Academy-Industry Collaboration

Mid-term evaluation of the Knowledge Foundation’s knowledge exchange programme

Anders Hanberger
Ingrid Schild
David Hamilton
UCER is an international research centre at Umeå University. The centre conducts evaluation research and provides postgraduate teaching and research training in evaluation.

UCER performs independent high-quality evaluations. The centre also develops the methodology of evaluation and designs evaluation systems.

UCER is governed by a Managing Board and supported by an international Scientific Advisory Group of distinguished researchers.

To order Evaluation and Research reports please contact:
Umeå Centre for Evaluation Research, Umeå University
SE-901 87 Umeå, Sweden

Phone: +46 (0)90 786 67 97
Fax: +46 (0)90 786 60 90
Academy-Industry Collaboration

Mid-term evaluation of the Knowledge Foundation’s knowledge exchange programme

Anders Hanberger
Ingrid Schild
David Hamilton
Table of Contents

List of Tables 3
List of Figures 3
Preface 4
Executive Summary 5

1 BACKGROUND 8
1.1 Aim of this report 8
1.2 Data sources 9

2 PROGRAMME CONTEXT 10
2.1 A brief background to the Swedish innovation system 10
2.2 The policy discourse 12

3 THE KNOWLEDGE EXCHANGE PROGRAMME 15
3.1 Programme goals 15
3.2 Programme logic 18
3.3 Programme funding conditions 19
3.4 Key participants’ motives 20

4 EARLY IMPLEMENTATION OF THE KNOWLEDGE EXCHANGE PROGRAMME 25
4.1 Origins of the programme 25
4.2 Industrial Research School Programme 26
4.3 Expert Training Programme 28
4.4 Collaboration between new university colleges and industry 32
4.5 New forms of knowledge exchange between SMEs and universities in networks 34
4.6 The Forestry Industry Programme 35
4.7 Summary observations 36

5 PROCESSES WITHIN INDUSTRIAL RESEARCH SCHOOLS (1): PARTICIPANTS’ EXPERIENCES 37
5.1 Establishing the research schools 37
5.2 Participants’ experiences 39
6 PROCESSES WITHIN INDUSTRIAL RESEARCH SCHOOLS (2): COLLABORATION 44
   6.1 Characterizing research school collaboration 44
   6.2 Project-based collaboration and knowledge transfer 46
   6.3 Comparative analysis of high and low intensity modes of project-based collaboration 56
   6.4 Beyond project-based collaboration 60

7 RESULTS AND CONSEQUENCES 67
   7.1 Benefits from the research school programme 67
   7.2 Added value 70
   7.3 Immediate effects 75
   7.4 Goal-achievements 77

8 CONCLUSIONS 80
   8.1 Implications for the Swedish innovation system 82
   8.2 Programme appropriateness 82
       Recommendations 84

References 86

Appendices 89
   Appendix A: Theoretical considerations 89
   Part 1: Innovation theory 89
   Part 2: The evaluation framework 94
   Appendix B: Table of the KK-Foundation’s Industry Research Schools by host organization and research profile 97
   Appendix C: Tables 98
   Appendix D: From Research Schools to the Entrepreneurial University: The International Advisory Group (IAG) Report 100
List of Tables

Table 1: Overview of sub-programmes in the knowledge exchange programme 17
Table 2: The six most prominent reasons firm contact persons gave for participating 23
Table 3: Number of students who thought that they had contributed to their university and their firm through their joint industry/academic affiliation 71
Table 4: Firm supervisors’ experience of collaboration 72
Table 5: Firms’ estimated need for university level qualifications 98
Table 6: Number of research students reporting that they contribute to knowledge exchange, by research school 98
Table 7: No. of firm representatives who reported that collaboration had grown stronger as a result of participating in the programme 99
Table 8: Firm representatives who reported that collaboration with universities had grown stronger as a result of participating in the programme 99

List of Figures

Figure 1: Framework for evaluation of the knowledge exchange programme 95
Figure 2: A Taxonomy of Policies for Promotion of Industry-Academic Linkages 105
Preface

Umeå Centre for Evaluation Research (UCER) and the Swedish Center for Business and Policy Studies (SNS) are jointly responsible for a research-based evaluation of the Knowledge Foundation’s (KK-foundation) knowledge exchange programme. The evaluation is planned as a five-year evaluation project running from July 1998 to June 2003. This evaluation report is a mid-term report which deals with the background, processes and early results of the programme. A plan for the second half of the programme (not included here) has been presented to the KK-Foundation.

The knowledge exchange programme embraces 1.2 billion Swedish kronor, excluding co-financing. Programme activities commenced in 1995 and seven sub-programmes have been initiated. This mid-term evaluation report mainly focuses on the research school programme, the sub-programme which has developed the furthest. As such, the report is an extension of a previous report presented in May 2000 (Schild and Hanberger 2000). This report integrates new data, primarily from the participating firms, and extends the analysis. Further, the conclusions are presented along with recommendations for the ongoing programme work.

The evaluation has been supported and followed by an International Advisory Group (IAG) of distinguished innovation policy researchers, together with a reference group of industry representatives. Both groups are convened by SNS. The evaluation work, including the framework, data-collection, interpretations and conclusions have been discussed and validated by the members of the reference groups, as well as with project leaders in the research school programme and administrators at the KK-Foundation. Even so, Dr Anders Hanberger, Dr Ingrid Schild and Professor David Hamilton, researchers at UCER, are themselves responsible for the content and analysis in this report.

Stockholm and Umeå, April 2001

Göran Arvidsson
Research Director, SNS

Lars Lindholm
Director, UCER
Executive Summary

General

Between 1995 and 2000, the KK Foundation launched a knowledge exchange programme with a budget of 1.2 billion Swedish kronor, excluding co-financing. The programme aims to support knowledge exchange between universities, industrial research institutes, and industry, in order to improve the innovative capacity of Sweden’s firms, and thus boost the country’s competitiveness.

Fostering R&D collaboration between the public and private sectors is nowadays regarded as an important economic policy instrument. This reflects the abandonment of a linear understanding of the innovation process, in favour of a more systemic approach to understanding and making policies for innovation, as the latter is now widely understood as an iterative learning process. The KK Foundation’s knowledge exchange programme, an initiative which comprises several sub-programmes, is in line with this prevailing policy trend. The programme seeks to bring about greater interaction between the public and private sectors by injecting catalytic funds into the innovation system.

The programme has been launched successfully, according to the terms established by the KK Foundation. However, sub-programmes have been delayed by pre-contractual negotiation, multi-lateral networking, underdeveloped routines, and difficulties recruiting collaborators and students. Such delays should be seen as a function both of the organizational complexity of the programme concepts themselves, and of the implementation problems that follow from that.

The KK initiative has injected the Swedish innovation system with a new source and form of funding. It has made an important contribution to the creation of industrially relevant, interdisciplinary research schools in Sweden. The initiative is in line with (and thus serves to reinforce) the most widely accepted diagnosis of the current problems in the national innovation system, and how these should be remedied. With minor modification, the programme could also strive to influence the qualitative (as well as quantitative) aspects of growth, through taking account of sustainability and regional issues.
Benefits

A number of specific benefits arising from the programme have been identified.

Some projects in the research school programme have succeeded in building entirely new network relationships. Although the majority of the links are based on pre-existing links and networks, these are often strengthened and given a new dimension through the project.

Firms in the Industrial Research School sub-programme report that they have benefited from collaboration with universities in various ways. They have:
• benefited from subsidized research and its results
• gained access to academic contacts
• gained access to expensive lab equipment
• entered new research areas
• collaborated with other firms
• strengthened their image and learning capacity.
Firm differences in perceived benefits appeared to vary more by technology area and/or prior experience of collaborating with academia, than by firm size.

Within higher education, academics have been able to:
• raise capital for doctoral training
• initiate new research projects relevant to a firm’s or industrial sector’s problems
• strengthen their relations with one or more firms
• KK funds have also enabled some project leaders (the majority of whom are academics) to realize personal visions of what can be achieved through an industrial research school.

Finally, participating research students
• feel that they have added something fresh to the knowledge exchange process
• view themselves, variously, as university-industry brokers, knowledge-carriers and network-builders.
Potential programme weaknesses

The report also points to some potential programme weaknesses.

- In the research school programme, the university industry connection may in some cases be too heavily dependent on the work of the students themselves. This is not in the long term ideal, as students are a transient population, and the relations should ideally flourish after the student has completed his or her project.
- Students and their projects can easily get caught between two sets of quite different interests. The line between product development and research can be very thin; students at times need protecting from strong firm influences on the direction of their research.
- Small firms can find it difficult to meet the requirement for co-financing.
- There are insufficient incentives for firms to invest in generic (technology) areas of importance for entire sectors.
- Participating firms’ actual current need for PhD level graduates may be significantly lower than anticipated. Likewise, firms’ current need for graduates with first degrees, masters’ or licentiat qualifications may be underestimated.

Recommendations

In the light of the evaluation findings, the Foundation might give attention to:

- The funding terms by:
  - offering more flexibility for SMEs
  - including incentives to support generic research areas
- Strengthening its capacity as a facilitator of knowledge exchange by:
  - promoting learning from projects
  - coordinating the dissemination of knowledge
- Recognize the importance of the sustainability and regional dimensions in innovation and growth.
1 BACKGROUND

The KK Foundation was created to strengthen Swedish industrial development through fostering the development of knowledge and skills in key areas. This is done both by supporting industry relevant research and high-level training, and by supporting the development of IT in sectors such as schools and the health system.¹

The KK Foundation launched a knowledge exchange programme in the summer of 1996 as part of its overall strategy of supporting economic growth in Sweden. The programme has a framework of 1.2 billion Swedish kronor, excluding co-financing. It aims to support bridging and networking activities between universities,² industrial research institutes, and firms, in the expectation that academia and industry will derive mutual benefit from closer interaction. In the programme’s first year, activities were largely focused on one sub-programme - the creation of industrial research schools. By September 2000, six other sub-programmes had been developed to support knowledge exchange.

In 1998, the Umeå Centre for Evaluation Research (UCER) and the Swedish Center for Business and Policy Studies (SNS) were commissioned to carry out an evaluation of the KK Foundation’s knowledge exchange programme. The evaluation is designed as a real-time, research-based, stakeholder evaluation. The evaluators have been continuously assisted by an international advisory group of innovation policy researchers, and a reference group of representatives of Swedish industry and (to a lesser extent) academia. Both groups are convened by SNS.

1.1 Aim of this report

This mid-term report analyses: the background context of the knowledge exchange programme; the first phase of its implementation; and some early results. In so doing, the report seeks to provide insight which may inform decisions relating to the future implementation of the programme.

¹ For a brief description of the Foundation’s aims and activities see Schild and Hanberger (2000, section 2.1).
² Unless otherwise stated, ‘university’ as used in this report designates university colleges as well as the new and older universities proper.
This report focuses mainly on the Industrial Research School sub-programme, with only cursory attention paid to the other sub-programmes. The research school sub-programme constituted the focal point of the first phase of the programme. Amongst the sub-programmes, it is the one, which has so far accounted for the largest share of programme funding, and thus may be assumed to have the greatest potential to provide insight into the knowledge transfer process.

1.2 Data sources

The evaluation data derive from three sources: interviews; electronic questionnaires; and programme documents. Over 100 individuals working at different levels within the programme were interviewed in 1999 and 2000\(^3\). Electronic questionnaires were sent to the following three groups of participants: project leaders; research students; and firm supervisors or contact persons, during the spring and autumn of 2000. Response rates were as follows: project leaders returned 11 of the 12 electronic questionnaires sent out; research students returned 73 of the 99 questionnaires sent out (74%); and firm supervisors/contact persons returned 48 of the 73 questionnaires sent out (66%).\(^4\)

---

\(^3\) The number of individuals interviewed and their capacity are as follows: Participants in the Industrial Research School Programme: project leaders/administrators (15); university supervisors (26); industrial research institute supervisors (7); firm contact persons (21); students (36 some in groups of two or more); Swedish R&D managers (12); Köf group and KK board (4); KK Foundation staff (3)

\(^4\) Each firm supervisor/contact person responding, supervises at least one student, and represents individual research projects rather than firms. A number of these respondents work in the same firm, such that 33 firms are represented amongst the 48 responses from firm supervisors; four firms are over-represented amongst these responses (Ericsson, Telia, BIM Kemi AB and Karo Bio AB).

A fourth electronic questionnaire has been sent out to 26 project leaders in three other sub-programmes (Expert Training, New forms of knowledge exchange between SMEs and universities/university colleges in networks, and Collaboration between new universities/university colleges and industry). Responses from this questionnaire are coming in continuously. Nine responses had been received at the time of writing (see footnote 17, p.25).
2 PROGRAMME CONTEXT

2.1 A brief background to the Swedish innovation system

Collaboration in the innovation system

Sweden was relatively early in its recognition of industry’s dependence on scientific knowledge, and in introducing policies to promote industrial science. For example, a number of industrial research organizations were founded from the inter-war years and onwards (Sörlin and Törnqvist 2000). Universities, however, did not partake significantly in industrial collaboration until relatively recently. Rather, the relationship between industry and research was heavily characterized by government procurement, whereby the State procured a new technology, normally of an infrastructural nature, from a large firm. Examples of lasting relationships built up in this way are those between Vattenfall and Asea, Televerket and LM Ericsson, SJ and Asea, and Flygvapnet and Saab.6 Swedish technical development throughout the 1900s was characterized by this demand-pull dynamic driven by the State and its infrastructural capital. Indeed, this mode of knowledge-based economic growth has been labelled the ‘Swedish model’ (Sörlin and Törnqvist 2000 p.91).

The idea that higher education institutions and university research might promote technological and industrial development is still relatively young in Sweden (Sörlin & Törnqvist 2000). In contrast to countries such as the United States, where a number of universities developed close relationships with industry early on, Swedish universities have largely developed independently of industry, and have only relatively recently begun collaborating extensively with industry. Even more recent is the expectation (enshrined in law since 1997) that universities will collaborate with local communities - the so-called ‘third mission’ of universities (Sörlin and Törnqvist 2000). Greater university-industry collaboration has traditionally been hampered by ideological opposition. Significant numbers of researchers

---

5 Appendix A, part 1, gives a broad overview of the systems of innovation approach in innovation studies, which provides an implicit context in which the programme is understood.

6 ‘Vattenfall’ is the state-owned company originally responsible for the development of hydroelectric power; ‘Televerket’ was the public company responsible for telephony (today partially privatized and renamed Telia); ‘SJ’ (Statens Järnvägar) was the public company responsible for the entire railway network (parts of which are today privatized); and ‘Flygvapnet’ is the Air Force.
still resist greater university-industry interaction on the grounds that the accompanying greater dependence on industrial funding will lead to an erosion of academic freedom and thus research quality.

Yet formulations of science policy now give much greater priority than earlier to the needs of industry, and a range of actors (public as well as private sector) are now encouraged to collaborate within the innovation system. In short, in a bid to boost the country’s economic and technological performance, government, industry and universities are seeking new forms of collaboration in the pursuit of industrial innovation (SNS and UCER 1998).

R&D expenditure in the late 1990s

One measure of a country or region’s innovative performance is expenditure on research and development (R&D). In 1997, Sweden spent 3.9% of its gross domestic product on R&D (a total of 67 billion Swedish kronor or 7.5 billion US dollars), a greater proportion than any other country. When this investment is calculated on a per capita basis, only the USA spends slightly more (Prop 2000/01:3, p.17). Expenditure on R&D in Sweden, the USA and Finland has increased more than the EU average over the last decade (ibid. p.18). Yet there is some concern in Sweden that the return from its R&D investment is lower than might be expected (SNS and UCER 1998).

As in most countries, the lion’s share of Sweden’s R&D investment is attributable to industry, with 66% of its R&D activities funded by industry. Further, Swedish industry is currently increasing its R&D investment, in line with international trends. Swedish industrial R&D investment is largely spent on development activities, which account for 80% of industrial R&D expenditure, the remainder being spent on basic and applied research. Industrial R&D expenditure is concentrated to a few sectors, and to the limited number of companies dominating those sectors. Thus the multinationals Ericsson, Astra-Zeneca, Pharmacia, Volvo and ABB are together responsible for the majority of Swedish R&D funding; pharmaceuticals being the fastest growing sector in terms of R&D investment during the 1990s (Prop 2000/01:3, p.19).

Overall public R&D funding in Sweden has also increased during the 1990s. The main sources of public R&D funding in Sweden are the Swedish government (including research councils), the research foundations, and the European Commission. The Swedish government spends almost as much on R&D per capita as the US government. Whilst the establishment of the research foundations in the first half of the 1990s brought new money into
the innovation system, the government simultaneously reduced its own research expenditure. A notable difference between the structure of Swedish public R&D funding and that of some other European countries is the relatively small proportion allocated to industrial research institutes (4% of the national R&D expenditure, compared to 45% in Germany) (Prop 2000/01:3, p.19).

