2000

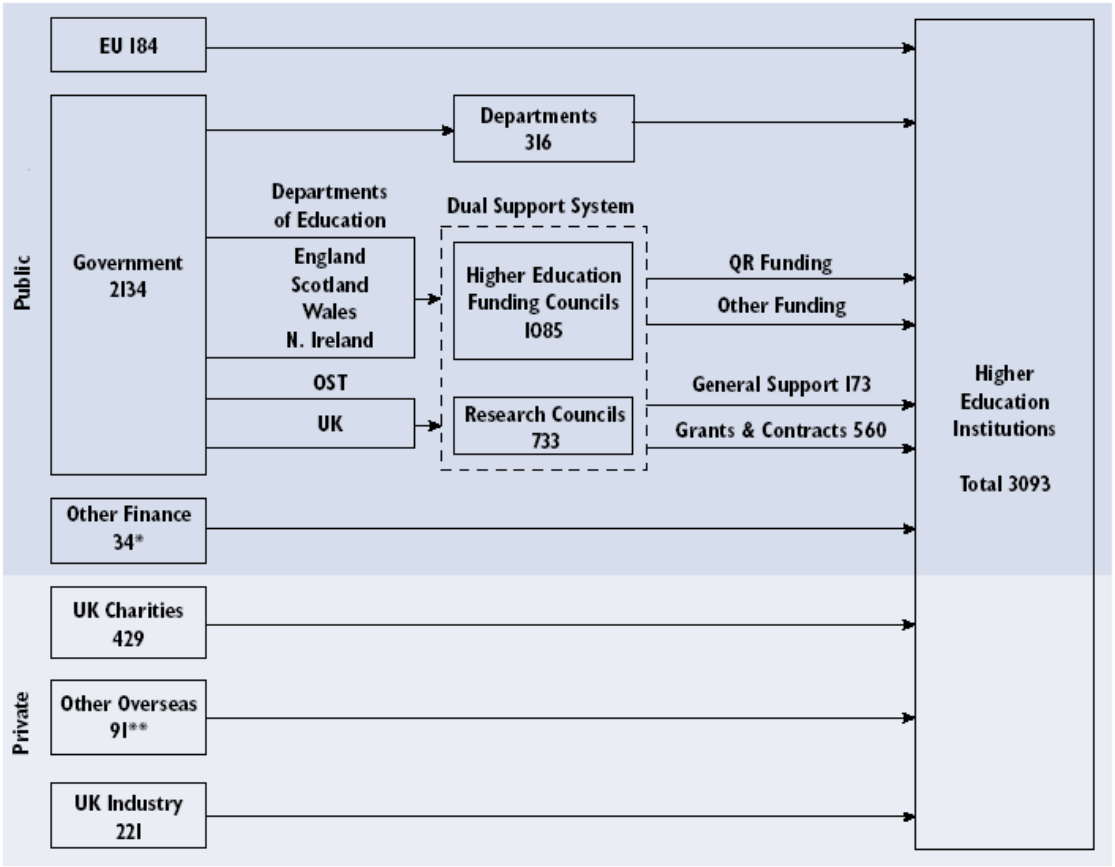
Biotechnology and Biological Sciences Research Council		*Medical Research Council*	
Income from IPR	Proportion of receipts paid to inventor(s)	Income from IPR	Proportion of receipts paid to inventor(s)
First £ 1,000 (gross)	100 %	£ 500 to 1,400	100 %
£ 1,000 to 50,000 (gross)	20 %	£ 1,400 to 80,000	33.3 %
£ 5,000 to 500,000 (net)	10 %	£ 80,000 to 600,000	25 %
£ 500,000 to 1 million (net)	5 %	£ 600,000 to 1.5 million	20 %
Over £ 1 million (net)	2.5 %	£ 1.5 million to 15 million	15 %
		Over £ 15 million	10 %

Source: EC 2001

4.2.3 Institutional setting

Universities in the UK receive their research funding from a range of different sources. The below chart gives a graphical overview of university research funding in UK.

Figure 4.4 Research policy and research funding in UK, 1998-1999 (£million)



Source: DTI 2002

The UK government provides two streams of funding, known as 'the dual support system' (DTI 2002: 29). One stream of funding is provided by the Funding Councils. There are such separate Funding Councils for Wales, for Scotland, for Northern Ireland, and for England. The name of the latter is the Higher Education Fund for England (HEFCE). These Funding Councils belong to the Department of Education side of the dual support system, and they provide what is termed 'block funding' for universities. This block funding primarily covers expenditures on infrastructure and the proportion of salaries to academic staff allocated to research. This funding is intended to enable research departments to cover costs relating to: (i) building research capabilities (ii) training new researchers, (iii) making credible proposals for research project funding, (iv) pursuing a certain amount of blue-skies research (DTI 2002). The amount of funding given to individual universities

and departments is determined by a formula largely determined by the ratings awarded in the Research Assessment Exercise (Georghiou 2001: 256). Therefore, this block funding is also termed Quality Related funding (QR). The effect of this RAE-based allocation of block funding is that resources are concentrated heavily in highly-rated departments.

The second stream of public funding is provided by the Research Councils, funded by the Office of Science and Technology (OST), situated within the Department of Trade and Industry. The funding provided by the Research Councils is project funding based on open competition and peer review. At present, there are seven such Research Councils in the UK, cf. Table 4.3.

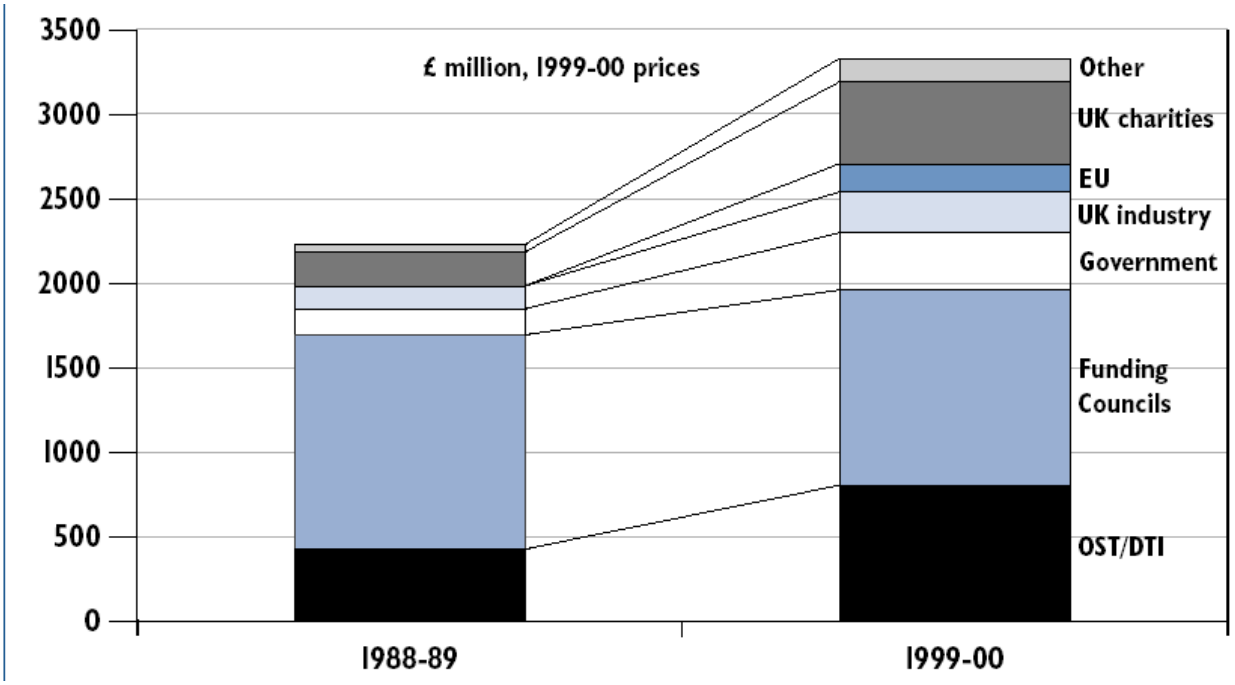
Table 4.3 Research Councils in UK, 2002/2003 budgets

Research Council	Budget (£m) total
Medical Research Council (MRC)	374
Biotechnology and Biological Sciences Research Council (BBSRC)	239
Natural Environment Research Council (NERC)	203
Engineering and Physical Sciences Research Council (EPSRC)	498
Particle Physics and Astronomy Research Council (PPARC)	228
Economic and Social Research Council (ESRC)	84
Council for the Central Laboratory of the Research Councils (CCLRC)	11
Total	1,638

Source: DTI 2002

Over the course of the 1990s, this type of funding for university research has grown in importance relative to block funding from the Funding Councils, as apparent from figure 4.5. The figure also shows that funding for university research has grown by around 50 pct in the period, driven mainly by third party income, especially from research charities.

Figure 4.5 The development of university research funding over the 1990s



Source: DTI 2002

A few concluding remarks is called for. The institutional setting for universities in the UK may be said to be characterised by a high degree of organisational independence (EC 2001: 244), for two reason primarily. First, there are no specific working contract regulations for university researchers and secondly, no basic funding for universities are provided by central government. Funding for basic research and teaching is provided by the Funding Councils only in accordance with the results of the RAE. For an extended period of time the public streams of funding were declining, and universities were forced to find other sources of funding. As a result, today funding from third parties accounts for more than 40 pct of total research funding. As will be apparent in later sections, however, public as well as private R&D spending in the UK remain at a relatively low level compared to other OECD-countries.