Innovation and firms

In a survey of 6,000 Swedish companies with more than 20 employees, covering the years 1996-1998, 60% of the firms described themselves as product innovative and 30% as process innovative (NUTEK and SCB 2000). Comparing these results to those of the second Community Innovation Survey (CIS II), suggests that the number of innovative firms in Sweden has increased during the 1990s (ibid.). Innovation in Sweden is largely carried out by individual firms (48% of innovative activity is estimated to be carried out in this way) or by firms in collaboration with other firms or with other organizations in the system (40% of innovative activity is estimated to result from firms in some form of collaboration) (NUTEK and SCB 2000). The KK Foundation’s knowledge exchange programme is designed to facilitate this latter type of innovative activity, involving more than one type of actor.

2.2 The policy discourse

The KK knowledge exchange programme may be conceived as a response to a particular understanding of the national economy’s weaknesses. This section describes the way in which these weakness are largely conceived by policy makers and the business community itself, and the implications this has had for research policy.

There is a general consensus within the economic policy and business communities that Sweden needs to strengthen its competitiveness in the global economy, and that R&D and innovation provide effective and desirable motors of growth (Prop. 2000/2001:3, p.19). More specifically, high-tech and innovative firms generally, are considered key potential sources of economic growth (NUTEK and SCB 2000). Consequently, innovation (and indeed research) policy is considered a key element of economic policy. An effective innovation policy is in turn assumed to be one which promotes successful

---

7 Eurostat was commissioned to survey EU innovation activities in 1990-1992 (CIS I) and 1994-1996 (CIS II). The Swedish results are published by Statistics Sweden (SCB 1998).
industrial innovation by supporting industrial renewal, helping actors and organizations become (more) innovative, and encouraging (greater) interaction between industry, the university sector and the state. The KK Foundation’s knowledge exchange programme builds on this generally accepted diagnosis of, and suggested solution to, the country’s economic problems.

**Implications for research and research policy**

This prevailing view that innovation can and should play a key role in fostering economic growth, naturally has implications for the role ascribed to research and thus research policy. From this economic perspective, a successful research policy is one which best serves the needs of industry and its innovative capacity in particular.

This approach to research policy is evident in some developments in Swedish higher education and research over the last two decades. For example, as a means of stimulating regional economies, the university colleges were assigned a research role in the 1980s, whilst subsequent initiatives were aimed at strengthening their research capacity. Other more general initiatives are designed to encourage universities to respond more readily to industry needs. These include the promotion of applied research and industrial collaboration, and the introduction of funding structures encouraging departments to compete for industrial and other external forms of research funding.

Such policy efforts to enhance the university’s economic role are seen to be associated with, but not necessarily causally linked to, a widely accepted observation that ‘the university’ - broadly conceived to represent the publicly supported institutional infrastructure for basic scientific research - is currently undergoing an international epochal shift. This transformation is allegedly marked by pervasive changes in research practice, which taken together signal the emergence of a ‘new mode of knowledge production’, alongside the traditional discipline-based method of conducting science. The new mode of knowledge production involves a much greater involvement of industrial interests in university research, and a far stronger emphasis on the transfer of knowledge from the university to industry in a commercially applicable form (Gibbons et al. 1994). Those nations in which this pattern of development is most pronounced, it is suggested, will be winners in the struggle to gain competitive advantage and leadership in an increasingly ‘knowledge-based’ world economy.

The dominant research policy trend and the putative universal systemic shift in the way knowledge is produced, outlined above, are not entirely
uncontroversial, nor are they entirely representative of developments in the Swedish research enterprise. Dissenting voices are particularly to be heard within the academic community itself. Academics with strong allegiances to independent research and teaching as the basic missions of the university, do not always favour the university’s ‘third mission’. They are keen to preserve the integrity of research, fearing that the pressures of competition and extraneous influences may erode its quality. This view – at odds with the dominant research policy paradigm - has to some extent been politically endorsed in recent government policy documents, such as the so-called ‘Research 2000’ report (SOU 1998:128, prop 2000/2001:3). However, policies and programmes such as the KK knowledge exchange programme look to the more entrepreneurial ‘three-mission’ academics to effect renewal and change within the research system.
3 THE KNOWLEDGE EXCHANGE PROGRAMME

The knowledge exchange programme furthers the KK Foundation’s overall aim of strengthening Swedish industrial performance, by seeking to foster contact, networks, and increased collaboration between universities, industrial research institutes and industry (especially SMEs). The ultimate aim of promoting such knowledge exchange is to strengthen the innovative capacity of Swedish firms, and particularly SMEs. The knowledge exchange programme is organized into seven sub-programmes (see Table 1, p.17).

With the advisory support of the Foundation’s working committee on knowledge transfer, and as part of an ongoing learning process within the Foundation, the programme has gradually evolved to its present form since it was launched in 1996. Thus the Expert Training and Forestry Industry sub-programmes were initiated after 1997. Further, changes in emphases have been made within sub-programmes.

It should perhaps also be pointed out that the Foundation’s programmes and respective sub-programmes are not necessarily clear-cut discrete initiatives; in practice there may be some overlap between the means and goals of the various programmes/sub-programmes. This is the case with the knowledge exchange programme, and both reflects the evolutionary nature of the programmes, and a deliberate desire on the part of the Foundation to integrate programme areas.

3.1 Programme goals

The knowledge exchange programme was developed in 1996 and translated into a programme in 1997, with the following as three explicit objectives:

- to enhance the level of expertise and high-level skills in industry
- to facilitate the exchange of knowledge and experience between industry and universities, for the benefit of both

---

8 For a description of the development of the knowledge exchange programme see section 4.1 in this report, see also Schild and Hanberger (2000, Chapter 2).
9 Formerly the KöF group, now renamed the SAM group
10 The Swedish name for this sub-programme Expert Kompetens will be translated as ‘Expert Training’ in this report.
• to establish and further develop research collaboration between universities, research institutes, and firms in areas of strategic importance for Swedish industry (KK-stiftelsen 1997 p.27)

The objectives of the Industrial Research School sub-programme, the sub-programme concentrated on in this report, as defined in the annual report for 1997 are:

• to increase the number of employees with research training in industry, through a greater movement of research trained graduates from universities to firms, and through larger numbers of firm employees undertaking research training

• that universities, research institutes, and firms will pool their knowledge, expertise and resources in cooperating over industrial research schools (KK-stiftelsen 1997 p.28)

These goals have subsequently been elaborated and new ones added. For example, as the knowledge exchange programme has evolved, greater emphasis has been placed on the needs of SMEs (KK-stiftelsen 1997, 1999a, 18.5.99). Further, the annual report for 1999 implies a new goal for the research school programme: that interactive learning should take place between the researcher and industry during the research project itself, as well as after its completion (KK-stiftelsen 1999a p.27). The name change from ‘Consortia for Capacity Building’ to ‘Expert Training’ reflected this programme’s shift in emphasis towards the economic goal of strengthening national competitiveness. This explicitly economic goal now runs alongside the earlier defined goals of fostering the development of high-level skills amongst SMEs, and creating networks amongst universities, university colleges, industrial research institutes, and firms.

---

11 These are written as two objectives in the annual reports.

12 An internal (KK) learning goal has also been added ((KK-stiftelsen 1999a p.27).

13 In Swedish Consortia för Kompetensutveckling.
Table 1: Overview of sub-programmes in the knowledge exchange programme

<table>
<thead>
<tr>
<th>Name of sub-programme</th>
<th>Earmarked funding (m SKr)*</th>
<th>Remarks*</th>
</tr>
</thead>
</table>
| Expert Training - tailor-made training courses for        | 500                         | • Short expert courses in specific growth areas, organized by consortia of universities, new university colleges, and research institutes, largely for SMEs  
| Sweden’s firms                                            |                             | • Currently 3 contracts*                                                |
| Industrial research schools and Master’s degree training | 570                         | • Are currently 13 industrial research schools and approximately 3 masters’ courses,14 |
| programmes                                                 |                             |                                                                          |
| New forms of knowledge exchange between SMEs/universities | 36.8                        | • To help firms create networks between themselves and universities and university colleges  
| in networks                                                |                             | • Largely an experimental project  
|                                                           |                             | • 7 projects were launched 1996/1997                                  |
| Collaboration between new university colleges and industry| 60 from KK + 60 from NUTEK  | • Funds ‘third mission’ work at new university colleges (especially collaboration with SMEs)  
|                                                           |                             | • Initially a government initiative  
|                                                           |                             | • Co-financed by NUTEK  
|                                                           |                             | • Approximately 19 contracts                                           |
| Developing knowledge on academic-industry relations       |                             |                                                                          |
| Dissemination of research results                         |                             |                                                                          |
| Forestry Industry Programme                               | 60                          | • Strengthen competitiveness of forestry industry, e.g. through collaboration with universities.  
|                                                           |                             | • An initiative by the State, which is also a partner in the programme together with industry  
|                                                           |                             | • Currently 3 contracts*                                                |

* Source for figures: KK-stiftelsen (1998, 1999); remarks partly based on interviews with KK administrators.
**Correct as of September 2000,

14 This number is approximate, as three different data sources give three different figures for the number of projects within the masters’ degree arm of the industrial research school programme.
Most of the sub-programme objectives constitute means of fulfilling the aims of the knowledge exchange programme, which in turn constitute means of fulfilling the overall aims of the Foundation. However, the Forestry Industry sub-programme – the aim of which is to strengthen competitiveness – shares its goal with the overall goal of the Foundation. Similarly, the goal of sustainable growth found in the Forestry Industry sub-programme, is not (yet) echoed amongst the key goals of the knowledge transfer programme, nor is it evident in the Foundation’s general growth goal. Nor, indeed, do the qualitative aspects of growth feature strongly in the economics of innovation literature.

3.2 Programme logic

The goals and means of the knowledge exchange programme build on certain theoretical assumptions about the role of innovation in the economy, and how best to foster innovation. The way these assumptions are operationalized in the programme constitutes the programme logic or rationale. This section will briefly examine this programme logic in order to understand how the knowledge exchange programme is intended to work within the innovation system.

Primary assumptions underlying the knowledge exchange programme are that innovation is a key source of economic growth, and that innovation is well served by collaboration and networking between the public and private sectors. Beyond this, the programme can be examined by relating it to a very simplified model of an innovation system, itself based on some key concepts developed in systems of innovation theory.

An innovation system can be conceived as comprising three key components: organizations; institutional rules; and resources. The way in which actors or organizations (such as firms, universities, and funding bodies) act and interact (e.g. exchange knowledge, collaborate, carry out research, learn) in the innovation system is to some extent shaped by the informal and formal rules and regulations or ‘institutional rules’ which pattern their behaviour (see pp.92ff. for a more detailed discussion). Thus changes within the system can be brought about by manipulating the ‘institutions’ governing the behaviour of organizations (in combination with injecting resources).

By injecting funds with particular conditions attached to them, into the innovation system, the Foundation seeks to bring about organizational changes. These changes are intended to result in greater exchange and
collaboration between the three types of organizations: universities, research institutes, and firms. Ideally, new and lasting constellations and networks are created amongst these organizations. As a result, interactive learning (knowledge transfer) takes place, which enhances innovative capacity. In addition, the new constellations and networks help bring about, and are in turn reinforced by, new institutional rules governing action and interaction and which represent systemic change. Thus it may be said that through its role as a funder and facilitator, the Foundation seeks to initiate a chain-reaction, resulting in self-sustaining changes, which enhance the performance of the innovation system.

In short, one of the key ways the KK Foundation is trying to effect change is by introducing new types of funding incentives (‘institutional rules’) into the innovation system (see following section). Contract compliance is thus also a key tool used to effect change. It should perhaps be added that the programme logic as outlined here, is first and foremost relevant at the programme-level, and does not provide clear guidelines for how individual project leaders in the sub-programmes can best work to fulfil programme goals.

The emphasis in the programme on knowledge exchange, collaboration and networking is entirely in line with current thinking in the economics of innovation, which emphasises the importance of external sources of knowledge and ‘interactive learning’ for maintaining a high rate of successful innovation (e.g. Lundvall ed. 1992). Indeed, the recognition that networking, tacit knowledge (know-how), and learning are central to innovation broadly explains why the innovation process is now widely conceived as systemic (e.g. Edquist ed. 1997, Lundvall ed. 1992, Nelson ed. 1993). Further, in tandem with identifying the economic importance of science-based technologies (e.g. biotechnology, ICTs, new materials), the innovation literature also acknowledges the potential and actual importance of the research base for national and regional wealth creation. However, whilst the economic importance of public sector research is not in question, there is less certainty in the literature about the mechanisms underlying this contribution (see for example Salter and Martin 1999).

3.3 Programme funding conditions

The knowledge exchange programme is a relatively substantial programme in funding terms (approximately SKr 1.2 billion, from 1995-2000, excluding co-financing) (personal communication). Of this, the Foundation has allocated approximately SKr 1.1 billion (KK-stiftelsen 1999b p. 81). As outlined
above, this funding is intended to have a catalytic effect within the innovation system, bringing about changes that will allow currently supported projects to find alternative funding once the KK support terminates.

The rules and conditions governing the allocation of funding within the knowledge exchange programme are designed to induce behaviour which is compatible with fulfilling the programme objectives. For example, the allocation of funding in the Industrial Research School programme is determined by a number of quite specific relevance criteria, such as interdisciplinarity, public-private sector collaboration, preferably inter-firm collaboration, and preferably a new area of research. Further, the 50% co-financing required of participating firms acts as an incentive for these firms to participate actively in the programme. The traditional research funding criterion of research quality is thus supplemented with, and probably out-weighted by, a new combination of relevance criteria, which together constitute new ‘institutional rules’.\(^\text{15}\)

### 3.4 Key participants’ motives

As a stakeholder evaluation of a multi-actor programme, this report assesses the programme not only in relation to the explicit programme goals defined by the Foundation, but also from the perspective of participants’ own criteria. One way to access participants’ own success criteria is by analysing their motives for participating. Accordingly, this section draws on interview and questionnaire data to identify the motives, and thus the success criteria, of four groups of participants in the research school programme. The success criteria of groups of participants in the other sub-programmes have not yet been scrutinized; once these groups have been consulted, the range of criteria will naturally widen. The various criteria of success identified here will form the basis of an assessment of participants’ experiences within the programme (chapter 5).

*Project leaders’* motives for seeking research school funding and becoming involved in research school activities tended to differ between those based in universities and those based in research institutes. University-based project

\(^{15}\) Certainly the KK Foundation is not primarily concerned with controlling the internal scientific quality of the research it sponsors within the programme, though research quality in the conventional sense is not irrelevant as a funding criterion. Rather, it is one amongst many criteria. Unsurprisingly, project leaders and other academics with experience from various funding bodies, do report significant differences between funders in the degree to which they emphasize internal scientific criteria in their evaluation processes.
leaders’ motives for applying generally reflected their need to generate external forms of income. Several viewed this funding source as a means of adding volume to their existing activities. They also saw a KK grant as a means of cultivating new firm contacts and consolidating existing ones, thereby strengthening their chances of winning future research funding from certain other agencies (e.g. EU and NUTEK).

Project leaders based in research institutes were generally motivated by a need to maintain and improve the level of their institute’s scientific and technical expertise, both in the short and long term. Employing doctoral students was seen both as a means of augmenting research capacity, and as a means of enhancing the institute’s skills level. For most of the research institutes in the programme (Trätek, IOF/ACREO, SIK), the research school is part of the institutes’ programme of privatization and restructuring in which the KK Foundation is playing a key role.

Like university based project leaders, academic supervisors generally viewed the KK programme as a source of funding and a means of strengthening their chances of gaining future research funding. Beyond this general motive, academic supervisors fell into two broad groups. The first group saw the supervision task mainly in terms of the project’s potential contribution to scientific knowledge, and were thus primarily concerned with the academic quality of the student’s work. Supervisors in the second group paid significant attention to the industrial application of the student’s project and the associated firm’s problems.

The vast majority of students replying to the student questionnaire said that they were aiming for a doctoral degree. Only two students said they were aiming for a licentiat. Students were also motivated by the opportunity to pursue research in a particular area of interest to them. Students’ reported career plans are largely in line with the KK Foundation’s aims. A small majority of students hoped to pursue an industrial career. Of these, the majority hoped to begin this career in their current firm or research institute. A further third of the students were primarily interested in a combined industrial/academic career.

Participating firms were motivated to join the programme by a need or desire to foster relations with universities and research institutes, in order to access a range of ‘assets’ which these institutions could provide. The particular ‘assets’ firms sought to access varied by firm, but can be grouped into four main types. Thus through collaboration, firms sought to gain access to: university knowledge; research equipment and facilities; scientifically and technically
trained people; and credibility. Participating firms desired to access these for a variety of reasons, some of which are given below.

Firms saw accessing university knowledge as a means of achieving the following: developing new or more profitable products, applications, and markets; reducing production costs by developing a more sophisticated understanding of their own or their customers’ process or product; helping customers’ production to become more effective (thereby potentially increasing own sales); cutting risks and costs in explorative/pre-competitive research; and developing a strategic research area.

Firms hoped that gaining access to university trained people (research students and supervisors) would have the following effects: improve recruitment in the longer term by raising the company’s profile amongst students and academics (one firm, for example, used its research student in a recruitment advertisement); raise the skills level of the firm (in cases where research students were recruited from amongst current employees); reduce ‘academic fright’ in the company (by introducing a research student into the firm); develop closer customer interaction through staff (a research student or research-trained graduate) who can ‘talk the same language’ as customers.

Finally, firms hoped the ‘credibility’ factor perceived to be conferred by having close relations with universities would serve as a strong marketing mechanism, helping them to attract good potential recruits and more customers. Showing customers and suppliers that the company takes research seriously can engender their trust. Accordingly, at least two firms were financing the student from their marketing budget.

The above analysis is based on interview data. The questionnaire data allowed firms’ motives to be quantified. Table 2 shows the six main reasons firm contact persons gave for participating in the programme. The figures show the percentage of firm contact persons for whom the given reason explained ‘to a great extent’ and ‘to some extent’ why the firm had entered the programme. The percentages are based on 48 responses.
Table 2: The six most prominent reasons firm contact persons gave for participating

<table>
<thead>
<tr>
<th>Reason firm had for participating in the programme</th>
<th>% Firm contact persons who responded that the given reason was a significant motive for the firm to enter the programme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‘to a great extent’</td>
</tr>
<tr>
<td>Benefit from research project results</td>
<td>53</td>
</tr>
<tr>
<td>Gain access to academic links</td>
<td>46</td>
</tr>
<tr>
<td>Enter a new research area</td>
<td>25</td>
</tr>
<tr>
<td>Benefit from subsidised research</td>
<td>23</td>
</tr>
<tr>
<td>Gain access to expensive lab equipment</td>
<td>21</td>
</tr>
<tr>
<td>Positive image for the firm</td>
<td>14</td>
</tr>
</tbody>
</table>

Participants’ success criteria

The following list of participants’ success criteria is based on analyses of their motives, as were briefly described above. The list indicates that a number of rationales exist within the programme. Note that no significance should be attached to the order in which either the participants or the success criteria themselves are listed.

The KK Foundation
- Effective knowledge transfer between sectors
- Raised levels of skills and expertise within Swedish industry
- Ongoing knowledge exchange during the course of students’ research projects (as well as after a project’s completion)

Project Leaders
- Fulfilled vision for the research school
- Obtained research funding (in the shorter and longer term)

16 The KK continuously apply various instrumental criteria of success, such as successful implementation of the funding criteria, and progress in implementing the programme. However, these do not directly concern programme outcomes, and are thus not listed above.
**Academics**
- Obtained research funding (in the shorter and longer term)
- Developed links with firms
- Development of quality research

**Firms**
- Benefited from research results
- Gained access to academic links
- Positive image for the firm
- Entered a new research area
- Benefited from subsidised research
- Gained access to expensive lab equipment

**Research students**
- Gained a doctorate
- Pursued research of interest to them
- Development of successful industrial or combined industrial/academic career

Participants’ various motives and success criteria provide one indication of the degree to which the programme funding is likely to bring about KK’s desired effects. Ideally of course, participants’ motives should coincide or at least be reconcilable with the programme goals as set up by the KK.
4 EARLY IMPLEMENTATION OF THE KNOWLEDGE EXCHANGE PROGRAMME

This chapter describes the development and implementation of the knowledge exchange programme. Section 4.1 describes each sub-programme, largely though not exclusively, from the perspective of the Foundation itself. Section 4.2 focuses exclusively on processes within the research school programme from the perspective of programme participants. The process of implementing the sub-programmes may be thought of in terms of a pre- and post-contract phase. The bulk of the processes described in this chapter concern the pre-contract implementation phase.

4.1 Origins of the programme

The programme originated in a comprehensive information gathering exercise carried out by the Foundation in the autumn of 1995 and spring of 1996 (at which time the Foundation had only existed for a year or so), and which was partially coordinated with similar efforts made by other agencies such as NUTEK. The overall aim of this exercise was to identify ways in which the Foundation could help strengthen the Swedish economy, by analysing the specific needs of firms and by mapping existing initiatives.

As part of this process, the Foundation held several seminars and round-table discussions around the country with small and large firms, new and established universities and university colleges, and other relevant interest groups such as industrial associations. Interviews were also conducted with individuals based in relevant government organizations, local authorities, the confederation of industry, and firms, to construct a picture of what could be done to promote national competitiveness. In parallel with this activity, the Foundation set up a working committee on knowledge transfer (the Köf group) to advise the Foundation’s director on the focus and content of the programme.

A central topic focused on during this process was the provision of high-level training courses specifically for industry, and industrially relevant PhD and master’s level training. Other issues discussed included whether the programme should prioritize certain industrial sectors or technological areas,

---

17 Section 4.1 is largely based on data gathered from the Foundation.

18 Industriförbundet in Swedish
or indeed geographic regions. This was decided against (though it was recognized that IT was a particularly deserving sector), largely on the grounds that such prioritizations would quickly be overtaken by rapid industrial developments. The eventual focus chosen for the programme was to foster new ways of collaborating within the innovation system: a unique focus amongst similar national initiatives. The sub-programmes which were subsequently developed within this programme differ considerably, as does the way the Foundation works with them.

4.2 Industrial Research School Programme

During the background preparation work described above, it had emerged that though many firms (though not generally in primary sector industries such as the forest, food, or steel sectors) felt a need for research-trained employees, they were not generally employing them. This was because they had found that it took an unacceptably long time for PhD-level graduates to adjust to working in industry; primary sector industries were especially reluctant to employ research-trained graduates. Consequently, the Foundation also studied models of industrially relevant research training found in other countries, such as Denmark, the UK, and France.

With the help of input from the Köf group, it was concluded that the Foundation could partially address the problem outlined above by supporting a new form of research training programme characterized by considerable industrial input and involvement. Graduates from such programmes would hopefully embark on industrial careers and be of immediate benefit to their companies.

In the summer of 1996, an invitation to apply for funding from the new Industrial Research School and Master’s Programme was sent to universities, industrial associations, and large firms. The stipulated criteria were that the projects should involve multi-actor collaboration, preferably be in interdisciplinary and emerging areas of science and technology, and be co-financed by industry. The Foundation received 260 notifications of interest, from which – after an arduous and time-consuming selection process – 90 were selected and invited to produce a more comprehensive application, which was to include details of firm interest. The bulk of these applications were for PhD-level training programmes; interest in the master’s degree arm of the Research School Programme was limited.

None of the applications received by the Foundation fitted the research school concept well enough to merit funding immediately. Rather, promising
embryos of industrial research schools were selected, and applicants developed these concepts further in a dialogue with the Foundation. This dialogue represented an iterative process, whereby applicants were helped to mould their idea to fit the KK’s research school concept, and the Foundation gradually developed a clearer vision of its particular research school concept through interacting with applicants.

Developing workable and comprehensive contracts was an integral part of the complex learning process of developing the research school concept. Contracts were the main mechanism by which the Foundation sought to achieve its vision for the selected projects. Writing contracts that covered the many eventualities and ensured appropriate firm involvement was a challenge for the Foundation, which until then had had limited experience of writing such contracts with universities.

The KK vision for its industrial research schools, which crystallized out of this process, was that the research schools were to be made up of a group of students that meets regularly, shares some joint activities, and has the opportunity to exchange ideas and experiences. This is perhaps the key way in which these research schools differ from other industrial PhD models. Further, the research schools were to: collaborate with universities, firms, and industrial research institutes (where appropriate); be co-financed by industry; be in a defined scientific or technological area; and offer training elements (e.g. project management) particularly attractive to industry. Ideally, research schools were also to foster network building amongst participating companies.

As applicants’ concepts matured and became well-suited to the programme, and mutually agreeable contracts were formulated, individual research schools received funding. The applied IT research school at Linköping University and the biotechnology research school at Karolinska Institutet were the first to do so.

The process of launching this sub-programme took much longer, and was more arduous, than the Foundation had envisaged. The latter had not for example foreseen the degree of interest in this funding, nor that dialogues with potential beneficiaries would be as drawn-out as they were. The process represented a time-consuming learning process for the Foundation as well as for the research school project leaders-to-be.

The geographical spread of the existing 13 research schools throughout the country, their spread across a number of industrial sectors, and across different types of institutions (universities, industrial research institutes,
one industrial association) is to some extent a chance outcome of the selection process outlined above (see Appendix B for a list of the research schools). In other respects, however, diversity amongst the existing research schools is partly a function of their age. As the Foundation has pointed out, the more recent research schools are more interdisciplinary, have more links with new universities and university colleges, and are more likely to be in new scientific fields, than those created at the start of the programme.

A total of SKr 390m was earmarked for use in the research school programme for the years 1997 and 1998; 71% of this had been spent by the end of 1998. By 1 January 2000, ten research school contracts had been signed (with 2-3 in the pipeline) (Appendix B). Section 4.2 of this chapter will analyse processes within these research schools from the perspective of the participants themselves.

4.3 Expert Training Programme

In the course of the preparation work for the knowledge exchange and industrial research school programmes described above, it emerged that even masters’ degrees were far too extensive forms of training to interest many firms. Firms required short, high-level courses for their employees on a more continuous basis. This evident need underpinned the development of the sub-programme initially called ‘Consortia for Capacity Building’. Central to this programme idea was the recognition that lifelong learning will become an ever more prominent feature of the economic landscape.

The key concept underlying the development of this sub-programme crystallized relatively early in its history. This was to encourage universities, university colleges, and industrial research institutes (where such existed) to collaborate in ‘consortia’ in the development of short courses, which from their inception were to be designed in relation to firm’s needs. The sub-programme began to take shape from early 1998, when the Foundation recruited two new members of staff with responsibility for developing it further.

Again, the Foundation undertook a major review and preparation exercise in the run-up to launching the renamed ‘Expert Training’ programme. In order to develop a clearer programme profile, the programme idea was discussed at workshops in Stockholm, Malmö and Umeå, to which universities, university colleges, industrial research institutes, firms, and industrial interest organizations were invited. Fewer firms attended than had been hoped, but industrial support and interest organizations did participate. A further project
was carried out to analyse which scientific, technological or other areas merited supporting in this way. This was done in conjunction with an extensive study carried out by the Swedish EU Program-kontoret,\textsuperscript{19} in which many firms were interviewed to identify their future skills needs. KK also sought the views of officials responsible for industry at the municipality \textit{(kommun)} level.

These exercises eventually resulted in the development of a number of programme criteria, and in the identification of some substantive areas. The key criteria which determine funding allocation have been defined as follows:

- Each ‘Expert Training’ project is to be national in extent, and develop and deliver courses at the master’s or doctoral level. These courses are to be developed in relation to firm needs and for the employees of SMEs. Firm relevance is to be assured through strong firm representation on the boards of the consortia.

- An area for development in the programme may be within a sector or transsectoral.

- Each course is to meet the needs of a group of firms. The courses are to be made up of short modules that may be taken separately or in blocks. Courses are to be accessible on the Internet and it should be possible to take them as distance learning.

- The Foundation’s funding is first and foremost to support the development of the courses and the promotion of relations with companies. Participating firms are responsible for the costs incurred through loss of worker time, for the costs of sending employees on courses, and are required to pay a participation fee. The activity should be self-financing after the six-year programme funding has ceased.

(KK-stiftelsen 14.4.99)

In practice, a fifth criterion is added to these four when selecting projects: that the project should be in an innovative area, rather than merely adding volume to existing efforts (and further, that no similar courses should exist anywhere on the market). This criterion is evident in the combinations within existing projects, which for example, pair up electronics and mechanics, and food and biotechnology.

In short, the twin long-term aims of the programme are the promotion of economic growth and the creation of lasting networks between old and new universities, research institutes and firms. The medium through which these are to be achieved is by linking these latter organizations in consortia that are then responsible for the content and delivery of high-level courses for industry. Firms benefiting from such courses should in turn become more competitive.

\textsuperscript{19} The Swedish EU Program-kontoret is an EU body set up in 1995 to support development projects in the areas of education and capacity building.
Once a substantive area has been identified, and the KK board has approved a funding frame of SKr 50m-60m to develop the project, a temporary group of experts is recruited to oversee the development of each area. These groups are mainly made up of industry representatives active within the area concerned; their tasks are to conduct an analysis of the training and skills needs of firms, and to participate in the selection of programme beneficiaries. Partly perhaps because of these groups’ close involvement with the development of the projects, the Köf (now SAM) group appears to have played less of a role in the development of this programme than in the research school programme.

The KK board indicated that the first project in the programme should be in an area of IT. Consequently, during the spring of 1998, the Swedish Institute for Systems Development (SISU) was asked to identify promising areas in which to develop such a programme. Embedded Systems, a modified version of one of SISU’s suggestions, was adopted, and thus became the first project within this programme.

The Foundation interviewed 200 firms to map demand in the area of embedded systems. It then informed universities and other education providers of the needs the courses were to fulfil, and the project criteria, inviting them to submit notifications of interest. Approximately twenty such notifications were received, and those that seemed most promising were invited to a hearing in order to explain their plans further. At the hearing, emphasis was placed on how candidates planned to work with SMEs, and on their prior experience with distance learning. With the help of the appointed expert group, four or five candidates were selected from those invited. Of these, the candidates who wanted to be nodes of the consortium entered into a dialogue with the expert group in order to produce a programme proposal. The completed proposal was then presented to the Köf group and the KK board.

Mälardalen University and the industrial research institute ACREO (Advanced Centre for Research in Electronics and Optics) are the coordinators of the Embedded Systems consortium. Other members are Jönköping University, Halmstad University and Luleå University of Technology. Thus, as with the research schools, programme participants are distributed throughout the country. Activity within this consortium began in the autumn of 2000.
When selecting areas for this programme, there has been a conscious desire to ensure a spread of projects across sectors. At the time of writing, two other areas, Food and Biotechnology and Strategic Business Development, had been launched as projects, with contracts and boards, though only Embedded Systems had reached the stage of developing courses. A number of other areas are currently being developed within the programme. These include Experience Industry and Product Development.

The Food and Biotechnology consortium is coordinated by SLU (Swedish University of Agriculture) and SIK (the Swedish Institute for Food and Biotechnology); other members are Kalmar University, Lund University, and Umeå University. Over 10 notifications of interest were received for this programme, fewer than in the Embedded Systems programme, and as a member of the Foundation staff pointed out, this may reflect the smaller number of new universities involved in food and biotechnology research and teaching.

The third area, Strategic Business Development, has been launched on a trial basis in Sweden’s six most southerly counties, with SKr 20m over 20 months. The coordinator is Jönköping University; other members are Umeå University, Göteborg University with Chalmers University of Technology, and Lund University. If successful, the programme will be scaled up. The hesitancy in launching this as a national programme partially reflects the ill-defined nature of the area. Three sub-areas have however so far been identified within this programme: analysing and monitoring the surrounding business world; management for change; and working in alliances/networks.

The Experience Industry area is still at the preparation stage. The Foundation carried out an extensive mapping of the area, identifying 17 sub-areas. These span conventional and more modern forms of ‘experience’ and entertainment, as is evident in examples such as the music industry, film, theatre, and fashion design, as well as computer games and edutainment. Training and skills needs within the sector are currently being mapped.

The area Product Development is at a comparatively early stage of development. It is directed at the manufacturing sector; manufacturing firms’ need for training and collaboration with universities in this area is induced by the economic pressure on firms to produce ever more sophisticated products ever more quickly. To remain competitive, firms can no longer afford to leave product development to trial and error, but need to develop rational systems for their innovative activity.
Experiences

An initial challenge for this sub-programme may be to attract large numbers of SMEs. The Foundation is however employing specific tactics to get such firms interested in the programme at an early stage. These include persuading a perhaps recently retired, trusted individual with a background in an SME to act as a door opener or figurehead. Another way SMEs can be attracted to the programme is through workshops at which clear success stories are demonstrated. However, experience has shown that in order to secure their participation at seminars and workshops, it helps to use key ‘buzz-words’ in the seminar title. For example, a general seminar about the Embedded Systems Programme attracted roughly 20 SMEs, whilst one about Blue Tooth technology attracted approximately 100. It is only to be expected that the process of building networks with the SMEs will take time.