4.2.4 Intermediary structures

UK universities has a strong tradition in terms of an institutionalised interface with industry. When by the mid-1980s, UK universities started creating technology licensing offices this could be done within already existing industrial liaison offices. At the other end of the spectrum of intermediary structures, further from the universities themselves, the UK have a wide range intermediaries, including Chambers of Commerce, Business Links, Regional Development Agencies, and sector-specific bodies such as the Association of British Pharmaceutical Industry (ABPI), the BioIndustry Association (BIA), and the Association of Independent Research and Technology Organisations (AIRTO). These intermediaries play an active role in the promotion of industry-science relations in a number of ways. However, observers increasingly question the establishment of intermediary structures as a means to promote technology transfer and commercialisation. In the OECD benchmarking report, the concluding section in the chapter on UK said:

> A relatively large infrastructure of intermediary organisations has developed in response to succesive initiatives… The issue at stake is whether excessive emphasis on specialised transfer agencies could monopolise knowledge flows and act as a barrier to the creation of positive knowledge culture diffused throughout the industry-science nexus. In other words, is there a risk in consigning ISRs [Industry-Science relations] to peripheral units away from the core? (OECD 2002: 153)

A similar concern has evolved with regard to science parks. Not only has science parks not really delivered the expected results in terms of new revenue for their owners, but furthermore there are severe doubts as to whether science parks may in fact reduce rather than promote the overall entrepreneurial orientation of universities. In the words of the director of PREST, the science policy research unit at the University of Manchester:

> Probably too much emphasis has been given to the phenomenon of science parks… A newer trend is for on-campus incubators and laboratories… These developments are based on the belief that only the closest proximity is likely to produce the required cross-fertilisation (Georghiou 2001: 276-277).

Observers expect that the more recent phenomenon ‘incubators’ will gain ground in the coming years. Incubators are located within existing or new buildings in close association with a university, include on-site management expertise, and are usually focused upon a particular technology or subject area, such as nanotechnology (OECD 2002: 128).

4.2.5 Public promotion programmes

In the following the main public promotion programmes in UK will be described. Particular emphasis will be given to the Foresight programme, the Science Enterprise Challenge, and Higher Education Reach-Out to Business and Community (HEROBAC).[25]

(a) The Foresight Programme

Only one year after its foundation in 1992, the Office for Science and Techonology launched a White Paper on Science, Engineering and Technology (OST 1993). A key instrument of this White Paper was the Technology Foresight Programme. This programme was designed to serve three objectives: (i) informing priorities for public spending on science and technology; (ii) bringing together the science base and industry in new networks; and (iii) promoting a 'foresight culture' The Foresight Programme is managed by the Office of Science and Technology (OST). At the core of the Programme are 16 panels with varying degrees of academic representation in their membership, along with representatives from industry and government. The first phase of the Programme culminated in the publication of sectoral reports by each panel. These reports aimed to identify the likely social, economic and market trends in each sector over the next 10 to 20 years, and the developments in science, engineering, technology and infrastructure required to address these future needs. The conclusions were based upon widespread consultation. Since the publication of the reports, there has been extensive dissemination of the findings and numerous events have been held. Most of those events have aimed to promote the development of academic-industrial networks to support the exploitation of opportunities revealed by the Programme. The most recent phase of Foresight has concentrated on stimulating wider and deeper engagement of business, beyond the R&D function, towards marketing, finance and business planning. A key follow-up measure was a dedicated scheme, the Foresight Challenge competition, allowing consortia of business and the science base to apply for matching funds for projects addressing Foresight priorities. Foresight activities are regarded as being one of the most effective government mechanisms in the promotion of ISR.

[25] The following descriptions of UK promotion programmes are extracted from EC 2001, OECD 2002 and Georghiou 2002.

(b) Teaching Company Scheme (TCS)

The Teaching Company Scheme was founded in 1975 and has been regarded as one of the greatest successes of UK industry-science links. The TCS was initiated by the DTI and aims to develop active partnerships between Higher Education Institutions and industry in the field of education. The scheme sets up partnerships between firms and Higher Education Institutions through the formation of teaching company programmes. Firms take on graduates, known as TCS associates, to work full time on specific projects jointly supervised by the and the company. Projects are intended to be closely linked to the interests of the firm and should be aimed at achieving a substantial and comprehensive change in the firm, for example in management and production techniques. Partnerships are exclusively between Higher Education Institutions and firms within the region as the associates must travel regularly between the two organisations. The scheme has five formal objectives, namely to: (i) raise the level of industrial performance by effective use of academic resources, (ii) improve manufacturing and industrial methods by the effective use of advanced technology, (iii) train able graduates for careers in industry, (iv) develop and retrain existing company and academic staff, and (v) provide academic staff with broad and direct experience of industry, to benefit research and enhance the relevance of teaching.

A typical programme lasts for two years. The graduates have a science and engineering background and are recruited jointly by the partners. The associates spend 90% of their time working in the company on specific projects and are paid at industrial rates. The remaining 10% of their time is spent within the HEI undergoing training. Until 1981, the TCS was financed totally out of public funds, but since then firms have provided up to one-third of the cost of new programmes and at least 50% of the cost of renewed programmes. The programmes range in size from one associate over two years to 14 associates in a three-year programme which is then renewed. A review in 1996 found that 70 % of associates are offered employment in participating companies at the completion of a TCS programme. There has been a growing involvement of TCS with smaller companies and in 2000 nearly all the schemes in operation (91 pct.) were with SMEs. Well over 2,000 TCS partnerships have been created since it was first established. The cost of government grants to the scheme was around GBP 23 million in the financial year 1999-2000. Plans are currently being made to increase the number of schemes through a doubling of the budget allocated to the TCS.

(c) HEROBAC & HEIF

The Higher Education Reach-Out to Business and the Community scheme aims towards developing the capability of HEIs to respond to the needs of business, by enabling HEIs to put into practice organisational and structural arrangements to achieve their strategic aims in this area. The HEROBAC Fund is intended to initiate a permanent third stream of funding, complementing the Higher Education Funding Council for England's existing grant for teaching and research, to reward and encourage HEIs to enhance their interaction with business. The mechanisms whereby these links may be developed could include the establishment of centres of expertise, training and development for staff, staff exchange programmes, and one-stop-shops in HEIs so that businesses have easy access to advice and expertise. The HEROBAC scheme has however, now come to an end and while there are a number of operational projects, all major future third mission funding through government will be channelled through the Higher Education Innovation Fund (HEIF), which was announced by the government's White Paper on Science and Technology in 2000. HEIF thus marks an attempt to consolidate and simplify what might be seen as a confusing array of third-mission support initiatives (Hill 2002). The HEIF scheme has as tis core the belief that all HEIs should be engaged with business in different ways. The fund is intended to enable them to develop links across the full range of their academic endavours. HEIF receives funding from across government, from the Department of Trade and Industry, from the Higher Education Funding Council for England, and from the Department for Education and Skills. The broad funding base indicates a high level of support and commitment for third mission activities across government.

(d) Other public promotion programmes

The above three promotion programmes are widely recognised as being highly effective in promoting industry-science relations. There are, of course, other important public promotion programmes than these. The Science Entreprise Challenge, which provides funds for establishment of ‘enterprise centres’ at universities, and the University Challenge Fund, which provides capital investment for the very early stages of commercialisation, are two important programmes, both introduced in 1999. The main public promotion programmes are summarised in table 4.4 below.

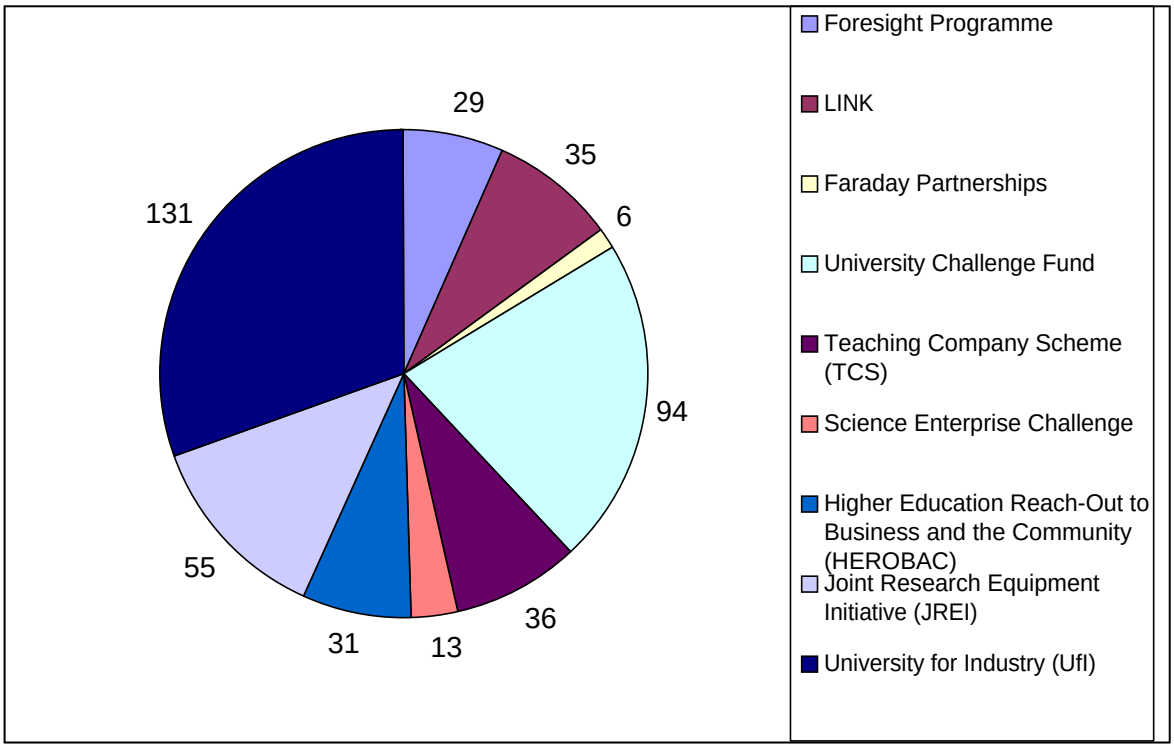
Table 4.4 Major Public Promotion Programmes

Name of Programme	*Main Approach*	*Type(s) of Interaction Mainly Addressed*
Foresight Programme	Building up of networks and consortia, strategic vision of technology development	Networking, collaborative research
LINK	Funding for collaborative research projects which shall act as demonstration projects	Collaborative research
Faraday Partnerships	Establishing intermediary infrastructure for technology transfer in certain fields of technology	Collaborative research, start-ups, personnel mobility, training & education
University Challenge Fund	Support to universities or consortia of universities to set up local "seed" funds supporting early stage commercialisation	Start-ups, IPR, prototypes
Teaching Company Scheme (TCS)	Subsidies to enterprises for employing highly qualified graduates on specific projects	Personnel mobility
Science Enterprise Challenge	Establishing "centres of enterprise" at up to 8 universities, encouraging the incorporation of entrepreneurial training into science and engineering curricula	Training & education, technology transfer
Higher Education Reach-Out to Business and the Community (HEROBAC)	Funding for the establishment of centres of expertise in HEIs, ISR-oriented training for HEI staff, "one stop shops" for business partners.	Contract research, networking, personnel mobility
Joint Research Equipment Initiative (JREI)	Funding of equipment in areas of high quality research	Contract research, collaborative research
Collaborative Awards in Science & Engineering (CASE)	Grants to students for carrying out doctoral research addressing industrial problems and jointly supervised by HEIs and firms	Training & education
University for Industry (UfI)	Support to HEIs for activities in the education of adults, especially concerning new technologies	Training & education

Source: EC 2001

The relative significance of these promotion programmes in terms of levels of funding is illustrated in the below chart.

Figure 4.6 Main promotion programmes: levels of funding, 1999 (million euros)



Source: EC 2001

4.2.6 Concluding remarks

The objective of promoting industry-science relations have become the central organising principle for new science-funding initiatives in the UK (OECD 2002: 109). The OECD study of framework conditions in the UK even reported that interviewees felt that the range and mix of policies was "too extensive and therefore too complicated" (OECD 2002: 152). Whereas the UK approach to the third mission agenda, in a range of ways to be described in further detail in later sections, certainly qualify for the term *best practice*, the proliferation of promotion programmes cannot escape the fact that the fundamental barrier to university entrepreneurship in UK remains unchallenged. The Research Assessment Exercise, upon which block funding of universities is based, still constitutes the core of the incentive-structure of UK universities, providing strong disincentives to innovative research and third mission activities. A reform of the way in which block funding is allocated to universities is a key element in the concluding section on *future challenges*.

4.3 University of Newcastle case study

The University of Newcastle was founded in 1963 when the Newcastle based colleges, which were founded in the 19th century, separated from the University of Durham. The University at present has 14.600 full time students, and 1.600 part time students. The University of Newcastle employs 2000 academic and 2000 other staff. Its overall budget is 320 million euros, with 49 pct being competitive and external funding, i.e. non-block funding.

4.3.1 Entrepreneurial policies/support structures

During 2002, University of Newcastle has undertaken a major institutional and managerial restructuring.[26] Over and above, the initiation of this process of institutional change was intended to enable the university to better respond and contribute to development of the region. As part of the process, the University reformulated its mission, which today is:

> To be a world class research led educational institution and to play a leading role in the economic, social and cultural development of the North East of England

Among the most important objectives of the institutional restructuring was a better coordination of operational and strategic management, a culture encouraging innovation at all levels (teaching, research, and reach-out), and increased income generation. The restructuring plans recognised from the outset that increased external engagement would put new requirements on university management at all levels. It was further recognised that while a traditional university adopts administrative processes (controlling activity and ensuring procedures are followed), an entrepreneurial university should pursue management processes which would seek out opportunities and make things happen. The key challenge was thus seen to alter management practices in several dimensions: financial management; personnel management, student management, research management and management of the information systems to support these processes. To achieve this, the following overall time-schedule was launched:

- New management team to be in place by January 2002
- Reviews of teaching, research and administration to be completed by March 2002
- New resource allocation methodology in place by June 2002
- New academic structures to be in place by August 2002

In parallel with these restructuring processes a set of new principles for interacting with business and community were being devised. Previously, research-based third mission activities focused

[26] The following is extracted from University of Newcastle 2003.

exclusively on technology transfer, spin-off companies, and consultancies. Now, transfer of knowledge through students came to the fore of third mission thinking. Students were thought to be the main "carriers" of knowledge, and as the potentially most effective channel for employers to the global knowledge base. In line with this, substantial effort was given to the development of a Careers Services unit within the university (see further description below). The other main change with regard to the University's strategy for third mission activities was a professionalisation of the University's interface with business. This is described in further detail below.

Services for business

A key aspect of the restructuring that has taken place at the University of Newcastle is a professionalization of its interface with business.[27] This is immediately apparent when one logs on to the university web-site. This immediately connects you with 'Services for Business':

> As one of the UK's leading universities, our reputation rests on the quality of our research, teaching and the services we provide to the business community. We will match your needs with our expertise and find the right solution for your company - whatever its size or location. For more information about our services please contact us and join the hundreds of companies who already benefit from collaborating with us.

The 'Services for Business' website then leads in a number of directions: Collaborative Research and Consultancy; Professional Development and Training; Graduate Recruitment; Conferences and Corporate Hospitality; Business News; and Feedback. In the following, a brief description will be given of the most important bodies of expertise and services provided in the areas of Collaborative research and consultancy and Graduate recruitment.

Knowledge House

In 1996, the Higher Education Support for Industry in the North (HESIN)[28] set up the Knowledge House to provide an interface connecting the universities and industry in the North East. Its task is to encourage local SMEs to take advantage of the combined resources located within the six North Eastern universities. The Knowledge House functions as a centrally co-ordinated enquiry and response service providing local industry with a single point of contact for advice, guidance and support on a range of technology and management-related issues. The Regional Technology Centre (RTC North) acts as the central co-ordinator of the Knowledge House, with additional managers

[27] The following extracted from the University of Newcastle website, www.newcastle.ac.uk, from interviews with key personnel involved in Services for Business, and from EC 2001.

[28] HESIN was formed in 1983 as a local industry-academic consortium. HESIN's constituent bodies were five Higher Education Institutions in the Northern region: the University of Newcastle upon Tyne, the University of Durham, the former polytechnics of Newcastle, Sunderland and Teesside together with the Northern regional office of The Open University.

based at each of the universities. The central aims of the Knowledge House in terms of providing research services to local firms are to: (i) provide a rapid and confidential response services, (ii) offer a free initial search and diagnosis package, (iii) "source" local assistance wherever possible, (iv) arrange initial introduction between the firm's staff and the university personnel, and (v) monitor the progress of the delivery of the service once specified.

Contact by firms can be made either through the Central Co-ordinator at RTC North, or to individual Knowledge House managers which operate at each of the six universities. Where necessary, assistance is provided by defining the exact nature of the enquiry; often an important issue for SMEs who are not used to using external research or technical assistance. This service is provided free of charge by the Knowledge House team. The enquiry is then confidentially circulated throughout the Knowledge House network and sources of assistance and expertise are identified. In order to achieve a high and even standard of service, once a proposal and a contract is agreed the progress of the project is then closely monitored by the Knowledge House team.

The Knowledge House has received several accolades in the UK. It also has been commended and promoted in the UK National Inquiry into Higher Education. Its initial enquiry and revenue targets have been exceeded and SME repeat business has been achieved.

Research and Innovation Services

The purpose of Research and Innovation Services (RIS) is to help promote and support research within the University of Newcastle, and promote its use for social and economic development. To achieve this, RIS provide a range of services. There are two main lines of activities. First, RIS works with individual researchers and research groups in identifying sources of research funding, preparing and negotiating research proposals, and secondly, RIS assists in developing commercialisation opportunities. RIS handles over 1200 research applications each year and processes over 1000 new awards with a value of more than £50million. Currently, the RIS database has more than 800 research sponsors. RIS prepares and negotiates around 100 collaboration agreements and sub-agreements each month which brings it into contact with a large number of other research organisations who collaborate with the University. RIS supported 21 UK Patent and 14 PCT filings in 1999/2000. Around 20 new Invention Disclosure Records are filed by researchers each year. RIS has excellent contacts within major research funding organisations as well as in commercial and government organisations. RIS is a member of AURIL (Association of University and Industry Links), SRA (Society for Research Administrators) and AUTM (Association of

University Technology Managers). Through these professional groups, RIS maintains and develops networks with professional colleagues in the UK and Internationally.

Technology Transfer Office

The team members of The Technology Transfer Office all have wide experience of academic research and commercial product development, together with knowledge of contractual, licensing and intellectual property issues. The Office aims to offer a range of services to University staff and industrial partners, to bridge the gap between academic research and commercialisation. Technology transfer consists of a number of stages where the researcher, the Technology Transfer Office and commercial partner(s), work together. The Technology Transfer Office thus gives advice and assists in a number of different matters, including: Identification of valuable ideas and expertise; Invention and intellectual property rights issues; Patents, copyright and trademark; Assessment of commercial potential; Contacting potential commercial partners; Confidential disclosure agreement; Negotiation of a commercial contract; Licenses and royalties; and Project management.

The technology transfer team handles around 40 new enquiries per month and has a current project portfolio of 120 commercialisation projects.

Business Development Team

The primary role of the Business Development Team is to achieve a clearer and more comprehensive understanding of the needs of business with particular focus on those clusters identified as key in international, national and regional strategies. The team is responsible for matching those needs with expertise and capabilities available within the university. The Key Areas of Business Development at Newcastle University are the following:

- Bioscience & Pharmaceuticals
- Agricultural, Marine and Food Sciences
- Engineering and Offshore
- IT & Informatics

The Team operates internally within a network comprising academic Faculties, Research and Innovation Services, The Careers Service, The Teaching & Learning Support Unit, The Teaching Company Scheme and Knowledge House.

Regional Development Office

By working with colleagues throughout the University and with a wide range of regional and local organisations, the Regional Development Office (RDO) seeks to enhance the partnership at all levels between the University and its Regional Community. As a key element in these efforts, the Regional Development Office have formulated a Regional Development Strategy for the University. The Regional Development Strategy is intended to provide a framework within which the University can pursue its regional role, interests and activities. The overall aim of the Strategy is to:

> Achieve and develop a set of relationships with a range of regional companies, organisations, agencies and individuals that brings and maximises mutual benefits to the University and its regional partners and which improves the region's quality of life.

The University has three inter-dependent criteria which are used to prioritise various potential and actual regional activities, to evaluate whether to embark upon a particular regionally-focused activity: Academic benefit through teaching and research; Effective access to funding not otherwise available; and Enhanced reputation and influence.

The role of the Regional Development Office is to act as the focal point for the implementation of the Regional Development Strategy, for the monitoring of its outcomes, as well as for the continuous adaption of the Strategy to internal and external changes. The RDO thereby provides an overall focus on the University's regional opportunities, disseminating them and co-ordinating responses; encouraging Faculties and Departments in the identification and promotion of regional opportunities; playing a major role in relationship building with external partners; and ensuring that the University's potential and achievements are marketed and communicated as effectively as possible.