Being the first active consortium, the Embedded Systems project has experienced a longer than expected and arduous start-up phase. The complexity of implementing this project on the ground is compounded by the involvement of five actors in different parts of the country, and it has been difficult for the project leaders to follow the agreed plan. Further, as one project leader in the Expert Training programme observed, the Foundation is itself undergoing a considerable learning process at this stage in programme implementation. Symptomatic of this is that ‘many things [in my project] have had to be reconsidered in retrospect’ (project leader: Expert Training). Such changes, which according to the project leader, included changes to the programme name, the IT strategy, and points in the contract, can contribute to programme delay.

4.4 Collaboration between new university colleges and industry

The origins of the sub-programme ‘Collaboration between new university colleges and industry’ (which for the sake of simplicity will here be referred to as the KK-NUTEK programme) lie in a government initiative to foster ‘third-

---

20 At the time of writing, nine responses had been received from a short questionnaire sent out to 26 project leaders in the three sub-programmes Expert Training, New forms of knowledge exchange between SMEs and universities in networks, and Collaboration between new university colleges and industry. These nine responses are drawn on to a limited extent here and in the next two sections on the other sub-programmes. It should be noted however, that the responses received so far may not be entirely representative of this population of project leaders. An analysis of the results of this questionnaire will be presented in the Spring of 2001, once more responses have been received.
mission’ work at universities. The programme was initially funded at SKr 60m and administered by NUTEK. The KK Foundation suggested that it could adopt the programme, as it fitted the Foundation’s profile; however, NUTEK’s share of the programme funding could not be transferred elsewhere, and thus the programme became a joint responsibility, with 60 Million from each of the funding bodies.

The programme is designed to help the new universities and university colleges establish closer relations with firms, especially SMEs. More specifically, the programme aims to encourage the new universities to develop new concepts in fulfilment of this aim. The hope is that this will improve their ability to meet industry’s needs for knowledge and expertise (KK-stiftelsen, 26.5.2000).

To prevent fragmentation in the programme, one programme coordinator, working 80% at NUTEK and 20% at the Foundation, is responsible for administering the programme. Further, the programme is implemented through a joint NUTEK-KK working group which for example participated in project selection.

This programme differs from the others in the knowledge exchange programme, in that all the new universities and university colleges were individually invited to apply for funding. The invitation came with explicit instructions that the new universities or university colleges could apply for the funds to build up their organization’s network with firms in the region. According to the Foundation, their various ideas around this theme were very different. There are approximately 19 contracts within this sub-programme, all dated August 1998. NUTEK has been responsible for the first SKr 60m of programme funding, with KK funding the last two years of the programme at the same level.

According to the small number of questionnaire responses from project leaders in this sub-programme (see footnote 20), the establishment of projects appears to have been relatively smooth. One project leader pointed out the value of a programme funding university ‘third mission’ tasks, which generally lack funding. These KK funds had given him the opportunity of working with very small firms, and facilitating their cooperation with a new university. Another project leader, however, was concerned that the seeds sewn by his technology transfer project might die with the funding. He suggested that KK and NUTEK needed to address this question.

---

21 See table in UCER (2000)
Project implementation has naturally not been entirely problem free. A project leader based in a university technology transfer office stressed that a far-sighted approach combined with patience are necessary attributes when working across the academic industry divide: things inevitably take much longer than planned, with drawn-out decision-making a feature of the academic world and firms not always easy to work with either. Another project leader indicated that he felt that NUTEK and KK’s monitoring routines were ad hoc: he had written at least three project reports in 2000, which he regarded as excessive. A small number of project leaders in the research school programme also indicated that the Foundation’s routines for monitoring projects lacked clarity.

4.5 New forms of knowledge exchange between SMEs and universities in networks

During the information gathering exercise that paved the way for the launch of the knowledge exchange programme, it had emerged that SMEs often had no contact with the university sector, and that only a small proportion had graduates amongst their staff. This observation, together with a reluctance to over-burden SMEs with new programme initiatives, provided the impetus for the Foundation to seek links with an existing technology diffusion programme, again administered by NUTEK. Thus, like the KK-NUTEK programme, this programme also originated in a NUTEK initiative, though in this case the Foundation gained sole responsibility for the programme.

The stated long-term aim of this programme (referred to here simply as New forms of knowledge exchange) was to increase the number of employees with university degrees in SMEs. The more immediate aim was to stimulate a group of SMEs, which had not previously had contact with the university sector, to seek such contact, and to learn that they could benefit from cultivating university relations. Within the terms of the programme, participating firms were encouraged to create networks amongst themselves and with universities; they were able to identify a problem that a university could help them with, and nominate a project leader to mediate the relationship with the university.

This sub-programme took the form of a trial, or pilot project for the Foundation. The latter was keen to use the programme to learn more about how SMEs with no links to the university world, work and think, and how a programme such as this could benefit firms. The Foundation has reported
that it did indeed benefit by learning from this project, and that in certain cases, participating firms were stimulated by the discovery that university links could open up new possibilities for them.

Seven firm-networks were funded in this programme in 1996, -97 and –98. However, as this was a trial programme, and as the Foundation prefers to work at the master’s degree level of expertise and upwards, the programme will not be continued. A small amount of money is however kept in the programme budget for small, miscellaneous, largely trial interventions.

As with the KK-NUTEK sub-programme, the small number of questionnaire responses indicate that in the main, project leaders in this programme felt that their projects functioned well. Though again like the KK-NUTEK programme, implementation has not been entirely without its problems. Thus, echoing one of the project leaders in the KK-NUTEK programme, a project leader from a small firm illustrated the difficulties that can arise when collaborating with a different work culture. He complained that his university collaborators initiated far too many meetings both at the beginning and during the project. He added:

Representatives from universities are incapable of carrying out and completing projects in a professional way. They don’t follow the agreed project plan, or the decisions that are taken along the way. Unfortunately this results in annoying ‘dilly-dallying’ and wasting resources. (…)

(Project leader in sub-programme New forms of knowledge exchange)

Another project leader expressed a desire for more personal contact and advice from Foundation staff, but had had some difficulty contacting them.

4.6 The Forestry Industry Programme

This programme originated in a state initiative, when the former director of the Foundation was commissioned to develop a Forestry Industry programme with industry involvement. The programme has several partners, and aside from KK, is co-financed by the Department of Industry, NUTEK, and some big companies. This sub-programme’s profile towards a specific sector (rather than a form of collaboration) is somewhat at odds with the rest of the knowledge exchange programme. Its place within this programme appears to be based on administrative convenience rather than clear programme logic. Three contracts have been signed within this sub-programme.

---

4.7 Summary observations

By the end of 1999 (the first 3-3½ years of the five-year knowledge exchange programme), 271 million (or 25%) of KK’s total allocation to the programme (of SKr 1.1 billion) had been spent (KK-stiftelsen 1999b p.81). This suggests that programme implementation has been slower than anticipated, though most of the (albeit small number of) project leader respondents referred to in this section (4.1) felt their projects were functioning well and in line with intentions.

Reasons for the slower than expected implementation to some extent lie in the Foundation’s ambition to encourage structural change. Not only did the Foundation need to develop new criteria and rules, but the restructuring rationale needed to be understood by the actors drawn into the sub-programmes. The KK programme concepts are challenging to get off the ground; for example, finding industrial co-financing can be a particularly time-consuming process for university actors. The trial and error approach to programme development (as evident in this section) is also conducive to a slow start.

A further reason for the slower than expected implementation may lie in the relatively low staffing level at the Foundation. The KK staff has grown as the Foundation’s activities have grown, but the Foundation might even so appear under-staffed at times. Staffing changes (in the Foundation and in sub-programmes themselves) have also slowed progress, as mutual rapport established in earlier negotiations needs then to be re-established.

The Foundation is now entering a new phase in its development. It has initiated a host of new projects in its short history, and as its activity is growing, so its role is shifting from that of an initiator to a more managerial role. The Foundation is now facing the challenge of devising administrative routines for monitoring its large stock of projects. The growth of activity is also reflected in organizational changes within the Foundation. No single individual has overall responsibility for the knowledge exchange programme alone any longer, the programme being managed at the sub-programme level. The managing director has overall responsibility for all programmes. Whilst this managerial structure reflects an ambition to encourage greater integration and synergies between programme areas, it may also undermine the development of a holistic perspective on the knowledge exchange programme itself.
5 PROCESSES WITHIN INDUSTRIAL RESEARCH SCHOOLS (I): PARTICIPANTS’ EXPERIENCES

This chapter describes processes within the industrial research school programme from the perspectives of groups of participants. Section 4.2.1 describes the process of establishing the research schools from the perspective of project leaders, whilst section 4.2.2 outlines various groups’ experiences within the sub-programme. These two sections draw heavily on Schild and Hanberger (2000, Chapters 4 and 5 respectively), where more detailed analyses can be found. The final section 4.2.3 provides some observations on learning and collaboration in the research schools.

5.1 Establishing the research schools

On the basis of empirical material gathered mainly from research school project leaders, three stages of the establishment of the research schools have been identified: Negotiating contracts (stage 1); Enrolling partners (stage 2); and finally, Consolidating collaboration (stage 3). It is important to note that these stages are not meant to represent a linear process, rather they serve the heuristic purpose of structuring a description of the implementation process (Schild and Hanberger 2000, Chapter 4).

The Negotiation stage (stage 1) begins with the iterative process of applying to the KK Foundation and ends with signing a research school contract. Activities for project leaders and other initiators included courting the interest of industrial partners and negotiating contracts. Stage 2, Enrolling partners, begins when the contract with the Foundation has been signed, and ends when the research school is running more or less at full student capacity. This stage is characterized by the diverse range of parallel activities entailed in getting the research school up and running. These included enrolling research school participants (the board, industrial sponsors, students and supervisors), the iterative and collective process of linking various actors with appropriate roles within the research school, and distributing available material resources accordingly. During stage 3, Consolidating collaboration, the research schools are working more or less at full capacity. They are beginning to stabilize as identifiable, though heterogeneous (and often geographically dispersed) collectives. Activity is focused on developing stable and workable forms of collaboration.

Mapping the twelve research schools onto these three stages indicated that they have reached different points of development, which is of course to be
expected since they started at different points in time. They largely, though not invariably, followed the expected pattern whereby the earlier research schools have progressed the furthest. The research schools did however differ in the amount of time taken to proceed through the various stages, reflecting differences in the factors affecting implementation, and the kinds of obstacles they faced.

During stage 1 Negotiating contracts, research schools which could draw on existing networks, or re-activate old ones, appeared to be able to proceed at a faster rate than those which had to build entirely new networks. This variation was closely associated with whether the host organization had a tradition of working across the academic-industry divide.

During the stages Negotiating contracts and Enrolling partners, an important factor affecting implementation was the difficulty of engaging firms and convincing them of the value of investing in a research student. Attracting firms was difficult for many reasons. First, firms which showed initial interest, were at times subsequently unwilling to invest in the research school, either because they found they were unable to allocate staff time to PhD training, or because the individual in the firm who had expressed interest had changed roles in the firm, or moved elsewhere. Second, firms which were approached did not always perceive the scientific or technological focus of the research school as sufficiently central to their key business areas to merit a unilateral investment. Third, the pool of potential companies was at times somewhat small. Fourth, the necessary investment (SKr 1,600,000 for a research student over four years) was considered a major commitment, especially by SMEs. For these reasons, many research schools spent much time building the trust of firms and convincing them of the benefits of participating in the programme.

Some research schools also experienced difficulty recruiting students during the stage Enrolling partners. To some extent this reflected a lack of student demand, though it was also associated with the difficulty of recruiting firms. In many cases, students could not be recruited before firms, as the latter often participated in defining the project and in recruiting or at least sanctioning the recruitment of the student. Further, as mentioned above, firms at times found at the last moment that they were unable to release staff for doctoral training.

During the later stages of implementation – especially during Consolida\nting collaboration – problems relating to collaboration came to the fore. Research schools’ attempts to find workable forms of interaction and collaboration were sometimes hampered by company changes (e.g. mergers, failures,
changed business strategies). Further, quite apart from such unexpected events, effort was required on both sides for the collaboration to function smoothly. Small, mid and low-tech firms in particular were not always used to being involved in research, and at times needed help to understand the nature of the research process. Collaborations pre-dating the research school, and which were reactivated in the context of the research school, appeared easier to make effective than entirely new collaborations. This may partly explain why a substantial proportion of the collaborations in this sub-programme are based on pre-existing relations.

Enrolling and collaborating with academic partners were less arduous tasks for research schools than enrolling industrial partners. This is of course to be expected, since the financial stakes are much lower for academic partners (who are not required to co-finance a student), and since the majority of host organizations are themselves academic institutions used to collaborating within academia. The data do however contain two instances of intra-university departmental collaboration which did not appear to function in line with research school objectives.

In short, whilst some research schools have reached far with relatively little effort, others have put in much hard work without advancing as far as they or the Foundation had hoped. By 1 January 2000, 88 students had been enrolled in the industrial research schools, 58% of contracted capacity (see Schild and Hanberger 2000 p.25). Some of the explanations for why this figure is not higher are given above.

5.2 Participants’ experiences

The theme permeating this sub-section is that participants’ motives for joining the programme (see pp.20 ff.) steer their participation and thus experiences within it. This is evident in the way different motives within participant groups (especially academic supervisors and firms) are apparent in within-group differences in how participants manage their programme participation, and derive experiences accordingly.

Project leaders’ experiences

The majority of project leaders reported that their research school was being implemented in line with the Foundation’s original intentions. Amongst the problems mentioned by them, the most commonly expressed was the difficulty of recruiting firms as co-funders. This had generally proved more time consuming than expected, in turn delaying the recruitment of students.
Other problems mentioned were a (perceived) lack of resources for joint research school activities, and a dissatisfaction with the clarity of the Foundation’s reporting requirements. Two project leaders were for example concerned that their KK funding did not cover all the administrative and other overhead costs; one of them reported that he was making up the shortfall through unpaid overtime and money transferred from other projects.

As earlier sections of this chapter illustrated, the knowledge exchange programme has evolved to its present form, partly as a result of learning processes within the Foundation. Consequent changes of emphases in research school guidelines at times left project leaders uncertain about aspects of project management. There was thus no consensus amongst project leaders on such issues as whether students were to be admitted as a cohort, the extent to which the research school was to be a collective entity, whether the Foundation allowed funding concessions to small firms, and whether industrial research institutes were eligible to co-fund research students.

Changes in research school guidelines were particularly apparent to some of the project leaders based in industrial research institutes. This was because the first three of the four research schools hosted by research institutes (p.97) were initiated as part of the KK’s efforts to revitalize the institutes, rather than in the explicit context of the knowledge exchange programme (see p.21). Consequently, these research schools serve a different purpose to, and started out with somewhat different ground rules from, those hosted by universities and established later.

*Academic supervisors’ participation*

The different motives characterizing the two groups of academic supervisors identified on p.21 were reproduced in the groups’ different ways of managing their participation. Those primarily concerned with the student project’s scientific contribution, reported that supervising these students was more work intensive than usual, largely because the latter had different backgrounds from conventional students; some amongst this group of supervisors suggested that students recruited by sponsoring firms were not always the best qualified to enter research training. Generally, this group of supervisors was sensitive to any perceived compromise in the quality of the student’s research resulting from the partner firm’s interference. They thus expressed concern in cases where firms attempted to exert tight control over the project, particularly when the firm was not able to offer the student much if any supervision. In such cases they attempted to shield their own activities and their student’s project from what they regarded as unacceptable firm intrusion.
Supervisors particularly interested in the industrial application of the student project, were on the whole more tolerant of firm involvement, and were more ready to collaborate with the company over the direction of the project. Both groups of academic supervisors reported the need to initiate students from research institutes and firms into the academic world and way of thinking.

Firms’ programme participation

Reflecting their different motives for joining the programme, firms varied in how they managed their participation in the programme. These ‘management’ issues related to the intensity of the firm’s involvement, and included: involvement in, and method of, student recruitment; whether the firm employed the student during his or her doctoral studies; and the degree of involvement in defining the student’s research topic, and in the project itself.

In cases where the firm was primarily interested in deriving direct benefit from the results of the project per se (see p.21), and the project was thus closely related to the firm’s core activities, firms generally attempted to maintain relatively tight control over the research project. This was particularly evident in traditional process industries (e.g. food, chemicals and mining). Some of these companies preferred their research students to be based in the company for a significant proportion of their doctoral studies. This was to give students the opportunity to gain familiarity with the process or product, and to get to know longer-serving staff (for example in production divisions). Such a policy might also increase the chances that the student would choose to stay in the company after completing his or her degree.