Careers Service

In line with the overall policies of the University, the Careers Service Unit takes a much broader approach to its mission than most similar units in other universities. Ultimately, the objective of a Careers Services Unit is to help graduates find jobs and to help companies find graduates. The approach taken in Newcastle emphasises the need to foster the employability of its students by encouraging the creation of an entrepreneurial culture within the university. The Careers Services has formulated a graduate enterprise policy and strategy, *Progression into Entrepreneurship*, and stresses the importance of the contents of the actual courses that students take as a key to create an entrepreneurial culture. The Careers Services Unit has therefore been involved in developing

courses with a significant 'enterprise-element'. Find below one example of how this was done in the case of a degree programme in Biosciences.

Business for the Bioscientist is a new 10 credit module aimed at Stage 3 undergraduates on four of our degree programmes: Biochemistry with Biotechnology, Microbiology, Medical Microbiology, Medical Microbiology and Immunology. The course will run during the second semester of stage 3, starting January 2003 with around 60 students participating.

The aim of this module is to introduce students to enterprise and entrepreneurship in relation to the Biotechnology and Pharmaceutical industries. Small and start up enterprises will be examined alongside established 'blue chip' organisations.

Input will come from academic staff from the Schools of Biochemistry and Genetics, and Microbiology and Immunology as well as a number of external experts who have agreed to lead specialist workshop sessions.

Several workshops are already confirmed:

- Dr Andy Kelly, Vice president and co-founder of BioTecnol SA, a small biotech company producing therapeutic proteins: *Setting up a biotechnology company - from academia to entrepreneurship*
- Dr Dale Athey, Business Development Manager for Biosciences and Pharmaceuticals at the University of Newcastle: *Intellectual Property Aspects of Commercialising Research in Biotechnology*
- Dr Elli Oxtoby, University of Newcastle Research & Innovation Services: *Spinning out Technology - an innovative approach*
- Mr Duncan Lowery, Investment Executive, Northern Enterprise Ltd: *How business finances itself and the role of venture capital*

Further workshops will cover *Marketing*, *Ethics* and *Public Understanding of Science*.

A Biotechnology student isolating recombinant bacteria that express novel therapeutic proteins suitable for large scale production and commercial exploitation

The course will cover:

- The small Biotechnology Company: Priorities and objectives (BioTecnol SA. as an example)
- The international Pharmaceutical Company: Priorities and objectives (Astra Zeneca as an example)
- Exploiting a good science idea
- Intellectual Property Rights
- Finance and Planning
- Marketing
- Public Understanding of Science and Ethical Issues

Assessment will be continuous throughout the module consisting of a series of individual and teamwork tasks, presentations and reports. The tasks will be designed to establish that students have gained an understanding of some of the important issues, both scientific and commercial, faced by bioscientists in the biotechnology and pharmaceutical industries.

Source: University of Newcastle 2002

Unfortunately, it is beyond the scope of the present report to describe the activities of the Careers Services Unit in any further detail.

4.3.2 The University Innovation Centre for Nanotechnology

The UK Government, in its February 2001 enterprise, skills and innovation strategy document *'Opportunity for All in a Time of Change'* announced the establishment of the *University Innovation Centre for Nano-technology*, the core component of which is the Institute for Nanoscale Science and Technology (INSAT) and its commercial arm INEX – both situated at the University of Newcastle.

Miniaturisation technology underpins innovation in most high-technology sectors, including the biotechnology, defence, communications, electronics and medical sectors.[29] Government and industry advisors worldwide view micro- and nano-technologies as keystones for economic and technological competitiveness. It is widely predicted that the nanotechnology era will lead to the next technological revolution. INSAT builds on top rank research in physical and biological sciences and medicine in the faculties of Medicine and Science, Engineering and Agriculture. Thanks to its commercial arm, INEX, the University Innovation Centre for Nanotechnology is not only a centre of research and training excellence of international repute, but also acts as a key cross-sector driver for regional high-technology based cluster development. Both INSAT and INEX are based on-campus.

The 2500m^2 state-of-the-art centre provided through INSAT consists of:

- a 230 m^2 clean room including a class II microbiological facility for both inorganic and hybrid bio-inorganic micro- and nano-device fabrication, packaging and evaluation,
- a 120 m^2 microbiology/ chemistry/materials synthesis laboratory,
- a 150 m^2 microscopy/analysis laboratory,
- office accommodation for researchers, business development and administrative staff,
- a training suite/seminar room,
- 8 business accelerator units for spin-off and other companies.

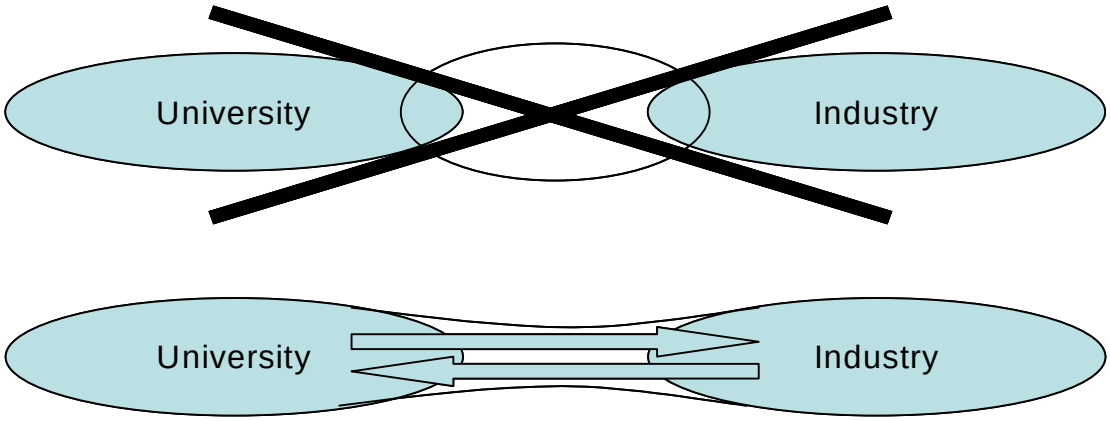
INEX considers it crucial for the outcome of university-business interactions that the interface is managed effectively. The following list contain the key elements in the INEX strategy to achieve such effective management:

[29] The following is extracted from Snowdon 2002a, 2002b, 2003, and INEX 2003.

- Providing external users from industry, academia, and government with access to a dedicated bio-hybrid and micro-nanofabrication facility (Si, polymer, glass)
- Employing a dedicated team drawn from industry to run and manage the facility
- Mapping INSAT capabilities with industrial needs
- Providing continual professional development courses from short 2-day highly specialised programmes to substantial and rigorous longer courses
- Set up as a one-stop shop for licensing and investment opportunities
- Act as a focal point for academic staff to exploit their inventions and developments

Effective management of the university-business interface is only one component of INEX' strategy for commercialisation. The research director of INSAT has developed a model for commercialisation that is quite different from traditional thinking in this field. The model abandons the traditional model of 'technology transfer', and the notion that university interaction with industry should take place in intermediary structures, such as science parks located more or less distant from the university itself. Instead, the Newcastle concept argues that industry must be brouhgt into the university, and only then will new industries spin-out of the university, in any noteworthy scale.

Figure 4.7 The Newcastle Concept



Source: Snowdon 2003

In the INEX model the dual objective of (i) efficiently creating spin-off companies and (ii) rapidly developing a more entrepreneurial culture at the university go hand in hand, and mutually reinforce

one another. The model takes as its point of departure a recognition of a problem of *scale*. In the words of Ken Snowdon:

> High-flying academics in our universities are a source of novel and imaginative ideas, however the absolute number of such academics is limited. Convert them all to spin-off company technical directors and watch UK academic research output falter as they concentrate their efforts on bringing just one idea to market (Snowdon 2002).

The INEX model proposes to base commercialisation on a combination of the *ideas* of top level researchers, and the *work and effort* of the constant flux of students that pass through university research departments. Only a small change is needed to get this model up and running. The 'standard' state of affairs is depicted by Ken Snowdon in the following manner:

> Academics routinely propose promising lines of enquiry for a never-ending stream of research students and postdocs to pursue. Those young researchers enthusiastically mould those raw ideas into research theses or publications. They submit those theses and publications, while giving little thought (except in the last paragraph of the thesis and moments before submission) to opportunities for commercial exploitation of what they have done. They submit their work (at 5 pm on the last day of term, go out and celebrate), and the next day - they move on. Their work lays gathering dust, a new student arrives, and the cycle is repeated (Snowdon 2002).

A key problem is that submission of a research thesis is the final act for most advanced degree programmes. A second problem is that although business and entrepreneurial skills training by now form a compulsory component of many UK degree programmes, it remains largely unconnected with the actual research the students perform. It is left to the students to make the connection, often without the active support of their thesis advisor. Programmes do not embed young people within the private sector business support infrastructure or connect them with its key individuals, nor does it introduce those individuals to the commercial opportunities emerging within universities. In the words of Ken Snowdon:

> These young people - undergraduates, postgraduates and post-docs - represent the largest untapped resource within the UK university system. They are enormously enthusiastic and highly possessive of their research projects. They are the key to the establishment of new high-tech companies and the development of rapidly expanding advanced technology clusters with strong links to the knowledge base (Snowdon 2002).

INEX has devised a mechanism to 'exploit' this largely untapped resource. The objective is to change the prevailing view among our young people that 'an academic career or a job in industry' are the only career options following graduation. The aim is to make young people aware that starting their own company towards the end of their degree programme, based on technology they themselves have developed, is a viable and attractive career option. In line with this vision, business skills development is an essential component of all undergraduate and postgraduate degree programs supported by INEX. Other than that, the INEX commercialisation model is build upon the

following three pillars: (i) Instant IP identification, (ii) Parallel Commercial R&D, and (iii) Spin-off Company Environment & Support.