A second group of firms, largely in the biotechnology and biomedical sector, sponsored the research student primarily as a way of outsourcing and cutting

23 According to data collected from the ten research schools that had contracts by 1 January 2000, 76 firms were participating in the research school programme by that date, of which 35 were SMEs (see Schild and Hanberger 2000 p.29). The majority of these firms had cooperated with the university sector prior to entering the research school programme. This description of firms’ participation in the programme is based on 18 interviews with firm supervisors or mentors, and the electronic questionnaire sent to all firm supervisors. The 18 interview respondents represent nine research schools, and are distributed between large firms (8 respondents) and SMEs (10 respondents). The electronic questionnaire had a 66% response rate (see p.9).
risks in explorative research. Organizing a university project in this way was an experiment made possible by the 50% KK contribution to the research school; without this additional funding, these firms would likely have contracted out the research to an established university research group. Firms in this group appeared less concerned about the value of their investment than the group described above. Some for example, preferred to keep the project at arm’s length, in the belief that scientific quality could best be assured by the collaborating university. Whilst the process companies referred to above were prepared to cut short a project that was not yielding the desired results, biomedical companies generally espoused a broader notion of success, for example acknowledging the project’s value in terms of research training.

Students’ experiences

Interviews with students revealed that they experienced working in two very different environments simultaneously, in different ways, and that this was broadly related to the nature of the collaborative relationship between university and firm supervisors. Where the collaboration between the latter worked smoothly, students generally only saw the benefits of being linked to a firm and a university department. Where there was a lack of dialogue between academic supervisors and industry mentors, students at times felt that their programme of study and research lacked coherence, and that this was having a negative impact on their progress. Interviews revealed instances of quite fundamental disagreements between university and firm supervisors over the direction of the student’s work. In one case, a dispute arose over access to intellectual property, forcing the student to take sides.

The questionnaire responses showed that as a whole, students were slightly more likely to feel integrated into their cooperating firm than their university department. This should doubtless be understood in the light of their predominantly industrial backgrounds. They were however relatively more satisfied with their university-based than their firm-based supervision; the level of dissatisfaction with firm-based supervision was approximately 30%.

These research students appeared to have a heavier work load than students following more conventional programmes of study, as they were generally expected to spend time in the firm, facilitate knowledge transfer to the firm, and perform as well academically as an ordinary research student. Further, in cases where students’ firms and academic departments were in different parts of the country, travel could be time-consuming and organization complicated. Some of these observations suggest that these students may need more time to complete a doctorate than students without affiliation to a firm. Certainly
supervision must be effective if they are to complete their degrees in the allotted time.
6 PROCESSES WITHIN INDUSTRIAL RESEARCH SCHOOLS (2): COLLaboration

This chapter is largely, though not exclusively, based on interviews conducted with 21 firm representatives (contact persons or mentors and managing directors) involved in the research school programme. These 21 interviewees represent 18 firms and nine KK research schools; and these 18 firms in turn represent a range of sizes and industries. The perspective adopted in this chapter then, is largely (though not wholly) that of firms.24

6.1 Characterizing research school collaboration

Two forms or levels of collaboration in the research schools can be identified, each of which serves a different purpose and is motivated by different interests on the part of those involved.25 The first of these, here labelled project-based collaboration, is characterized by research school actors collaborating ‘over’ student projects. The student project brings together a specific firm and a specific university group or individual supervisor; the project forms the focus of the collaboration and shapes the dynamics of collaboration in various ways. This form of collaboration can be thought of as instrumental (serving a specific purpose) and is normally anticipated by the partners involved.

The defining characteristic of the second form of collaboration, here labelled beyond project-based collaboration, is that it transcends the student project and involves a wider set of partners than those immediately involved in the research project. This form of collaboration is characterized by looser collaborative relationships amongst a broader set of actors within and perhaps across and beyond research schools. The focus of these collaborations varies. Collaborative activity may for example be loosely centred on the research school itself, or it may not have a clearly defined focus, its existence serving largely to incubate a relationship that may serve a useful purpose in the future. The origins of these collaborations may be traced to the research project itself, or they may lie in broader contacts made through participating in the research school. In contrast to ‘project-based’ collaborations, these collaborations may

24 Note that the views of firm contact persons and firm supervisors or mentors do not necessarily reflect those of the company as a whole.

25 There are of course other ways of classifying types of collaboration than the categorization offered below. For example, collaborations between firms and industrial research institutes are driven by different motives and characterized by different dynamics than those between firms and universities. This specific point is developed in this chapter in the section on ‘beyond project-based’ collaboration (see p.63 ff.).
not have been anticipated by actors when they joined the research school programme.

Any single firm participating in a research school will have its own unique set of motives for doing so (see p.21 ff.). This specific set of motives will determine which of these two forms of collaboration is most apparent in the firm’s mode of interacting within the research school. A firm which joins the research school primarily in order to benefit from the results of a specific research project will most likely engage in collaborative activity similar to that of the first type outlined above. A firm primarily seeing the research school as a route, or entry point, to something else (e.g. other academic networks), will likely engage in the second kind of collaborative activity outlined above.

These two broad categories of motive tended to vary by type of firm, and thus by research school (since, with significant exceptions, a research school will naturally tend to recruit firms similar in size and sector). Of course, a firm will often have a mix of motives for joining the research school. Reflecting this, a firm’s collaborative activity in the research school will encompass a mixture of the two types of collaboration, though one may be more evident than the other.

Within the two broad categories of collaboration outlined above, various subclassifications can naturally be made. For example, the intensity with which a group of partners collaborated differed, as did the degree of formality in partners’ interactions. In other words, any project or research school can be described as more or less intensely collaborative, and these collaborative interactions more or less formally organized. The way partners manage a collaboration is partly determined by the significance partners’ attach to the collaborative goal, as well as by the nature of the collaborative goal itself. For example, firms varied greatly in the degree of responsibility they seemed to feel for the student project and for the smooth-running of the research school as whole, differences which are reflected in different collaborative dynamics.

The following section outlines how the dimensions of intensity and degree of formality can be used to characterize the ‘collaborativeness’ of the project-based collaborations. More specifically, the section outlines the main differences between ‘high-intensity’ and ‘low-intensity’ project-based collaborations, each of which has different implications for knowledge transfer and firm learning.

---

26 ‘Intensity’ refers here to both the frequency and quality of interaction. Any one partner may experience a collaboration as more or less intense, depending on the proportion of that partner’s time and energy which is devoted to the collaborative activities.
6.2 Project-based collaboration and knowledge transfer

The previous chapter described how firms managed their programme participation in different ways (see p.41); for example, they varied in the degree to which they helped define the student topic, in the degree to which they contributed to the development and progress of the project, and in the degree to which they treated students as employees. The way firms manage their programme participation has implications for the nature of their collaborative relationships within projects, and reflects differences in the way firms interpret their responsibility for the student project, as well as their different expectations of the project. In other words, firms’ different approaches to project-based collaboration are in large part rooted in differences in the degree and type of responsibility the firm felt it had for the project, as well as in firms’ differing expectations of the project.

Similarly, the different ways in which individual firms chose to organize their participation in project-based collaboration, can also be traced to their differing actual and perceived needs for information on, and for knowledge derived from, the ongoing project. Firms’ different (understandings of their) information and knowledge needs naturally informed their preferences for particular modes of knowledge feedback from academia to the firm. And firms organized their collaborative interactions accordingly.

Implicit in the above lies the observation that the mode and quality of knowledge transfer taking place between academia and the firm is inextricably bound up with the nature and intensity of the firm’s involvement in the collaboration. The more significant a firm perceives the project knowledge to be, the more the firm is likely to devote time to devising ways of facilitating knowledge transfer into the firm, and the more the firm is likely to engage intensely in the project collaboration (in order, for example, to closely monitor project progress and results). Reflecting firms’ different attitudes to the significance of the knowledge emanating from the student project, not all firms appeared to have thought out how to facilitate the transfer of this knowledge from the project, but most were aware of the need to do so.

---

27 The significance attributed by a firm to the student project was often related to the relationship between the subject of the student project and the firm’s core activity.
High-intensity project-based collaboration

This type of project-based collaboration is characterized by the relatively tight control exerted by the firm over the student project, and by the firm’s active approach to fostering close relations with the student and the student’s academic environment, particularly his or her academic supervisor.

Amongst the 18 companies interviewed, those choosing to adopt such an active approach towards the collaborations, were almost without exception in traditional process-based industries, belonging typically to the KIF, Luleå, and (to a lesser extent) SIK research schools (the chemical industry, mining and minerals, and food and biotechnology respectively). These firms are not in general research intensive, nor are they as familiar with the nature of academic research as some of the more high-tech companies participating in the research school programme. The firms adopting this approach to collaboration typically joined the research school primarily in order to obtain project results that could contribute to solving a relatively specific problem defined by the firm. Naturally therefore, the projects conducted by the students sponsored by these firms were often closely and directly connected to an area of the firm’s core activity.

The high premium these firms placed on the project results themselves is central to understanding their approach to project-based collaboration. Their necessarily strong proprietorial attitude towards the project and the resulting knowledge was for example evident in the way they tailored their collaborative interaction to serve the twin purposes of close project monitoring and continuous knowledge feedback. In short, the dynamics of these companies’ collaborations reflected their need to (metaphorically and actually) ‘own’ the project; firms generally made significant efforts to keep control of the project and guide its development. Enumerated below are some of the ways they sought to do this.

In line with their relatively specific knowledge needs, these firms generally insisted on playing a central role in deciding on the precise topic and emphasis of the student’s research project. However, for the project to be successful, it needed to be of scientific interest to the university supervisor, as well as of practical use to the company. The two sides needed to reach a mutual understanding of the aim of the project. Reconciling university and firm interests and understandings in one project was not always a straightforward process, and

---

28 See Appendix B p.97, for a list of the research schools and their research areas.
initial failure to do so was at times the source of some friction between collaborators.

In one case, friction between a company and its collaborating university department surfaced when the university supervisor left the department. The incoming professor insisted on changing the project’s emphasis to accord more with his own research experience. The firm was not satisfied with the new emphasis, and no agreement on the project’s new direction could be reached. This conflict was only solved when the student asked for help from a researcher in another department who was familiar with the company. This researcher developed the framework of a new project which successfully reconciled his own interests with those of the new professor and the firm, and he subsequently became the student’s second academic supervisor. The conflict was thus solved, having caused significant delay and anxiety for the student.

In a second case, progress in the project was again marred by seemingly intractable differences between the company and the university supervisor over the purpose and appropriate direction of the project. The university supervisor’s prime concern was that the project should be of the highest scientific quality. In his view, this quality was being compromised by the firm’s more utilitarian ambitions. This basic clash of interests expressed itself in a low-level undercurrent of dissatisfaction on both sides. For its part, the firm felt it needed to be on its guard lest the project ‘turn into complicated modelling’, whilst the university supervisor felt the firm did not appreciate the nature of the research process. This conflict was more drawn-out and less overt than that described above, and perhaps all the more harmful to student progress.

As mentioned above, the projects which these firms were sponsoring through the research school were often of considerable strategic significance to the company. Students and their academic supervisor(s) thus had access to company secrets of key economic importance to the firm. The smooth-functioning of these collaborations depended on the academic supervisor’s and student’s ability to perform the difficult balancing act of conducting quality applied research of direct use to the company, whilst keeping any sensitive information about the company’s products and processes tightly under wraps. Naturally, the firms expected their collaborating academics to cede any

29 In order to protect respondents’ identities, interview quotes are not attributed, and the gender of respondents is concealed by a random use of masculine and feminine pronouns.
knowledge ownership interests and commercial aspirations they may otherwise have harboured.

Firms defended their commercial interests by insisting that their collaborators sign confidentiality agreements. The success of the collaborations depended on the goodwill of academic partners in adhering to both the spirit and the letter of the agreement. However, keeping to the terms of a confidentiality agreement could be problematic for the academics. This was because they often interacted and shared projects with a relatively large and heterogeneous group of researchers and companies in the course of their daily work. The academic would therefore find it virtually impossible to discriminate between the various sources of his/her own active stock of professional expertise.

A particularly clear case of mistrust between a collaborating firm and academic supervisor arose when the firm became suspicious that the academic was infringing the firm’s intellectual property rights. The firm supervisor accused the university academic of ‘regarding our project as his own’, explaining that ‘he meets our competitors’. The firm’s interpretation of the situation was that the academic did not appreciate the subtle but crucial boundary between private and public knowledge, ‘he doesn’t understand industry’ (though an alternative interpretation may be that the academic understood industry too well for the firm’s comfort). In this case, the company supervisor plainly felt he had grounds for doubting his academic counterpart’s intentions, even morality, and the issue was taken up at the highest level in the company. At the time of these interviews, the collaboration appeared to be breaking down irreversibly. It was again the student who bore the brunt of the conflict, and as the collaboration crumbled, he had to decide whether to continue working with the company or with his academic supervisor (he chose the latter). This case highlights the importance of the projects to these firms.

These companies employ both formal and more informal means to maintain control of their projects and collaborations, and to ensure the continuous feedback of findings into the company. Among the formal ways firms achieved these tasks, conventional means, such as regular meetings and reports, featured strongly. Examples mentioned by firms included: holding regular meetings in the company to discuss the results, conclusions and future of the project; requiring the research student to write a report every three months; and fostering stronger contact with the university supervisor through the research student and the board of the research school. Some of these companies had also developed formalized routines for spreading the project knowledge within the firm. Thus one firm supervisor, based in the R&D department of a
sugar company, instituted channels to give regular project feedback to various development forums in the firm. And when the project delivered an interesting finding he invited a representative from the marketing department to the meetings. In the case of a mining company with a well thought out procedure for internal technology transfer, the individual developing the new method in the R&D department was responsible for ensuring that the production department had understood the implications of the new knowledge.

However, the bedrock of collaborative interaction took place more informally, according to conditions laid down by the companies. Uniting these firms’ approaches to managing the project, the collaboration, and the knowledge feedback, was their practice of encouraging the research student to integrate into the firm. To achieve this integration, these firms were keen for the student to be present in the company as much as possible; as one reported, ‘We want her here and not at the university’. Beyond requiring the student’s physical presence, these companies had also thought out how to introduce the student into the workplace and how to help him or her get to know the staff and their activities.

Firms gave a number of concrete examples of how they helped students integrate. Two companies for example encouraged their students to spend some time working on the production factory floor. This not only served to enlighten students on how the firm worked, but was also designed to encourage them to interact with production workers, hopefully with mutual benefits. More than one student reported that they had garnered information from production workers that was invaluable to their research, more valuable in fact than what they could learn from their official firm mentors. The companies were keen to treat their students as employees, and were concerned that the students should seen as normal employees by other company workers. They thus encouraged their students to mix generally with the firm staff. One company encouraged its students to begin their time at the company by interviewing the firm’s employees about their jobs. Another company sought both to harness the student’s knowledge and to break down barriers between groups of employees by asking the student to teach sales staff about the new process she was working on.

There are several reasons why these firms emphasized the importance of integrating the student into the firm. An important motive was the desire to imbue the student with a sense of loyalty for the company; a related motive was the hope that the student would choose to work for the company after graduating. As a representative of one of the companies pointed out, ‘It’s up
to us to offer the students as good conditions as we can, so they stay’, (he also intimated that the policy of encouraging students to live in the town in question certainly did not diminish the chance that they would find a partner there). Further, firms were keen for the students to get to know the firm’s products and processes, and to gain insight into the reality behind the more abstract problems they were working on; this would, in the view of firms, enhance the quality of the student’s work and facilitate collaboration over the project. Finally, and perhaps most importantly, these companies’ desire to integrate their students seemed to be associated with a particular understanding of knowledge as being inseparable from knower. Integrating students into the company was thus both a means of facilitating effective knowledge transfer from the project into the company, and a means of maintaining some kind of control over the literal embodiment of that knowledge. As one company representative pointed out, ‘The person is the most important, a report is a report’.

Low-intensity project-based collaboration

This second main type of project-based collaboration is characterized by firms’ hands-off approach to the collaborative project. Whether by design or default, this looser approach to collaborative project management by firms generally resulted in university partners (including students) playing a more proactive role in the collaboration, and enjoying greater autonomy within the project, than was the case in ‘high-intensity’ project-based collaborations.

A broader range of companies engaged in this form of collaboration for a broader range of reasons than was the case for the ‘high-intensity’ collaborations. The companies choosing to manage their collaborations in this way fell into two broad groups. The largest group is made up of research intensive companies working in an advanced area of technology, and belonging typically to the KI, Fenix, Linköping, and to some extent MARCHAL research schools (biotechnology, management, IT, and materials, respectively). These companies typically equal if not outstrip universities in their capacity for cutting edge research. They joined the research school programme for a variety of reasons; the opportunity it gave to out-source an explorative piece of research, or to strengthen relations with a key university department or academic featured strongly amongst them. The second (smaller) group of companies which engaged in this form of project-based collaboration is largely made up of firms in traditional industrial sectors, typically belonging to the Trätek and to some extent SIK research schools (wood industry, and food and biotechnology, respectively).
Both groups of firms left much of the responsibility of directing the collaborative project to university (or industrial research institute) partners, albeit for different reasons. Firms in the first group above certainly had the competence to take the lead in guiding the collaborative project. However, they generally classified their collaborative projects as exploratory and thus open-ended and not amenable to direction. They felt that university partners were best placed to secure the required research quality. In the case of the second group of more traditional companies, lack of research insight (and time) prevented them from overseeing the project work and concerning themselves with project details. In short, firms engaging in this form of collaboration were less concerned about the specifics of the collaborative project, preferring to leave academic supervisors to decide project details. Across both groups, the degree of actual firm engagement in the collaborative project varied from engaged and interested to disengaged and apparently uninterested.