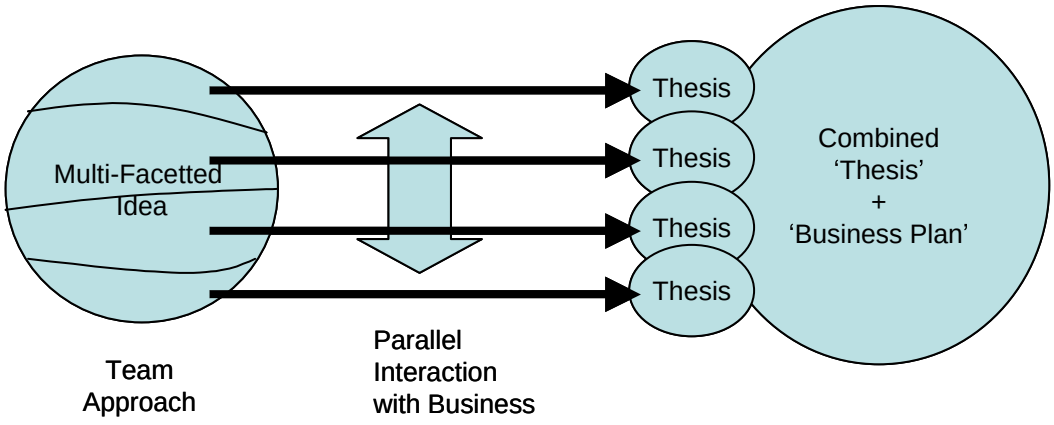
Instant IP Indentification

According to INEX, 'first-hour' identification of potentially valuable IP is crucial to ensure rapid and efficient technology pullout from the knowledge base. Therefore, a serial approach to technology transfer and exploitation should be avoided. This 'first-hour' identification is only possible if appropriately skilled commercialisation managers form an integral part of the R&D team and interact with it on a continual basis. Co-location and direct interaction with researchers is considered a necessity.

Parallel Commercial R&D

Installation of a parallel commercially oriented R&D programme is equally important. This lets young people develop the commercial aspect as a parallel activity, under the active guidance of a highly skilled and extensively networked business development team and the senior researchers who were responsible for the initial discovery. These parallel R&D programmes form the basis of novel MSc and PhD degree programmes that: (i) are based on commercially valuable IP, (ii) adopts a systems approach, allowing for larger and multidisplinary problems to be tackled in teams, (iii) puts in place potential partners for a future spinout company from the outset, (iv) requires students to assess IP, time to market and appropriate routes to commercialisation, and (v) requires students to draft business plans. The Parallel Commercial R&D approach is illlustrated graphically below:

Figure 4.8 The Parallel Commercial R&D Approach



Source: Snowdon 2003

This draft business plan is the last item of work to be submitted within the degree programme, increasing the probability that on the following day, students will have a meeting with seed-corn funders to develop further the ideas they have developed, rather than leave the region.

Spin-off Company Environment & Support

The third pillar is devised in recognition of the fact that young entrepreneurs have few assets, and that comprehensive support mechanisms to assist them in spin-out company formation must be installed, if they are to have any chance of survival. The INEX model therefore provides for: (i) Salary subidies in the form of Entrepreneurial Fellowships for up to 18 months, (ii) A full range of business support services, including administrative, financial, and legal advice, and (iii) Accommodation in incubator units entirely integrated within the on-campus university R&D environment.

Graduates are given a significant equity stake in spin-offs formed. Senior researchers, who may have generated the actual IP, receive a small equity stake. This reflects the respective levels of risk, and provides the necessary incentive to graduate entrepreneurs. Senior researchers, who would probably not have pursued the idea to commercialisation anyway, are incentivised via the opportunity, over time, to acquire equity in a large number of spin-outs, with the added advantage of negligible personal risk. For them it is a win-win situation. And they can continue to do what they do best – generate ideas.

4.3.3 Concluding remarks: from commercialisation to entrepreneurialisation

The University of Newcastle is an interesting case because the university management, in restructuring the university institutionally, has professionalised its interface with business and its contribution to the regional economy. Further, the University of Newcastle is an interesting case because of the model for commercialisation that it has devised within the confines of its national innovation centre in nanotechnology. This model constitutes a new and indeed cutting edge approach to the third mission agenda. The novelty of the approach is to systematically think in terms of processes and students, rather than narrowly in terms of senior researchers, patents and start-up companies. There is a shift in focus, from commercialisation of research results to an entrepreneurialisation of the university and its students as such.

4.4 Best practices in UK

The discussion of best practices in UK will emphasise the following three elements; the serious approach to third mission; the integrative approach to entrepreneurialisation; and the legal status of universities as charities.

4.4.1 Providing funds to universities for professionalising their third mission activities

UK policies are *best practice* in respect of providing a permanent stream of funding to support the institutionalisation and professionalisation at universities of their interaction with business and community. Paying lip service to the ideal of a knowledge economy, many European governments speak of a need to increase university interactions with business, but few of them realise that for such increased interactions to be of any significance in terms of scale and quality, considerable professionalisation is required. In UK there is wide recognition of this, and a separate stream of funding has been provided to enable universities to undertake the necessary institutional restructuring and professionalisation of its third mission activities.

Furthermore, commitments are being made to increase the level of this permanent stream significantly in the coming years. More specifically, an increase of third stream funding of more than 80 pct over the next three years is budgeted:

Table 4.5 Third stream funding budgets, 2002-2006

	02–03	03–04	04–05	05–06	per cent Increase in cash terms in 05–06 over 02–03
Knowledge exchanges	0		6	10	
HEIF from HEFCE	20	20	20	20	0
HEIF and other knowledge transfer from OST	42	62	75	84	100
Total	62	82	101	114	84

Source: DfES 2003

4.4.2 Comprehensive approach to third mission

There is generally a comprehensive approach to third mission in the UK. Whereas in other countries, policy discourse speaks of interaction with industry and of promoting commercialisation of research results, policy discourse in the UK speaks of promoting interaction with business *and community*, and there is an attempt to promote entrepreneurialisation of universities as such rather than merely promote a commercialisation of its research results. In these terms, the entrepreneurial policies and support structures at the University of Newcastle certainly qualifies for the term *best practice*.

University of Newcastle have been highly innovative in professionalising their practices in regard to the agenda of interacting with and contributing to the regional economy. But it holds more generally for universities in the UK, that they have a very high sense of regional mission. The table below shows that almost two thirds of survey respondents in higher education institutions in the UK find that the economic development of the region has high priority in the institutional mission of their university.

Table 4.6 Importance of regional development in institutional mission of universities

	Percentage of survey respondents *1997*	Percentage of survey respondents *2001*
High priority	61.5	64.9
Medium priority	33.7	30.1
Low priority	4.8	4.2

Source: Charles 2001

The focus on entrepreneurialisation of the university as such and the emphasis on contributing to the regional economy, are the core elements of what one could term the comprehensive approach to third mission charactertistics of the UK. The comprehensive approach to third mission is very significant at the level of public promotion programmes. Recent third mission policy significantly increases its commitment to these agendas, both rhetorically and funding-wise (cf., Higher Education White Paper, DfES 2003). As shall be apparent from the discussion of future challenges below, there are, however, some crucial challenges to be taken up by UK policy-makers for these policies to fully realise their potential.

4.4.3 The legal status of universities as charities

Although the institutions in the current higher education sector are diverse in origin, size and organisation, they share the following characteristics of being:

- legally independent corporate institutions
- bodies having charitable status
- accountable through a governing body which carries ultimate responsibility for all aspects of the institution.

All higher education institutions have charitable status. Charitable status confers a number of benefits, including exemption from capital gains tax and from income tax and corporation tax on income other than trading income arising outside the course of the carrying on of the primary purpose of the institution. All higher education institutions are normally exempt from VAT on the supply of education and research. They may however be liable for VAT on trading activities. Requirements that members of governing bodies need to bear in mind in relation to the charitable status of their institutions include: (i) applying the assets and income of the institution only for the defined charitable purposes, (ii) acting only within their legal powers, (iii), taking particular care in organising trading activities which may not be regarded as charitable, and (iv) managing and protecting the property of the institution (Commitee of University Chairmen 2003).

Having legal status as charities gives UK universities a major advantage over most other European universities. Being charities, universities are encouraged to generate funding from trading activities with business, community and public agents, whether in the form of sales of products, consultancy or other. Whereas in other European countries such trading activities are regarded as more or less problematic, and certainly requires the setting up a separate companies at arms-length of regular university operation, in the UK the establishment of such separate companies is required only when some particular trading activity is not in line with the charitable purpose, i.e, research and education. In the UK, the legal framework encourages and accommodates trading activities as an integral part of regular university operation, whereas in most other European countries trading activities are seen as potentially damaging to the university mission, and thus legally severely restricted and indeed impeded. On this background, the legal status of UK universities as charities certainly qualifies for the term *best practice*. In fact, a recent report making recommendations to further encourage the entrepreneurial activities of all UK charities – including universities –

suggested that any remaining restrictions on trading activities be abandoned. More specifically, the report recommended that Charity law be ammended to “allow charities to undertake all trading activity within the charity”, regardless of whether this trading activity was in line with its charitable purpose or not (UK Government Strategy Unit 2002: 44).

4.5 Future challenges in UK

The major challenge facing the UK is that of increasing its investment in R&D. This will be discussed extensively in the concluding remarks below. In this section, the focus will be on three less general challenges with regard to the promotion of university interaction with industry. These are: (a) Nurture talent not technology (b) Revise block funding system (c) Strengthen regionalisation.

4.5.1 Strengthen regionalisation

In April 1999, UK government created a number of Regional Development Agencies (RDAs), following the Regional Development Agency Act of 1998. The OECD benchmarking report described this initiative in the following manner:

> The Regional Development Agencies Act of 1998 gave new impetus to regional innovation policy, making each regional development agency responsible for furthering economic development, regeneration of its area, the promotion of business efficiency, investment and competitiveness in its area, employment, and the enhancement of skills relevant to employment in its area (OECD 2002: 141).

There are, however, serious reservations with regard to the actual impact of this legislation. Just as the impact of providing a permanent stream of funding for third mission activities is severely impeded by the UK science funding system, so are these equally admirable policies for promoting regional economic development. Furthermore, this seems to be, again, the result of a lack of coordination, or indeed integration, of UK policies across different policy areas. Being part of Regional Policy, the Regional Development Agencies are formally the responsibility of the Department of Environment, Transport and the Regions. Their mission is, however, more of a matter of economic, industrial and innovation policies. All those policies remain distinctly non-regional in their making as well as in their objectives (Charles & Benneworth 2002). When it comes to innovation policy as well as science and technology policy more generally, the focus of UK policy is exclusively and explicitly national. This puts the RDAs in a rather difficult situation:

> Each of the new English RDAs has the responsibility to write innovation strategies for their regions building on the work undertaken in the drafting of their regional econonomic strategies. The weakness of … these new regional arrangements was that although they were repeatedly informed of the importance of developing clustsers, their mandate did not extend much beyond mapping activities and facilitating business clubs. All the RDAs faced the difficulty of trying to write a strategy for a knowledge-based economy knowing that the most critical decisions affecting them are taken without consideration for … regional needs (Charles & Benneworth 2002: 75).