Centrally important to understanding the dynamics of these collaborations was the loose coupling between the topic of the collaborative project itself and the firms’ core areas of activity. These projects were not in general directly related to the firms’ current products and processes, but provided a way of exploring possible future avenues for the company; some of the projects also served the symbolic role of enhancing a company’s image. Consequently, students and their academic supervisors did not access confidential company information to the same extent as in ‘high-intensity’ collaborations. Firms had consequently no need to keep a tight rein on the project. They generally considered it to be in own their interests to grant their academic partners the autonomy to pursue unforeseen, potentially significant, avenues of investigation.

This apparent laissez-faire attitude however masked the paramount importance to companies of capturing any economically significant intellectual property before it was lost to publication. The intellectual property agreements biotechnology companies in particular had with academic partners appeared to be relatively generous, granting the academics a percentage of income from any licensing of an invention resulting from the research. Firms used such agreements as an incentive to encourage academic partners to seek out patentable ideas; the apparent generosity also served to maintain the trust of university partners and cement the collaborative relationship; as one biotechnology company representative commented, ‘We don’t want to be seen as stingy’.

Students in these collaborations were not integrated into their respective companies or involved in company activities to the same extent as in the
‘high-intensity’ collaborations; nor did companies see it as their role to facilitate such integration. On the whole, these companies expected their students to work independently. One biotechnology company supervisor explained that he sometimes attended joint supervisory meetings, but that he had no time to follow up the student’s activities in detail: ‘The project is running of its own accord; there is no reason to go in and steer something you’re not qualified to steer’. Biotechnology companies in particular saw independent lab work as the main way students learnt to do research. A biotechnology company supervisor echoed the opinion of his colleagues when he maintained that ‘The research students have too many taught courses, they need to work on their own to learn to work independently’.

One of the consequences of firms allowing students to enjoy a significant degree of independence, was that several students seemed to feel unsupported in an ill-defined role. Some felt their working life was unstructured and unfocused, and that they were losing valuable time.

Research schools and companies had however introduced some formal collaborative mechanisms to help monitor the project and bring some structure into the students’ working life. Company supervisors gave some examples of what these entailed. A company representative in the Fenix research school reported that he met the academic supervisors formally twice a year (and possibly more frequently on an informal basis). His company had also nominated a contact person in the firm to act as a ‘safety net’ resource for the students, should official communication channels fail. Further, the Fenix research school had introduced a reverse-mentorship scheme, whereby the students were to have a mentor in their company whilst themselves functioning as a mentor. SIK had established formal reference groups for each of its student projects which included a number of companies external to the research school. Firm representatives were thus able to meet students and monitor projects through the regular project reference group meetings.

Students did not always perceive these formal collaborative mechanisms as sufficient for support and feedback. (Firms were on the whole more satisfied with them as their main source of project feedback.) Formal collaborative mechanisms were at times reported by students to be too infrequent, vague or unrealistic to be helpful. For example Fenix’s reverse-mentorship scheme did not on the whole appear to have been successfully implemented as the precise role of a student mentor and the identity of the target group to be mentored was not always clear.
The degree of interest companies showed in students’ work however, did seem to make a significant difference to how students perceived their research experience. One company representative in the Fenix research school had observed that the students in her firm were progressing at different rates, and that their progress was closely related to how well each was being supported and encouraged by his or her company boss. This company representative admitted that her firm was not doing enough to facilitate the students’ role in the company: ‘We have to ask ourselves “what do we want to do with the research students?” We need to define everyone’s roles better’.

In fact, roles in general did not always seem as well-defined as in the ‘high-intensity’ collaborations. With companies taking a less active role in supervising the student project, they naturally depended on their academic partners, whether based in a university or an industrial research institute, to assume the leading role in project development. Where this did not happen student progress on the project was naturally hampered. In one case, a company supervisor in SIK’s research school felt there had been too much ‘dead time’ in the early stages of his project, suggesting that SIK had failed to support his student adequately.

To the extent that the firms in ‘low-intensity’ collaborations had a role in the collaborative project, they saw themselves as facilitators, rather than employers. Through these ‘facilitating’ companies, students could access a variety of facilities, resources, and contacts valuable to their research, and often took the initiative to do so. For example, through the fish-wholesaler with which she was collaborating, a SIK student was able to access raw materials (samples), fishermen and other contacts, and fishery organizations. The firm representative encouraged the student to approach the company with any questions she may have, and saw her role as brokering these contacts. Another firm in the SIK research school made its equipment available to its student. In this case however, the student acted just as much as a facilitator herself, forging links between her company and other firms not previously involved in the collaboration.

Those companies which had actively thought about the role they could play within the collaborative project, had generally also become aware of the importance of introducing mechanisms for channelling the knowledge back into the company (even if they had not yet thought out how to organize this). As a firm representative in the Fenix research school pointed out, absorbing the project knowledge into the company ‘doesn’t happen on its own accord’. Companies which had not actively considered how they could contribute to the project, had not generally thought out how to organize the feedback of knowledge.
into the company. Thus among the firms engaging in ‘low-intensity’ collaborations, some had a more active approach to knowledge feedback than others.

Perhaps ironically, it was the more traditional companies among those engaging in ‘low-intensity’ collaborations that had decided not to leave project feedback to chance. Thus the fish-wholesaler mentioned above was concerned that the company would not get enough information on the project; as the representative explained, ‘We’ll be interested in the thesis, but it may be too difficult for us to understand’. This company, along with another SIK company, realized they wanted ongoing project feedback, and saw regular seminars as an appropriate way of introducing new ideas into the company. These would be forums to which the whole staff would be invited to listen to the student and discuss her work. A wood flooring company was likewise aware of the importance of an active approach to knowledge feedback. One of this company’s ideas was to encourage employees working in process and production to ‘suck knowledge from the research student’; as the representative explained, ‘We have to adapt to [the students] and use them to the maximum’. Adopting an active approach to knowledge absorption is not only important in terms of firm learning; it also benefits the student in a positive feedback loop. This is clearly illustrated by an example given by a company representative in the Fenix research school. She knew of an instance in which a manager in her company had two research students in his division. The manager had, for esoteric reasons, given one of the students a good channel for bringing back knowledge into the company, whilst the other student had not enjoyed a similar benefit; the latter student floundered, while the former flourished.

In the same way that the high-tech firms engaging in ‘low-intensity’ collaborations do not appear to have given much thought to their role in the research project, so they generally had a more informal and passive approach to knowledge feedback. This is starkly illustrated by a company in the Linköping research school. The firm admitted it had no regular contact with the student’s university department, and had not taken sufficient interest in the research project; for example, no one at the firm had read any of the student’s work. The firm was not unwilling to take a stronger interest, but had simply not devoted time to thinking about the role it could play in the collaboration. In the event, the student had himself initiated meetings between the company and the university supervisor, but was disappointed at the disengaged attitude of both, and left the programme. A passive approach to knowledge feedback (of which this is an extreme example) would seem to go hand-in-hand with a
view of knowledge as deliverable in the form of a thesis. As one biotechnology company remarked, ‘The thesis is the most important’.

6.3 Comparative analysis of high and low intensity modes of project-based collaboration

A number of inferences about the relative merits of the two types of project-based collaboration can be drawn from the discussion in section 6.2. These are discussed here.

The potential for conflict differs

In the high-intensity collaborations studied, conflict was at times evident between the company and the academic supervisor; no overt conflict was observed in the set of low-intensity collaborations studied. These differences in the potential for conflict are ultimately grounded in the different motives underlying these two sets of firms’ participation in the research school programme.

In contrast to low-intensity collaborations, firms in high-intensity collaborations expected the collaborative project to contribute directly to solving specific problems defined by the company. These firms therefore needed to maintain tighter control over the focus and development of the collaborative project. They often had clearly defined expectations of collaborative project outcomes, and by the same token needed to share confidential company information with their academic partners. They therefore needed to trust academic partners to adhere to the pre-defined project goals, to respect the confidentiality of company knowledge, and to refrain from abusing any intellectual property agreements. Where firms perceived this trust to be abused they could react strongly and defensively.

The greater potential for conflict in high-intensity collaborations is associated with these firms’ attempts to maintain control, is compounded by the frequency of interaction entailed in high-intensity collaborations.

The nature of the knowledge transfer process differs

The degree of formality of the two forms of collaboration appeared to have an impact on the nature of the knowledge transfer process taking place within them. Perhaps counter-intuitively, high-intensity collaborations depended more on informal interaction than low-intensity collaborations. The former were ‘closer’, involving a myriad of informal encounters between partners;
knowledge transfer was thus a seamless process taking place in day-to-day situations. Low-intensity collaborations by contrast were looser; firms were less involved, interaction was less frequent, and intermittent formal meetings were the main vehicles of knowledge transfer.

Neither form of knowledge transfer can in and of itself be said to be superior, since each serves different purposes; broadly reflecting the different needs, expectations and preferences of firms. The two forms of knowledge transfer are differentially suited to different kinds of research projects, and different kinds of knowledge. Models of knowledge transfer based on frequent informal interaction are well suited to communicating knowledge which is difficult to formalize and difficult to divorce from specific situations or from its holder (e.g. local and tacit forms of knowledge). Models of knowledge transfer based on formally orchestrated infrequent interaction are best suited to communicating knowledge which is generalizable beyond specific situations, and capable of being codified and transported in discrete packages such as theses and scientific papers. Indeed, a sensitivity to the nature of the knowledge they were chiefly dealing with, may have partly informed firms’ choice of collaboration (and therefore knowledge transfer) form.

The two styles of collaboration suit the needs of different groups of participants differently

This section examines the relative merits of the two types of collaboration from the perspectives of those involved. Chapter 3 established that the main groups of participants in the research school programme were motivated to join for different reasons, and have different notions of success (see p.20 ff.). In line with these differences, groups showed a marked preference for either high- or low-intensity collaboration, as indicated by within group differences in individuals’ general satisfaction with their research school experience. Firms’, students’, and academics’ perspectives on collaboration are discussed in that order.

It is somewhat circular to discuss the relative merits of the two forms of collaboration in terms of firms’ satisfaction, since firms’ different needs and preferences largely define the types of collaboration in the first place. However, discussing the two collaboration forms in relation to a number of firm success criteria, can provide insight both into the extent to which the collaborations are fulfilling firms’ expectations, and into some relative qualities of the collaboration types. The relative success of collaborations is discussed in relation to the following criteria: firms’ benefit from project results; firms’ satisfaction with the quality of collaborative relations; and firms’ satisfaction with the collaboration in general.
A strong motive for firms participating in the programme was the utilitarian one of *benefiting directly from project results*. Six of the 18 firms interviewed said they had gained new knowledge of direct use to their activities as a result of the collaborative project; four of these were engaged in high-intensity collaborations, and three of these four reported that what they had learned was being, or would shortly be, used in the development of new or improved products or processes. From this perspective then, high-intensity collaborations were more effective, as is to be expected since they are designed for the purpose of solving pre-defined problems. The success of high-intensity collaborations in these terms can to some extent be attributed to the way the firms supported and encouraged the students to find a role in the company. They had generally thought out more thoroughly how they would use the research student and how the knowledge would be channelled back into the firm.

The relative lack of success of low-intensity collaborations in terms of tangible benefits from results can perhaps be attributed to the longer time lag between investment and pay-off in these collaborations. Or perhaps these firms simply do not see this as the main purpose of the collaboration. Some certainly had a broader view of the benefits of research school participation than simply knowledge transfer.

The *quality of collaborative relationships with academics* also made a difference to how firms experienced their collaborations. Firms appreciated working with academic supervisors who knew the company and company needs, which in turn led to a relationship of trust. They also appreciated academics with whom they could build a mutual rapport. Academics could identify stronger with the types of companies engaging in low-intensity collaborations than with the traditional process oriented companies in high-intensity collaborations. They were also generally more positively disposed to low-intensity collaborations which granted them more freedom. Accordingly, firms in low-intensity collaborations generally succeeded in cultivating positive relationships with academia; the same could not always be said for firms in high-intensity collaborations.

Despite the fact that firms’ different motives and needs underpinned the distinction between the two forms of collaboration, the *two groups of firms were not equally satisfied with their collaboration in general terms*. Firms in high-intensity collaborations seemed more satisfied overall than those in low-intensity collaborations; for example, high-intensity collaborations were more effective at delivering what firms’ expected of them than low-intensity collaborations.
High-intensity collaborations were generally successful at promoting the immediate transfer of applicable knowledge into the firm. Firms in low-intensity collaborations were less happy with the outcome of their collaboration so far. A number of explanations can be found. Their goals were on the whole longer term, and perhaps less well defined than those of firms in high-intensity collaborations. Further, it was often not the quality of interaction per se that irked these firms, but rather the framework within it took place as dictated by the research school. In sum, those firms most used to working with universities, and which were not greatly involved in their students’ projects, were at risk of gaining less from their collaborations than firms in more traditional process industries, which generally involved themselves in the projects.

Students’ preferences for types of collaboration are indicative of their overriding industrial identity and ambitions. They seemed on the whole to prefer high-intensity collaborations; they were happier when their project was clearly directed, when their role in the firm was clear, and when firm supervisors were engaged, preferably protecting the student from the repercussions of a split existence. The worst collaborations from the students’ perspective were those in which firms took an informal (and passive) approach to interaction and feedback, and in which students’ role in the firm was not clear (i.e. some low-intensity collaborations).

In high-intensity collaborations, the key role played by students as the central vehicles of knowledge transfer was apparent. Perhaps these collaborations relied too strongly on the student as the bridge between industry and academia. For not only could this feel a heavy burden of responsibility, but an individual does not represent a strong link.

Academics played somewhat different roles in high- and low-intensity collaborations. In high-intensity collaborations their role was often to protect the academic nature of the research project through negotiations with companies. In low-intensity collaborations they enjoyed greater freedom of choice concerning the scientific details of the project, and their role was similar to that of a traditional university supervisor.

Academics benefited less from high-intensity collaborations than firms in terms of knowledge exchange; those in low-intensity collaborations were generally more satisfied with the collaboration. The closeness of high-intensity collaborations, combined with the often sensitive nature of the student project (from the firm’s perspective), meant that confidentiality was more important in these collaborations than in looser collaborations.
Academics needed to be sensitive to firms’ need for secrecy, preventing them from reaping the full benefits (in academic or economic terms) of the knowledge they were entrusted with and helped develop. A minority of academics did however observe that the close contact with a firm or industrial sector entailed in high-intensity collaborations provided them with information on research problems important to the sector or firm. They then used this information when applying for further research funding.

In sum, it is difficult, if not impossible, to identify a single way in which partners should manage their collaboration in order to best serve the purposes of knowledge development and knowledge transfer. Needs and preferences naturally vary by individual, organization, stakeholder group, and collaborative group. Conflict was worse in high-intensity collaborations. The scientific quality of high-intensity collaborative projects was seen by some participants to be threatened by the need for secrecy and by the relative lack of academic autonomy. High-intensity collaborations were however superior in terms of immediate knowledge transfer and student satisfaction.

6.4 Beyond project-based collaboration

This section describes the non project-based form of collaboration. This form of collaboration transcends the project itself, encompassing a different set and a broader range of partners than project-based collaborations, though it often overlaps the latter. Companies which sought to engage in this form of collaboration and participate in research school-wide networks were generally motivated by a broader view of the benefits to be derived from research school participation than merely project results (their motives are outlined on p.45 of this chapter).

Inter-firm collaboration

The research school concept has the potential to provide participating firms with the opportunity of exchanging information and experience with other firms, both within, between and beyond individual research schools. Such inter-firm links may, for example, have their origins in research school-wide interaction, or they may emanate from the collaborative research project itself.

The 18 companies interviewed were generally (but not universally) keen to increase their links with other firms in their research school. They were not however interested in doing so merely for the sake of strengthening ties; rather, firms seemed to favour the idea of facilitating links that would support particular types of couplings, such as between small and large firms, or
customers and suppliers. The firms interviewed did not on the whole feel that their research schools facilitated the creation of inter-firm linkages. A third of those interviewed reported that they would appreciate more opportunities to establish relations with other firms connected to their research school. These were with one exception large firms (half were in the Fenix research school), and largely engaged in low-intensity project-based collaborations (reflecting the overlap in motives behind ‘low-intensity project-based’, and ‘beyond project-based’ collaborations).