It is a major challenge for future UK policies to develop a coherent third mission policy, that cuts all relevant policy areas. It is a severe barrier to the advancement of third mission activities in the UK, that science funding is allocated and science policies formulated with no emphasis whatsoever on the ultimate objective of third mission activity: the regional economy. In the most recent formulation of third mission policy, the importance of contributing to regional economy is the single most emphasised objective. The chapter on third mission policy in the 2003 White Paper on Higher Education thus opens with the following statement:

> In a knowledge-based economy both our economic competitiveness and improvements in our quality of life depend on the effectiveness of knowledge sharing between business and higher education… Much has been done through specific schemes and the Higher Education Innovation Fund to improve [business] links. As a result, they are already excellent in some places, but good links are neither extensive nor consistent enough. To improve, institutions should increasingly be embedded in regional economies, and closely linked with the emerging agendas of Regional Development Agencies (DfES 2003: 36).

A practical expression of this emphasis on regional development is that the White Paper announces the decision to engage RDAs more closely in the distribution of HEIF funding, giving them a formal role herein from the year 2004/2005 (DfES 2003: 38). Other policies as well as other, much larger, streams of funding seem, however, to work in the direction of continued concentration of UK public R&D in South East England, largely due to the system of basing block funding on the Research Assessment Exercise (RAE).

4.5.2 Revise block funding system

In the recent OECD report benchmarking industry-science relations in UK, France, US and Japan, quite a lot of emphasis was given to the negative impact of the RAE on university interaction with industry:

> In the United Kingdom, framework conditions are increasingly favorable to the collaboration of industry and science. A change of culture is occurring in response to shifting incentives and there is a growing alignment between framework conditions and industry-science relations. However, within the universities, the importance of publication within the Research Assessment Exercise carries a risk that academic work embodying public good characteristics will continue to be undervalued… Specific policies for the promotion of ISRs may not be sufficient to counter opposing forces. The Research Assessment Exercise… has frequently been identified as a barrier to ISR, even if it fulfills a valuable function in terms of its main objectives (OECD 2002: 152-153).

UK faces the challenge of revising its system of allocating core funding to the universities; its so-called ‘block funding system’. Two main policy options exist. Either the connection between core funding and the RAE could be loosened, or the criteria of the RAE itself could be reformed. In June

2002, the Higher Education Council for England announced that it would conduct a review of the RAE, in partnership with other UK higher education funding bodies:

> The review will investigate different approaches to the definition and assessment of research quality, drawing on the lessons both of the recent RAE and of other models of research assessment, and will advise on the future of research assessment…There are concerns that the RAE does not give proper weight to applied research and favours basic research, which results in conventional research outputs, such as articles in peer reviewed journals. There are also concerns that the RAE, as a subject based exercise, does not give proper weight to inter-disciplinary research. Both these areas were given attention in the 2001 exercise. The review will need to consider, among other things, to what extent existing steps have been successful and what should be put in place to tackle these issues in future (DTI 2002: 30).

As it appears, UK policy makers are presently working on these issues, and there are strong indications that the latter of the two above listed policy options will be chosen.

4.5.3 Nurture talent not techonology

As mentioned previously, efforts to institutionalise and professionalise commercialisation at university level dates back to the mid-1980s, where many universities started establishing technology licensing offices to manage IP and other commercialisation issues. The focus on IP and start-up companies in the debate on the third mission of universities is easily exaggerated – in fact, the contribution of such start-up companies to the economy as well as to the university itself in terms of new revenue, is very limited, even in the vast majority of US universities (Barber 2002, OECD 2002:126). The agenda of increasing university interaction with industry is too easily reduced to an issue of promoting the formation of new companies. The report by the Science Policy Research Unit (SPRU) at Sussex University, evaluating UK policy in this area was given the title, *Talent not Technology* to stress this danger:

> [A]n exaggerated emphasis on promoting university commercialisation would be misplaced because it would see universities as a source of technology rather than talent… The evidence shows that the transfer of academic ideas into industrial practice is best achieved where universities are given the freedom and resources to conduct high quality research. Short-term, aggressive and narrow drives to force universities to commercialise technology are rarely successful. Universities should be magnets for talented people. The current environment in the UK of low pay, heavy administration and limited flexibility undermines the recruitment and retention of talent in the university sector (SPRU 2000: 73).

The OECD benchmarking report stressed the same issue from a slightly different angle:

> Commercialisation by spin-offs and licensing of technology has received central attention in research and innovation policy. Such activity is, of course, desirable but the balance of emphasis has distracted attention from the much larger challenge of fostering relations with existing firms, particularly those in more traditional sectors and of a smaller size (OECD 2002: 152)

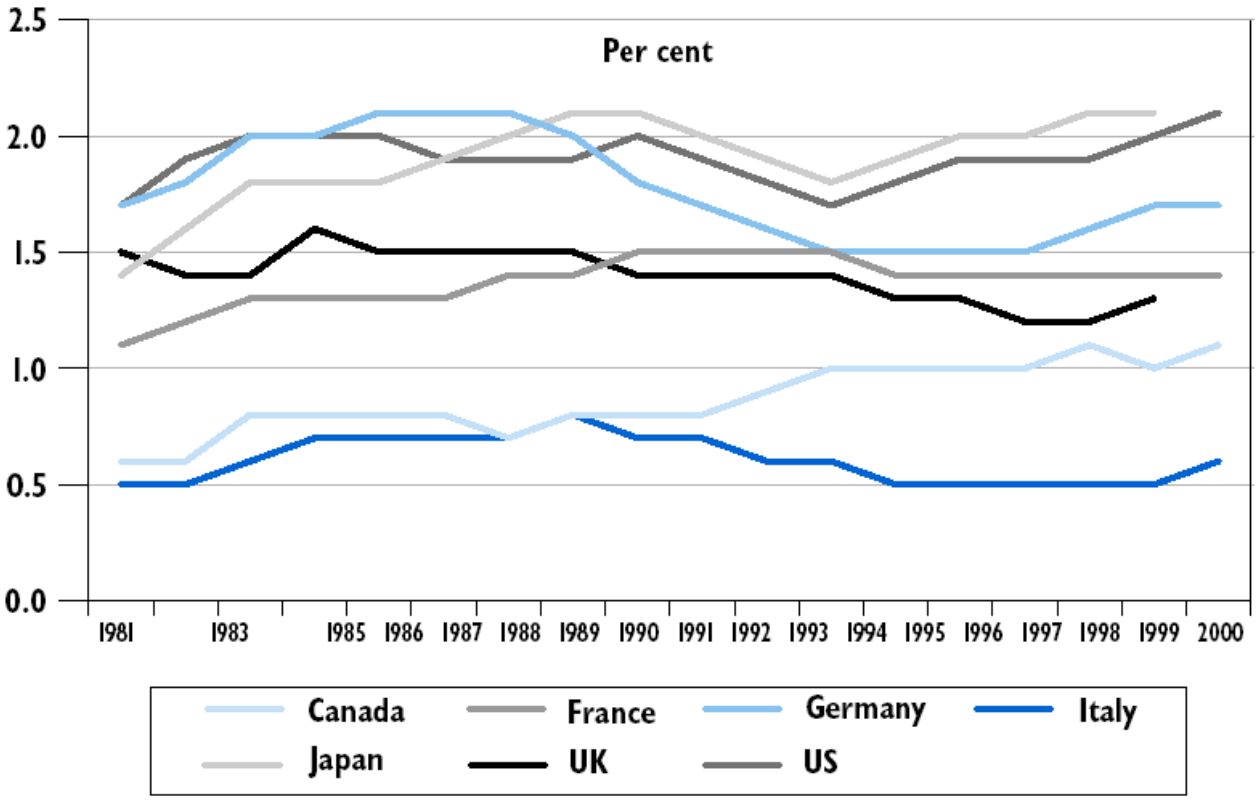
Future policies should move beyond the narrow agenda of promoting mere commercialisation of research results and technologies, to the promotion of an entrepreneurialisation of universities as

such. As evidenced by the above discussion of UK public promotion programmes, as well as by the entrepreneurial policies at the University of Newcastle, there are some important indications of a shift of emphasis in this direction. Further stimulation of this trend will be necessary, however.

4.6 Concluding remarks

In the OECD report benchmarking industry-science relations in a number of OECD-countries, it was stressed that the low level of investment in R&D in UK industry "greatly reduces the potential for industry-science relations" (OECD 2002: 153). The following chart compares R&D spending by business in larger OECD countries:

Figure 4.9 Business R&D spending as a pct of GDP



Source: DTI 2002

As it appears, UK business spending on R&D amounts to a smaller share of GDP than is the case in US, France, Germany and Japan. In fact, the chart underscores the scale of the problem. Spending on R&D by large UK companies is dominated by a small number of companies in pharmaceuticals and aerospace. Together these account for almost 50 pct. of UK business spending on R&D. Except for the pharmaceuticals, aerospace and health care sectors, UK scores very poorly in R&D scoreboards. Figures for R&D intensity – the ratio of R&D expenditure to total sales – brings this out very clearly.

> [UK] R&D intensity lags behind competitor countries. For example, average UK R&D intensity for all sectors in 2001 was 2.1 per cent, representing half the level of the US (4.3 per cent), Japan (4.2 per cent) and the international average (4.2 per cent). (DTI 2002: 78).

UK faces the overall challenge of increasing its national investment in R&D. The Finnish model of *driving* business R&D spending by increasing public R&D spending on collaborative research might indeed be a very useful model for the UK in its present situation. In a report by one of the two leading science policy research units in the UK, the challenge facing policy-makers were depicted as follows:

> The currently relatively low level of UK investment in publicly funded research hampers the ability of the UK to participate in the global knowledge-driven economy. The funding gap between the UK and the leaders of the OECD has been growing over the past ten years and only considerable investments will halt this pattern of decline (SPRU 2001: 71).

In summary, one may say that the legal framework in UK is very favorable for university interaction with industry, and that UK universities have more professionalised ways of managing interaction with business than do most universities in Europe. Further, in terms of cultural attitudes as well as in terms of third mission promotion programmes, as compared to most other European countries, the UK has good conditions indeed for industry-science interactions. However, without addressing the two fundamental problems of *basic disincentives* (cf., RAE) and *R&D underfunding*, the fact that a strong science base is not reflected in strong industrial innovation, can be expected to remain the focus of future studies of UK science and innovation policies.