Firms gave some indications of the ways in which they believed research schools could facilitate the kinds of inter-firm interaction they desired. For some, a discussion forum amongst research school members was adequate for their needs. This could allow firms to exchange experiences and ideas (though the success of these seminars might in part depend on the absence of competitors). Such forums could also provide a means of formulating and discussing research questions relating to industry-wide problems which no single company had the incentive to tackle. For others, using the research school as a platform from which to build networks was a more interesting proposition. One firm representative proposed that his research school should hold a day for its member firms to meet informally in relaxed circumstances. Firms did not however always consider research school members to be a broad or large enough group from which to develop networks. A Fenix firm representative commented that he was interested in working with small companies, but that the research school had failed to recruit any. Another Fenix firm representative remarked that his research school could serve as a hub in a network of firms extending beyond the research school, adding that Fenix did not presently offer access to a broader network.

Despite firms’ willingness to interact in various ways and for different purposes with other firms within (and beyond) the research school, very few had experienced increased links with other firms in their research school as an unexpected effect of participating. Some firms had no contact whatsoever with the other firms in their research school; indeed, not all firms identified themselves as being part of a research school, and at least one was unaware of its existence.

Some firms were however forging closer relations with firms outside the research school as a direct consequence of the student project. This was especially so in cases where the student project was in some way related to customers’ or suppliers’ needs (as was often the case in high-intensity project collaborations). Firms (sometimes indirectly through students) were developing stronger links with
these customers or suppliers as a result of the project, a development they were very positive about.

Student projects not only catalysed host firms’ relations with companies outside the research school, but were at times also instrumental in creating stronger *intra-company links*. New intra-company links were for example activated when the student or firm supervisor sought input into the project from another department of the company, or when another company division was particularly interested and approached them. A number of firm representatives commented that they were collaborating better with another division of the company, or with a sister company, as a result of the student project.

It would seem then that whilst firms are (at a still relatively early stage in the programme) failing to forge stronger relations with other firms in their research school, they are succeeding in establishing relations with firms outside the programme, as an unanticipated benefit of participating. The distinction between ‘research school initiated’ inter-firm collaborations and ‘project born’ inter-firm collaborations is significant for understanding this paradox.

Whilst student projects provided a fertile base from which firms could develop contacts with other firms and internal divisions, the same cannot be said for research schools per se. There are a number of explanations for the relative failure of research school-wide inter-firm collaboration compared to ‘project-born’ inter-firm collaboration. First, in project-born inter-firm collaborations, partners initially have something in common over which to collaborate (the project). Collaboration takes time, and partners will be less willing to expend the necessary time if there is no concrete task or purpose to the collaboration beyond vague notions of networking. Second, and similarly, firm participants in any one research school do not necessarily have much to gain from working closer with each other, since they are as a group (self-) selected for a different purpose (i.e. co-funding a research student). Firm partners brought together by projects are self-selected for their shared interest in the project. Third, research schools do not at this stage seem to be sufficiently integrated as entities to foster research school-wide inter-firm collaboration. Not all firm members identified with, or felt part of their research school. Fourth, and similarly, research school participation did not always occupy a prominent place in member firms’ R&D strategy, with consequent implications for research school-wide collaboration. As a firm representative in the Fenix research school commented, ‘It is difficult to get Fenix visible at an operational level in the firm’. Lastly, it needs to be remembered that these results reflect the situation at a relatively early stage of
the programme, and that research school-wide collaboration will likely increase as research schools consolidate their activities.

**Broadened academic collaboration**

Firms were generally very positive to the idea of increasing their academic network through the research school, and indeed for several, this provided an important motive for joining the research school. Some had their sights on entering the network of a specific academic, or group of academics, perhaps because these named individuals represented expertise complementary to that already found in the company. Other firms were primarily interested in linking in to the networks surrounding a specific scientific specialty or discipline. Thus a firm in the SIK research school which wanted to build up its own expertise in allergy research saw the research school (or more specifically the student project) as a way of strengthening its links with the university hospital.

Many firms saw the research student as the way in to broadened academic networks and collaboration. Some realized however, that it was important that the student was not the only link with the coveted academic network; as a supervisor in a biotechnology company saw it, ‘The research student should be the embryo to a link’.

For firms in research schools hosted by industrial research institutes, the need to cultivate broad relations with the university sector was less pressing, and their inclination to do so was less apparent than was the case for their counterparts in university-based research schools. These firms appeared to be very selective in the university relations they chose to foster, and were clear about the exact purpose these new academic links would fulfill. This was because their network needs could to a large extent be provided by the industrial research institutes themselves.

Again, it is premature to assess the degree to which firms had succeeded in forging broadened relations with academics through the research school. They seemed however to feel that they were able to access university networks through their research schools, without being able to be specific about the effects at this stage.

**Industrial research institute collaboration**

Firms in industrial research institute research schools seemed on the whole to participate more in research school-wide collaboration, than did firms in
university-based research schools; and there are several reasons why it was both easier, more natural, and more pressing for them to do so.

By virtue of their metaphorical location at the hub of an industrial network, research institutes were often in a more natural position to act as research school coordinators than many host university departments. They tended to put more energy into formalizing research school-wide relations than universities, as they saw this as part of their larger role as central nodes in industrial networks. Participating in an industrial research institute research school therefore often went hand in hand with participating in research school-wide activities. In other words, these research schools were to some extent more integrated as research schools than many of the university-based research schools. Firms in industrial research institute-based research schools seemed very conscious of being part of a research school.

Not only was it made easier for these firms to participate in research school-wide activities, but they also had stronger motives than firms in university-based research schools for doing so. For many, it was of central importance to have a substantive link to the institute, and the research school provided a convenient way for them to do so.

Firms for example needed to access research institute expertise. This was particularly the case for firms collaborating with the SIK and Trätek research schools. They could access the expertise they required both through the student project and through other research school activities, such as reference group meetings. Firms were also particularly keen to establish a broad-based collaboration with the research institute per se; this was partly as they saw the institute as a way in to broader academic and industrial networks. In other words, firms looked regarded these research schools from an industry-wide perspective. Many of these firms were not at all used to working with researchers, and from their perspective, the research institute provided their only conceivable access point to a research network.

In a twist on this theme, and highlighting the significance of the fact that research institutes were regarded as occupying central positions in their respective industrial sectors, one firm representative stated he was collaborating with the research school for purposes of legitimation only. He did not quite trust the research institute’s approach to problem solving, finding it too scientific: ‘[The research institute] doesn’t know our activity as well as the industry itself, [the institute] is too academic’. He found collaborating with customers more helpful to the development of the student
project. But the research institute could confer an air of legitimacy on the project and by association on the firm itself.

Research institute research schools were on the whole keen to encourage firm-firm interaction. However, whilst firms in these research schools were keen to access the research institute and the industrial and research network it could offer, they were not all equally enthused by the idea of interacting with the other companies in their research school. The degree to which they were interested in doing so was naturally a function of the common interests they perceived they had with the other companies. Thus a representative of a sugar company stated that he had no need to meet the other firms in the research school, whilst a representative in a chemical analysis company hoped the research school would lead to strengthened collaboration with the other firms in the programme ‘as most are customers’. Those firms which were unused to engaging in research activities could however find the formal meetings with other firms (for example in project reference groups) intimidating; as one commented of such a meeting, ‘It was obvious that they had worked longer with [the research institute] than I have’.

It would not be accurate to portray the dynamics of firm-research institute interaction in the context of the research schools as a one-sided relationship dominated by the supposed superior expertise, networks, resources, and status of the research institutes. Industrial research institutes are of course dependent on the support of firms in their industrial sector, some of which are paying members. Perhaps in recognition of this, at least one of the firm representatives explained her firm’s participation in the research school in terms of ‘helping’ the research institute. Her company could help the student build a network in the industry, and further, ‘We’re happy for [research institute] to get access to all we know. We’ve helped [the institute] with samples and now with the research student’.

In sum, research institutes often represent industry-wide interests, and firms needed to collaborate with them (through the research school) for this reason, rather than to purely get a project done. These firms then are apparently collaborating from a position of need, in contrast to firms in university-based research schools which were largely collaborating in order to exploit an opportunity. This apparent imbalance is however redressed by the ultimate dependence of research institutes on the support of firms in their industrial sector. At a deeper level therefore firm-research institute collaborations are more reciprocal than firm-university collaborations.
The distinction made in this chapter between ‘project-based’ and ‘beyond-project’ collaborations seems less relevant for understanding firms’ interactions with research institute-based research schools. The two types of collaboration are fused through the dual role played by the student project in firms’ motives for participating. The project is at once significant in its own right as well as representing a way of accessing research institute networks.

Comparing collaboration in industrial research institute-based and university-based research schools

Firms in research institute-based research schools on the whole seemed more willing than firms in university-based research schools to give time to research-school wide collaboration. This is partly because the former generally had more to lose by not doing so, reflecting their stronger reasons for participating in the research school. It is also because generally speaking, research school-wide activities were more formalized and better organized in research institute research schools, in turn a function of research institutes’ natural role as coordinators of industry-wide networks. In university-based research schools, the most successful inter-firm collaborations were those which originated in the student project, rather than in the research school per se. In other words, in these research schools the relevance of the research school for inter-firm collaboration lay in the student project. If firms in university-based research schools are to find it worth their while to engage more heavily in intra- and inter-research school collaboration, they need greater incentives to do so, and it needs to be better coordinated; their research schools need to be better integrated as entities. Encouraging such intra and inter-research school collaboration may help solve the conundrum that certain problems of generic importance for an entire industry are likely to get overlooked in a programme based on individual firms supporting individual projects.
7 RESULTS AND CONSEQUENCES

7.1 Benefits from the research school programme

According to theKK Foundation’s criteria of success, the programme has been successfully launched. The KK initiative has offered the innovation system a new source and form of funding. It has contributed to the development of industrially relevant, interdisciplinary research schools in Sweden and has enhanced the research system’s capacity for knowledge transfer between universities, industrial research institutes and industry.

Though most research school project leaders were unable to get their research schools off the ground as quickly as they had hoped, they have achieved one of their main objectives - to raise capital for doctoral training and research projects. Moreover, most project leaders have found that this funding has enabled them to work towards realizing their vision of a research school. They described their work in the following ways:

- The large scale of the research school makes it possible for us to develop new courses and for the students to get to know each other. This is very good.
- Close collaboration with industry - better understanding of the way industry thinks and acts.
- The distance between academic research and commercialization in firms is diminishing.
- The SMEs have a unique input into the company of knowledge and an SME-oriented person – a [future] ‘doctor’ – [to enhance] new product/process development, [and enable them to access] a new world-wide network of knowledge partners. For many companies, their first academic will be a ‘doctor’. The company has gained the possibility to be at the global research front.

Some project leaders observed that participating firms involved themselves more in the collaborative projects than is often the case in industrial research programmes. Excepting slower than anticipated starts, project leaders’ observations and experiences generally corresponded well with the Foundation’s aims.

Academic supervisors have also gained fresh research funds from their participation in the research school programme. Networks and collaboration with firms have been strengthened. As yet, however, a minority of the academics have developed new links with firms. Finally, generating student projects of high scientific quality has been a major concern for academics, but this goal cannot be assessed at this stage.
Research students’ success criteria are gaining a doctorate and launching or strengthening a successful industrial career or a career at the interface between industry and academia. It is at this stage too early to assess whether they are likely to achieve their career objectives. Two students have however already completed a doctoral degree – perhaps indicating that these students received the last part of their funding from the research school. The majority of students are generally satisfied with their supervision; 77% were satisfied with their university-based supervision, and 56% said they were satisfied with their firm-based supervision. Eighty-one per cent are satisfied with the opportunities they have of gaining commercially relevant knowledge and skills. From the students’ perspective, the main strengths of the programme are:

- Good supervision. Working in a team of other doctoral candidates with the same background but from other companies.
- The opportunity to get an academic degree while staying in industry.
- The opportunity to work with a company and to feel involved in something that has a direct application. I have felt that my knowledge is needed to accomplish something.

Some of the observations suggest that these students may need more time to complete a doctorate than students without affiliation to a firm. Certainly supervision must be effective if they are to complete their degrees in the allotted time.

Firm representatives’ perspectives on the success of the programme are indicated by the fact that nearly half the research projects (22 of 48) would not have started without KK funding. Further, of the 18 firms interviewed, five indicated that because of the subsidy available, the programme gave them the opportunity to have a student in an area of activity in which they had not previously engaged a research student (e.g. outside their core activity, or in a division which had not previously hosted a student).

Most firms reported positively on their participation, and a few firms felt that the student’s research project was already benefiting the firm. Collaboration with academia and research institutes appears to have been strengthened. Not all firms however reported achieving their own objectives. Respondents from firms expressed the programme’s value in the following ways:

- This is the only way our company can participate in fundamental research activities to build up our own skills and knowledge.
- We are able to build up new types of expertise and get new contacts.
- We were more confident in the commercialization process, [as we had someone working for ] a [research] degree to back up the arguments.
The training in methodology a research school can offer. I would however appreciate a closer connection between the different PhD studies going on within this programme.

Interviews with firm representatives gave a similar picture of overall satisfaction. Thus of the 18 firms interviewed, 12 said their firms had benefited from participating in the research school, five said they had not benefited yet, and one had no opinion either way. They described these benefits in terms of (in no particular order):

• gaining new knowledge (e.g. for the development of a new process or product)
• developing new inter- and intra-firm relations
• accessing important university equipment
• a workforce becoming more enlightened on the merits of a university education
• successful marketing (owing to enhanced understanding of own product/process)
• increased employee knowledge and skills (referring to the research student him/herself as well as to the positive effects of the student’s project on other staff).

Four of the firms interviewed indicated that as a result of their experiences of the research school, they were likely to introduce other opportunities for training in the firm, either using the doctoral student as a teaching resource or by other means.

Firm benefit from research school participation need not only be seen in terms of knowledge transfer. For example, firms in the biotechnology research school generally had an enlightened view of the value of research training, regardless of the substantive results that emerge, whilst some of the process-oriented firms only saw potential benefits in terms of specific research results.

Some data also indicates lack of firm benefit from the programme. Twenty per cent of the firm representatives (11 of 48) would have started the current research project whether they had joined the programme or not.\(^{30}\) There is evidence that these firms would have organized the research in other ways. Of the companies interviewed, two said they would have outsourced the project to a university group (both were biomedical companies); one would have hired a consultant; and a fourth would probably have carried out the project internally.

\(^{30}\) A third of the firm representatives (15 of 48) said they were not sure whether the project would have been initiated had they not joined the programme.
Of five firms among those interviewed who reported that they had not benefited from the programme, two reported that it was too early to notice any positive learning effects. Two firms said that their participation was a burden. One of these hoped for positive effects in the longer term, but the other said they would not participate in such a programme again because of the high administration costs and the ineffectiveness of the research (the students were thought to spend too much time on taught courses instead of in the laboratory).

### Benefits from the research school programme:

**KK Foundation**
- launched a new research school concept
- initiated knowledge transfer

**Project leaders**
- raised capital for doctoral training and research projects
- started to realise their visions of a research school

**Academic supervisors**
- raised research funding
- networks and collaboration with firms have been strengthened

**Research students**
- access to good quality academic supervision (77%) and firm supervision (56%)
- opportunities for gaining commercial knowledge/skills (81%)

**Firms**
- raised funding for current research project
- research project benefited firm in various ways
- strengthened collaboration with universities and research institutes

### 7.2 Added value

What has the knowledge exchange programme added to the knowledge transfer process? Would the collaboration have occurred without the KK
intervention? And has the knowledge exchange programme contributed itself to the innovation process?

The evaluation suggests that there are significant research school differences as well as variations among research students, firms and academics. On the whole, added value appears to be higher for research schools which already have extensive experience of collaboration across the academic–industry divide. Research students and firms in the majority of the research schools felt that collaboration had grown stronger. Academics did not report the same benefits from increased research collaboration.

Table 3 shows the number of research students who thought that their industrial and academic affiliation or networks contributed to knowledge exchange, as well as the number who perceived themselves as a link between academia and industry.