POLICY RECOMMENDATIONS

On the basis of the above three country reports, we recommend the following set of policies to be adopted in a new Danish science and technology policy. On the basis of the experiences of Finland, Sweden and the UK, and on the basis of the present state of Danish science and technology policy, each of the stated policy recommendations can be expected to make a significant contribution to the promotion of university interaction with business and community.

(1) Define interaction with business and community as a third mission for universities

Interaction with business and community, promotion of utilisation of new knowledge, and contribution to economic development should be defined as the third mission *of universities. This should be stated explicitly in university legislation, as done in Sweden.*

(2) Create incentives for universities to interact with business and community

Universities should be given economic incentive to interact with business and community by allowing and encouraging them to engage in trading activities, and thereby generate funds to further improve the quality of research and education, and professionalise their interaction with business and community. The UK model where universities have the legal status of charities seems particularly expedient to this end.

(3) Promote new cultural values within the university sector

Third mission should be promoted as a positive and progressive agenda for universities in the 21st century. The INEX model of promoting entrepreneurship and commercialisation in and through on-campus incubators and parallel commercial R&D programmes (cf. University of Newcastle) should be a key point of inspiration for policies in this area.

(4) Ensure that regulations, policies and incentives applying to universities are coherent

Two brief examples of lacking *policy coherence: In UK, the RAE-based block funding system impedes other policies aimed at promoting entrepreneurialisation, by means of the strong disincentives for innovative research and third mission activities which the RAE produces for individual researchers as well as for departments and universities as such. In Finland, higher education policy impedes university engagement in third mission actitivities by effectively illegalising the very same activities that Finnish science and technology policies so persistently seeks to promote. A first step in the direction of overall policy coherence should be the establishment of a science and technology policy council, as in Finland.*

(5) Use public research funding as a change agent

With regard to public funding the following three elements should be combined: An increase in the overall level of research funding, a shift in the balance between core funding and competitive funding towards the latter, and a reform of the competitive research funding structure to allow for more emphasis on collaboration and commercialisation. Finland may serve as role model here.

(6) Stimulate the development of seed capital and venture capital markets

Experiences with commercialisation in Sweden, UK and Finland all indicate the crucial importance of seed capital and venture capital for the commercialisation of research-results through formation of spin-out companies. Policy-makers must take a proactive role in providing such capital and stimulating the emergence of seed and venture capital markets. In Finland, Sitra is an important point of reference, and in UK, the University Challenge Fund may provide valuable inspiration.

(7) Develop policies that stimulate the broadest possible range of interactions

Having said the above (5-6), it should be stressed that reducing the third mision agenda to a concern with spin-out companies would be counter-productive. The main form of interaction between universities and industry is the production of graduates, and it is important that policies address this dimension thoroughly, seeking to promote entrepreneurship in and through students. Here, the policies and activities of the Careers Services unit at the University of Newcastle provides valuable inspiration.

(8) Develop policies that places the entrepreneurial agenda at the core of the university

This relates to 3 and 7 above: It is extremely important to recognise that for all of this to acquire a significant scale, it is absolutely necessary that university interaction with industry is not conceived as an 'extra', something to be somehow squeezed in between existing activities. Third mission should not be an appendix, rather it should be integrated at the core of the university. This requires visionary and progressive policy-making first at the national level and then at the level of individual universities. Here, all three university case studies in the report identifies key issues.

(9) Experiment with *diverse* forms of ownership and profiles for universities

A one-fits-all approach should be avoided, and different forms of ownership should be experimented with. In this regard, one may draw upon the experiences of Chalmers University of Technology in Sweden, and upon UK experiences with introducing three new forms of ownership of public sector research institutes: Government-owned, contractor-operated (GOCO); Companies limited by guarantee (non-profit company operating for public benefit); Transfer to a company via private contract.

(10) Provide financial support for university restructuring

It must be recognised that if universities are to take up the challenge of interacting more comprehensively and professionally with business and community, this will require an institutional and managerial restructuring of universities. The organizational structure of universities must be reformed to allow for an administration that is more supportive of entrepreneurial activities. Promotion programmes should be devised to provide public funding for this speficic purpose. The HEROBAC and HEIF programmes in the UK should serve as key inspiration.

(11) Facilitate actual interactions instead of building new intermediary structures

Constructing new intermediary structures is perhaps the best way of proving ones commitment and effort, but unfortunately not by far the most effective *way. In fact, the approach of building intermediary structures often seems to institutionalise a lacking interaction between universities and industry rather than proactively countering it. For Tekes in Finland, it is standard policy to promote competence development, not infrastructure. In relation to universities themselves, on-campus incubators is the future in this area.*

(12) Use evaluation as a key tool in the formuation of strategic science and technology policy

Strategic science and technology policies should be revised and reformulated continuously to respond to developments in the national innovation system. Using research and evaluation as a key tool in that process is of paramount importance. The use of research and evaluation in science and technology policy in Finland should be role model in this area.

(13) Participate in international science and technology policy organisations and their projects

It is important to take an active role in key international organisations pertaining to science and technology policy. To give one brief example, it is to the vast comparative disadvantage of Denmark, that it is currently not a member of The Association for Technology Implementation in Europe (TAFTIE).

(14) Develop policies that stimulates industry interaction with universities

This study has addressed the question of promoting university interaction with industry. But it takes two parties to interact. A coherent science and technology policy should investigate and analyse industry-science relations from the point of view of industry as well, and develop policies that promote industry interaction with universities.

POLICY DISCUSSION
Getting the Fundamentals Right

The general attitude toward universities in the United Kingdom is considerably more favorable to entrepreneurship than it is in Denmark.[30] But though attitudes are indeed very important when it comes to university interaction with industry, the difference is not a matter of attitudes only. The difference is reflected also in the regulation of universities in the two countries.

At the core of the overall issue of promoting university interaction with industry is a fundamental political dilemma, which is well-known in UK as well as in Denmark. The public and political opinion in the UK is, however, ahead of Denmark in terms of *working out* this dilemma. The dilemma consists in the following. On one hand, the political system is keen for the economy and the wider society to benefit as much as possible from the knowledge that is produced in universities on the basis of public funding. On the other hand, the political system has an ambivalent relation to allowing universities access to the markets through which society would indeed best benefit from their knowledge. In Denmark, this ambivalence has not been addressed, and thus consistent overall guidelines regulating the 'outreach' activities of universities have not yet been developed.

The ambivalence with regard to allowing universities access to markets consists of the following three main elements. First, there is a notion that public money should not be used to subsidise commercial activities. Secondly, there is a notion in some parts of the business community that universities should not charge a price for bringing their knowledge to market. And thirdly, there is a notion that universities should not operate as trading businesses although they are encouraged to be 'business-like' in their activities. To each of these three notions correspond a certain underlying idea, or assumption. First, the notion that public money should not be the basis for commercial activities is based on the idea that activities, and products, more or less based on public funding, constitute unfair competition and will thus distort markets and be detrimental to economy and society. Secondly, the notion that universities shouldn't charge a price for bringing their knowledge to market is based on the idea that this would amount to having society pay for the same product twice: first through public funding, and then again at the market-place. And finally, the notion that universities should not engage in trading activities is based on the idea that this would compromise the critical role of universities.

[30] The following is informed and inspired by interviews with the UK experts, particularly those with Adrian Hill (HEFCE) and Chris Henshall (DTI).

All three above-mentioned ideas constitute barriers to university interaction with industry not just – though this is in itself important – through the attitude they spread in universities and in society at large. In Denmark, they constitute barriers also in and through the regulatory element that they all feed into: the regulation that when a university brings its knowledge to market it must never more than cover its costs. Before further discussing the regulatory aspect, I shall give a brief overview of the three discussed notions, their underlying ideas, and the ways in which they are each based on misguiding reasoning, cf. the table below.

Notion/attitude	Public funding should not be the basis for commercial activities	Universities should not charge a price for bringing their knowledge to market	Universities should not engage in trading activities
Underlying Idea	Activities and products more or less based on public funding constitute unfair, distorting competition	If universities charge a price for bringing their knowledge to market, society pay twice for the same thing	If universities engage in trading activities their critical role in society will be compromised
Misguided element	This is so, only if activities and products aren't brought to market at a full commercial price. If a full market price is charged there is no market distorting under-bidding, rather there is a public good correcting a market failure	Public funding covers the costs of producing scientific knowledge, but not the costs of bringing that knowledge to market – thus, it does *not* amount to paying twice for the same thing	The implicit assumption seem to be that it will not be their critical ability that universities will bring to the market – though this is in fact their comparative advantage, and thus the very basis for any commercial activity they may have

In the United Kingdom, the ambivalence with regard to allowing universities access to the market has been sorted out by means of the following two simple principles:

(1) Universities should indeed bring public goods to market, the more the better
(2) When bringing public goods to the market, universities should always charge a full commercial price

In the United Kingdom, when universities bring products to the market they are expected to charge a full commercial price. By charging a market-price there is no under-bidding based on public funding. If the market chooses the publicly provided product it is then not because of underbidding based on public funding, but because the public producer brings a type of knowledge to the market, that the market has not itself generated. Thus, the public product corrects a market failure. Consequently, universities selling their products in the market-place are not seen as introducing

market distortions, but as bringing to market products and activities that are beneficial to society, correcting the failure of the market to produce these products and activities on a private basis. This, then, is perfectly in line with the fundamental mission of publicly funded universities: to produce *public goods*, i.e., goods that are not produced by markets, such as scientific knowledge and science-based education.

In legal terms, the operation of these two principles is based on giving universities full autonomy, within the confines of their legal status as *charities*. A charity may indeed generate a surplus, and retain it, but is of course required to use this surplus in accordance with its charitable status, which in this case implies spending it on *education and research*. Within this overall framework of universities as financially autonomous charities, a range of public promotion programmes seek to further increase incentives in universities for interacting with industry. Promotion programmes are not the key issue when comparing framework conditions in UK and Denmark, however. The really important thing to note, is that where as in the United Kingdom an institutional incentive exists for universities to interact with industry, in Denmark there is instead an institutional *dis-incentive* for such interaction.

In the United Kingdom there is widespread recognition of how important it is for the economy that universities and industry take up the task of cooperating and exchanging knowledge and services. Universities are encouraged to take up this 'third mission', and the political system has provided a new stream of funding for this type of activities – third stream funding – which is increasing, and expected to continue to increase in years to come. The idea is not that these money should finance such activities, rather that they should provide a form of seed capital for university investments in gearing themselves to take up this third mission in a professional and institutionalised manner. There is in other ways, a recognition that university interaction with industry is of paramount importance to british economy, and that this is not a task that the universities can carry out with their left hand.

In Denmark there is an institutional dis-incentive to university entrepreneurship. Universities are not allowed, through such third mission activities, to generate themselves the funds that would enable them to gradually increase their professionalism in interacting with industry. When a third mission activity is taken up in a danish university, economic costs in a narrow sense may be covered, but the complexity of the university's operations increases significantly, at the cost either of the standard of education and research activities, or at the cost of the individual researchers involved. This means that whatever institutional interaction the university has with industry, it has it

in spite of the legal regulation of universities. It is rather unfortunate that the incentive structure for universities works in opposition to the intentions and hopes that the vast majority of the political parties have for universities to increase their interaction with industry. On this background, it is no surprise that Denmark is lagging behind other European countries in this area.

It is paradoxical that on one hand we would like universities to increase their interaction with industry, and on the other hand we do not want universities to generate funds to finance their investment in this interaction. There is considerable irony in that one of the reasons why universities are prevented from generating funds by selling its activities and products at the market, is the idea that this would be unfair to private companies and to taxpayers. It is ironical because these notions in fact punishes rather than protects private companies and taxpayers. They do so in two ways:

(1) a stimulating interaction, and a new stream of funds is denied, at the cost of the future quality of research and education
(2) the use of scientific knowledge outside universities is impeded, at the cost of national competitiveness and economic growth, and thus ultimately at the cost of living standards at large.

If universities are to emerge in Denmark, that are at one and the same time (i) entrepreneurial, i.e. engaging in interaction and trading activity with business and community, and (ii) based on scientific knowledge production – an organisation and regulation of universities that supersedes the traditional private-public distinction is needed. Such an organisation and regulation of universities is precisely what is the main comparative advantage of British science and technology policy. In UK, universities are neither public, nor private, in conventional terms. They are private in the sense that they engage in trading activity, but non-private in the sense that the surpluses they generate can never be paid to anyone as profits, but must always be spent om further research and education. They are non-public in the sense that they are private charities, but public in the sense that the overall aim of their activities is to serve public ends; namely research and education.

A policy aiming at stimulating university interaction with industry must get the fundamentals right: positive institutional incentives must be created for universities to increase and professionalise their activities in this area. At present, economic disincentive caused by a counterproductive legal framework is the single most important barrier for university entrepreneurship.

REFERENCES

Academy of Finland 2002, *Biotechnology in Finland – Impact of Public Research Funding and Strategies for the Future*, Evaluation Report, Helsinki.

Academy of Finland 2003, Mission statement, www.aka.fi.

Benner 2001, *Controversy and Consensus: Swedish science and policy in the 1990s [Kontrovers och konsensus: vetenskap och politik i svenskt 1990-tal]*. Stockholm: Institutet för studier av utbildning och forskning (SISTER)/ Nya Doxa.

Castells & Himanen 2002, *The Information Society and the Welfare State – the Finnish Model*, Oxford University Press.

Charles & Benneworth 2002, Are We Realizing Our Potential? Joining Up Science and Technology Policy in the English Regions, *Regional Studies*, vol. 35 (1).

Committee of University Chairmen 2003, *The Legal Status of Institutions*, www.shef.ac.uk/cuc/guide /12.html

Dasgupta & David 1993, Towards a new economy of science, *Research Policy*, vol. 23: 487–521.

DfES 2003, *The Future of Higher Education*, White Paper, Department for Education and Science, London.

DTI 2002, *Investing in Innovation: A Strategy for Science, Engineering and Technology*, Department of Trade and Industry, London.

EC 2001, *Benchmarking Industry-Science Relations: The Role of Framework Conditions*, Final report, Research project commissioned by the European Commision and the Federal Ministry of Economy and Labor, Austria, Vienna.

Eriksson 2002, Interview, Copenhagen Business School.

Georghiou 2001, The United Kingdom National System of Research, Technology and Innovation, in Laredo & Mustar (eds.), *Research and Innovation Policies in the New Global Economy*, Edward Elgar Publishing.

Charles 2001, Higher Education-Business Interaction Survey, Research report commissioned by the Higher Education Funding Council for England, Bristol.

Heyman & Lundberg 2002, *Finansiering av Svensk grundforskning*, Vetenskabsrådet, Uppsala.

Hill 2002, Interview, Higher Education Funding Council for England, Bristol.

INEX 2003, http://nanocentre.ncl.ac.uk/, University of Newcastle.

Jacob 2003, Historical Overview of Swedish Science and Technology Policy, *Manuscript*, Copenhagen Business School.

Jacob, Lundqvist & Hellsmark 2003, Entrepreneurial transformations in the Swedish University System: the case of Chalmers University of Technology, *Research Policy* (forthcoming).

Kaukkonen & Nieminen 1999, Modeling the triple helix from a small country perspective, *Journal of Technology Transfer*, vol. 24 (2).

Komulainen 2002a, Interview, Tekes, Helsinki.

Komulainen 2002b, Technology Clinics, Tekes, Helsinki.

Lee 1996, `Technology transfer' and the research university, *Research Policy*, vol. 25: 843–863.

Liebeskind et al. 1996, Social networks, learning, and flexibility: sourcing scientific knowledge in new biotechnology firms, *Organization Science*, vol. 3: 783–831.

Lindholm Dahlstrand 1997, Growth and inventiveness in technology-based spin-off firms, *Research Policy*, vol. 26 (3).

Lundqvist 2003a, Presentation at workshop, February 5 Copenhagen Business School, Copenhagen.

Luukonen 2002, Interview, The Research Institute for the Finnish Economy, Helsinki.

Mansfield 1998, Academic research and industrial innovation: an update of empirical findings, *Research Policy*, vol. 26: 773–776.

Mäkiää et al. 1999, *Technology Transfer and Research Liaison*, Progress Report, University of Helsinki.

Mäkipää 2002, Interview with Heikki Mäkipää, University of Helsinki.

National Audit Office 2001, *Från forskning till tillväxt – statligt stöd till samverkan mellem högskloa och näringsliv*, Stockholm.

Mäkipää 2003, Workshop Presentation, Copenhagen Business School.

Nieminen & Kaukkonen 2001, *Universities and R&D networking in a knowledge-based economy – A glance at Finnish developments*, Sitra Report Series 11, Helsinki.

Odén 1991, Research training and the State: Politics and University Research in Sweden, in M. Trow and T. Nybom (eds.), *University and Society: Essays on the social role of research and higher education*, Jessica Kingsley Publishers, London.

OECD 2002, *Benchmarking Industry-Science Relationships*, Paris.

Ormala 2001, Science, Technology and Innovation Policy in Finland, in Laredo & Mustar (eds.), *Research and Innovation Policies in the New Global Economy*, Edward Elgar Publishing.

Ormala 2003, Telephone interview.

OST 1993, Science, Engineering and Technology White Paper, London.

Prihti et al 2000, *Assessment of the additional appropriation for research*, Sitra Reports Series 2, Helsinki.

Romanainen 1999, The Cluster Approach in Finnish Technology Policy, in OECD (ed.), *Boosting Innovation: The Cluster Approach*, Paris: Organisation for Economic Co-Operation and Development.

Romanainen 2002, Interview, Tekes, Helsinki.

Rouvinen & Ylä-Anttila 1999, Finnish Clusters and New Industrial Policy Making, in OECD (ed.), *Boosting Innovation: The Cluster Approach*, Paris: Organisation for Economic Co-Operation and Development.

Ruin 1991, 'Bending with the Breeze'. Political Preferences and Institutional Reforms in the Modern University System – A Case Study, in M. Trow and T. Nybom (eds.), *University and Society: Essays on the social role of research and higher education*, Jessica Kingsley Publishers, London.

Seppälä 2002, Interview, Science and Technology Policy Council, Helsinki.

Seppälä 2003, Workshop presentation, Copenhagen Business School.

Snowdon 2002a, Interview, University of Newcastle.

Snowdon 2002b, *Spin-Off and Entrepreneurial Training Model*, University of Newcastle.

Snowdon 2003, Presentation at workshop, Copenhagen.

SPRU 2001, *Talent, Not Technology: Publicly Funded Research and Innovation in the UK*, Science and Policy Research Unit, University of Sussex.

STPC 1990, *Review 1990: Guidelines for Science and Technology Policy in the 1990s*, Science and Technology Policy Council, Helsinki.

STPC 1993, *Towards and Innovative Society: A Development Strategy for Finland*, Science and Technology Policy Council, Helsinki.

STPC 1996, *Finland: A Knowledge-based Society*, Science and Technology Policy Council, Helsinki.

STPC 2000, *Review 2000: The Challenge of Knowledge and Know-how*, Science and Technology Policy Council, Helsinki.

STPC 2003, *Knowledge, Innovation and Internationalisation*, Science and Technology Policy Council, Helsinki.

Strategy Unit 2002, *Private Action, Public Benefit*, United Kingdom Government Cabinet Office, London.

Strömberg &Tydén 1999, Spännande möten mellan forskare och praktiker, Stockholm, Svenska Kommunförbundet

Tekes 2001, *Annual Report 2001*, Helsinki.

Tekes 2003, www. tekes.fi.

Tuunainen 2002, Reconsidering the Mode 2 and the Triple Helix: A Critical Comment Based on a Case Study, *Science Studies*, vol. 15 (2).

Tuunainen 2003, On the Possibility of a Research Group-Firm Hybrid Entity: Contesting Boundary Between Academic and Business Activity in a Traditional University, *Manuscript*, Center for Activity Theory and Developmental Work Research, University of Helsinki.

Tuunainen 2003, Contextualizing Transformation: How a University Research Group Became a Biotechnology Start-up Company, *Manuscript*, Center for Activity Theory and Developmental Work Research, University of Helsinki.

University of Newcastle 2002, Business for the Bioscientist, Centre for Academic Development.

University of Newcastle 2003, Business Services, www.newcastle.ac.uk.

Vinnova 2003, VINNVÄXT, www.vinnova.se.