<table>
<thead>
<tr>
<th></th>
<th>No. who contribute to firm</th>
<th>No. who contribute to university</th>
<th>No. who perceive themselves as a link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>46</td>
<td>48</td>
<td>51</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>No answer</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>No. of responses</td>
<td>73</td>
<td>73</td>
<td>73</td>
</tr>
</tbody>
</table>

A majority of the students felt that their industrial affiliation and network had contributed to the university in a number of ways; for example in terms of tacit knowledge exchange. An equal number also felt that their academic affiliation and network had contributed to the collaborating firm or industry in general. Two-thirds of the responding students viewed themselves as the link between the university and industry; that is they felt the knowledge exchange was channelled through themselves as individuals. Whilst some saw their role as an ‘initial link’, others saw themselves as a more permanent link. Moreover, several students had already initiated a process of network building: At the level of knowledge exchange then, the collaborative link as embodied by the student, would appear to be functioning as intended. Comments from students on how they contribute to knowledge transfer include:
There is a great amount of information about the processes in a firm that would never see the light of day if no one brought them out and analysed them. I have seen that working with these issues has put me in a position where I can connect people working at a firm and the university, and direct them to the people with the needed information.

I have taken initiatives to invite people from academia to hold seminars at my work. I have invited people from work to participate in workshops at the university.

According to students’ own responses, those who were linked to the Fenix, Linköping, Trätek, MARCHAL, and KIF research schools contributed more to the collaboration process than students linked to the KI and ACREO research schools. Responses of students in the SIK, Lund, and Luleå research schools are less easy to interpret (cf. Table 6, Appendix C, p.98).

Two thirds of the firm-based supervisors felt that collaboration with universities and research institutes had grown stronger as a result of their participation in the research school programme. Collaboration with universities in particular has grown stronger, as indicated in Table 4. However, a substantial minority of firm representatives (almost twenty per cent) felt that their collaboration with universities had not been strengthened.

Table 4: Firm supervisors’ experience of collaboration

<table>
<thead>
<tr>
<th></th>
<th>with universities</th>
<th>with research institutes</th>
<th>with other firms</th>
<th>with others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>17</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>To some extent</td>
<td>16</td>
<td>20</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Not at all</td>
<td>10</td>
<td>14</td>
<td>28</td>
<td>21</td>
</tr>
<tr>
<td>Unsure/no answer</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>No. of responses</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

The majority of firms had strengthened or revived old collaboration and several had made completely new contacts.31 Their comments on the contacts they had made included:

31 Seventeen firms responded to the question whether old or new contacts had been made. Eight firms said they had revived old collaboration, five firms said their contacts were both old and new, and four firms had only made new contacts.
Some are old contacts which have been ‘updated’, but most of the contacts are new. These new contacts have been very valuable mainly for the product development.

New contacts which enhance our technical base and an improved image/profile with our customers.

The KK programme has added new value, it seems, to firms that are new to research collaboration. Thirty five per cent of the firm representatives (17 of 48) said they were hosting a PhD student for the first time.\textsuperscript{32} Sixty per cent of these (10 of 17) would not have started the research project if the KK programme had not existed. And more than half of those who were hosting a student for the first time felt that their collaboration with universities and research institutes had grown stronger.

The data also reveal differences. Firms with less than a 10 \% R&D budget and firms for whom it has been a substantial investment to participate in the research school programme, more frequently felt that their collaboration with universities had been strengthened.\textsuperscript{33} There were also differences among the research schools. Firms participating in the KIF (in particular), Linköping, KI, and Lund research schools felt that the collaboration with universities had grown stronger, whereas in the other schools the outcome is less clear (cf. Table 7 and Table 8, Appendix C, p.99).

As noted, two-thirds of the students viewed themselves as a link between university and industry. Relatively fewer firms saw students in this way, though the extent to which firms viewed students as links differed between research schools. Thus firms in the Linköping and KIF research schools were more likely to report that their students acted as links or ‘knowledge carriers’ than firms in other research schools.

\textit{Academic supervisors} generally felt that they had contributed more than they had received from the collaboration. However, the interviews suggested that supervisors have different experiences of the knowledge exchange process.\textsuperscript{34} Those who were continuing a long-term collaboration within the research

\textsuperscript{32} This figure does not translate directly to the proportion of firms which were hosting a PhD student for the first time, since some of the firm representatives were from the same firm. In fact, approximately 50\% of firms were hosting a PhD student for the first time.

\textsuperscript{33} There is no clear correlation between firm size and university collaboration, except that more medium and large firms felt that collaboration with universities had not been strengthened at all.

\textsuperscript{34} Between two and four supervisors were been interviewed for each research school. Twenty-six supervisors were interviewed altogether (22\% of the total).
school, thought that the research school had strengthened the collaboration; yet they also accepted that it might have been strengthened irrespective of the research school. Further, some academics with established industry networks thought that they had gained new research ideas from their collaborating firms. However, it was important for supervisors that they could choose the student or project, rather than merely being assigned a topic and a student. Some academics who were assigned a research student did not feel that they had yet gained anything from the exchange. For this group an industrial research student was not a source of knowledge, just one more student to supervise.  

The overall picture is that different amounts of added value were accrued by the various participants. Generally, a majority of students and firms reported acquiring added value, whilst the accumulation of added value for academic supervisors seems more modest at this stage. Some academics feel that they give more than they receive. Some supervisors have reluctantly accepted students; while others may not be in sympathy with the third mission of the universities.

Research schools also differ. The majority of students, firms and academics linked to Linköping have experienced added value, whereas participants in the IOF/ACREO research school have had the opposite experience. Students and firms at KIF, but not the academics, have experienced added value. Overall, there has been no obvious common experience. The success of the applied IT school in Linköping could be explained by the prior existence of a well functioning structure for collaboration; whilst a clear vision for the research school, in combination with dedicated project leaders, might account for the KIF example.

The fact that certain firms (viz. some small firms, firms with a relatively low R&D spend, and firms for whom it is a substantial investment to participate) more frequently reported benefits from the programme could be explained by the fact that the KK programme offers them something not available elsewhere. Interview material also suggests that these firms put more into the whole process of hosting a student and facilitating knowledge exchange than some of the larger, and research intensive, companies. This may go some way to explaining their relative greater satisfaction.

---

35 Supervisors linked to Trätek, ACREO and KIF felt that they had contributed more than they had received, while supervisors in the Linköping, Lund and Luleå research schools acknowledged the extra value of participating in the programme.
7.3 Immediate effects

Collaboration

Immediate effects are evident at this stage in the programme. These include: strengthening of knowledge networks, product development, and R&D. Firm representatives report, for instance:

- A broadened academic network
- A lot of new knowledge which works as input to the product development.
- Concerning the very project I am involved in: no benefits, only time- and energy-consuming problems. The other two projects the firm is involved in have succeeded satisfactorily.
- A well-structured R&D plan has been worked out

Broader academic networks and knowledge transfer are intended effects, whereas the development of an R&D strategy was not an explicit intention of the programme.

Collaboration between firms is another immediate, if unexpected, effect of the programme. One quarter of the firms have strengthened their collaboration with other firms. Collaboration can either be intra-firm (within a company) or between firms (e.g. between customer and supplier). Most of these collaborations have arisen from the student projects themselves or as spin-off activities from these, rather than as a result of research school activities per se.

Learning in firms

Participants in the programme reported many examples of learning that have taken place through their participation. Willingness and capacity to learn seems to have been strengthened through the programme. Moreover, firms are building their capacity to solve tomorrow’s problems – as one respondent indicated:

We haven't introduced any innovations from the projects yet. But I feel that as I’m working with development, it feels like I've learned a fair amount. But perhaps I will use the knowledge in a different way than in the project, transfer it to a new area perhaps. We’re the ones who have to adapt to them [research students] and try and use them to the maximum, what we get out depends on how active we are.

36 Six of eighteen interviewed firm representatives said they had gained knowledge of direct use to their activities, as a result of student projects. Of these, three said that the new knowledge had been, or would be, used in the development of new or improved products or processes.
Interview data suggested that the learning benefit firms perceived they had gained was broadly related to the degree they had engaged themselves in the student project. Paradoxically, perhaps, companies less used to working with academia had, on the whole, considered more thoroughly why they were participating in the programme and how they wanted to manage this participation. This applied particularly to firms in the KIF research school. Those who reported no effects in terms of learning (3 of which were in the KI research school) preferred to let the university take responsibility for the project and did not have any need to keep a tight rein on the development of the project.

According to theoretical assumptions implicit in the programme, knowledge exchange should ultimately lead to enhanced industrial innovation and economic growth. Firms are engaged in improving their innovation activities at this stage. However, in most cases it is too early to look for new innovations and impact on economic growth.

**Academic courses**

Half of the research schools designed new courses specifically for the KK students. Some of these courses were also opened to other doctoral students. Not all project leaders however felt the need to design new courses – some universities already had courses tailor-made for industry-related degrees. One firm perceived the courses as the main benefit of the programme; that is, the research school offered ‘a good business-oriented education programme’.

**For academics**

A few academic supervisors benefited from close contact with firms or an industrial sector. They were able to identify research problems important to the firm or sector. Such information could then be used in applications for further research funding.

In some cases research school supervision took more time and effort than expected. This might be attributable to the students’ industrial backgrounds, and their resultant inexperience of academic research. This can be interpreted as a negative effect of the programme for academics.

---

37 Two project leaders said they planned to develop new courses in cooperation with other departments.
7.4 Goal-achievements

Most goal achievements cannot be assessed at this stage. Our assessment is first and foremost based on the industrial research school programme.

<table>
<thead>
<tr>
<th>Goal achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>The KK programme has been launched gradually, with some success</td>
</tr>
<tr>
<td>Research collaboration in both strategic growth areas and traditional areas of the economy</td>
</tr>
<tr>
<td>New modes of knowledge exchange between academia and industry have been initiated</td>
</tr>
</tbody>
</table>

Launching goal

The knowledge exchange programme has to some extent been successfully launched. However, all projects have not been implemented as smoothly as hoped. The distribution of funds indicates that launching and implementation may not have worked out as intended. The industrial research school programme has been launched successfully but slowly. By January 2000 six schools were more or less running at full capacity, whereas four were below capacity. Fenix had planned to spread admissions over two periods, whereas KI, MARCHAL and Lund have experienced problems of recruiting students and/or firms.

The launching problems are partially related to the research school concept. On the one hand the research schools had to minimize economic risks by screening out vulnerable firms. On the other hand small firms that invest in the programme assume a substantial financial burden leading to prolonged recruitment and negotiation. Some schools experienced problems of recruiting students and prolonged negotiation with the Foundation. Thus to set up an industrial research school around SMEs, which involves interdisciplinary research and firm collaboration is a demanding task.

New infrastructures have been established in various research school projects. But the research schools differ in the degree to which they have created new infrastructures and networks. Projects that were simple to get off the ground typically colonised existing structures and networks, whereas those that built
something entirely new encountered a more difficult task in launching their programmes.

*Strategic industrial research goal*

One of the overall goals of the knowledge exchange programme is to *develop research cooperation in strategic research areas*. The exact meaning of this is not specified. One way of assessing achievement of this goal is to identify projects funded in growth areas (i.e. areas of strategic economic importance).\(^{38}\)

Three of four projects in the ‘Expert Training’ programme and approximately half of the thirteen industrial research schools are clearly in strategic areas.\(^{39}\) Some of the projects in the other research schools may also have a strategic growth potential. Perhaps two of the master’s programmes are targeting strategic areas.\(^{40}\) In the Forest Programme, at least one of the projects can be related to a strategic area. With respect to the ‘New forms of knowledge exchange between SMEs and universities in networks’ and ‘Collaboration between new university colleges and industry’, obvious links to strategic research areas are difficult to establish.

Taken together, less than half of the projects funded by the knowledge exchange programme are clearly operating in strategic research areas. However, the innovation literature suggests that well-functioning economies need to build equally on strategic and traditional sectors. In practice, a welcome balance between old and new industrial research areas may have been achieved.

*Knowledge exchange goal*

While the objective of *knowledge exchange* has been partly achieved, differences exist between research schools and the various participants. Generally, the

---

38 These would include generic technological areas such as information technology, biotechnology, new materials, and nanotechnology.

39 Those in the Expert Training programme are: Embedded Systems, Food and Biotechnology, and Experience Industry. Those in the Research School programme are: Biotechnology (KI), Applied IT (Linköping), Optics (IOF/ACREO), electronic design (IMC/ACREO), medical bioinformatics (KI), and to some extent food and biotechnology (SIK), and materials (MARCHAL).

40 The Centre for Computer System Architecture in Halmstad and Institute for Food and Biotechnology (SIK).
research students, the firm supervisors and the academic supervisors, in that order, report stronger collaboration and knowledge exchange. The benefits experienced by firms in terms of knowledge exchange and collaboration tend to derive from the students’ projects, rather than from being part of a research school. Research schools as corporate entities do not always give added value to firms, though individual projects do have an impact. Students are key links in the transfer of knowledge between firms, universities and research institutes.

Effectiveness for firms in terms of knowledge transfer was to some extent related to how well firms supported and encouraged students to find a role in the company. Not all firms had thought out how they should facilitate knowledge transfer into the firm.

In cases where knowledge exchange takes place early in the implementation process, this occurs mostly through well-functioning pre-existing structures and networks, whilst time and resources are needed to build new networks. A strong vision for the research schools and dedicated project leaders also seem to be linked to the progress made in collaboration and knowledge exchange.
8 CONCLUSIONS

The overall conclusion at this stage is two-fold; on the one hand interesting and promising results are on the way, on the other launching and implementing the programme has been slow and uneven.

The benefit for participants, the added value and the immediate effects of the programme discussed in the report, indicate positive outcomes. However, the impact of the programme has been uneven. In short, the values added through the programme are:

<table>
<thead>
<tr>
<th>Added value of research school programme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half of the research projects would not have started otherwise</td>
</tr>
<tr>
<td>Almost half of the firms hosted a PhD student for the first time</td>
</tr>
<tr>
<td>A majority of the participants have gained value</td>
</tr>
<tr>
<td>A majority of students act as knowledge transfer links</td>
</tr>
<tr>
<td>Old collaboration has been strengthened</td>
</tr>
<tr>
<td>New links created between universities, research institutes and firms</td>
</tr>
<tr>
<td>Presence of students reduced ‘academic fright’ in firms</td>
</tr>
<tr>
<td>Firms explored new areas of research</td>
</tr>
<tr>
<td>Firms’ activities more knowledge-intensive</td>
</tr>
<tr>
<td>Increased capacity for learning in firms</td>
</tr>
<tr>
<td>New industry-relevant courses created</td>
</tr>
</tbody>
</table>

At the same time as promising results are on the way it is recognised that most research schools have experienced delays of up to two years. Four research schools are not running at full capacity, first and foremost due to problems of recruiting students and firms. In the sub-programme Expert Training only three contracts have been signed and a number of others in the pipeline. Contract construction has been prolonged because the Foundation is acting as a re-structuring agency, and because the research school concept is demanding. To introduce a networking model of innovation necessarily implies multi-lateral negotiations. Launch problems might also be explained by the fact that the programme is still being developed and that KK’s capacity to coordinate and manage an innovative and evolving programme needs strengthening. The working procedures of the Foundation, including pre- and
post-contractual practices, have been perceived as \textit{ad hoc} by some research school project leaders.

As described in chapter 4, it has been the Foundation’s strategy to build the sub-programmes up interactively and in a manner which is responsive to the needs of the target groups. This allows the Foundation to learn from early experiences in a sub-programme and refine the concept accordingly. The slow start commented on above is partly a symptom of this strategy.

Research collaboration in strategic growth areas of the economy has been initiated in under half of the projects. The range of industrial sectors represented in the programme is to be welcomed since innovation theory suggests that a mix of industries is a strength in an economy: strategic (i.e. generic technological) research areas can help firms in traditional sectors strengthen their economic competitiveness. Whilst there is some attempt at integrating information technology in, for example, the Trätek research school, a 50-50 % co-financing model may not in general be conducive to supporting the diffusion of generic technologies in the economy. This is because whilst a generic technology such as IT is important for the development and growth of entire sectors, few firms in a given sector may be willing to support a research student in such an area, as it is unlikely to be one of their core activities. Strengthening intra- and inter research school collaboration could be a way to alleviate this problem.

A measure of new knowledge exchange, across the academic-industry border, has been initiated as a result of the programme. However, much of the knowledge exchange may have occurred if the programme had not existed - particularly between firms and universities with extensive experience of collaboration. Nevertheless, knowledge exchange takes place in a different way as a result of this programme; for example, by research students in firms who are hosting a student for the first time. Such knowledge exchange may however be jeopardised because students are a transient mode of knowledge exchange.

Despite the implementation problems, which may first and foremost be associated with the launching of a new and demanding concept, some interesting and promising results are on the way. However, it is too early to say if the programme is good value for money. The intended impact on innovation and economic growth is still to be seen.
8.1 Implications for the Swedish innovation system

If the same course of action is followed:

- new capital linked to new institutional rules will be invested in the innovation system
- a new research school concept will be extended
- weak links in the innovation system will be strengthened
- research students will be recognised as important agents of knowledge exchange
- the programme will continue to reinforce the most widely accepted perception (within the policy community) of problems in the national innovation system and how these may be solved.

A modified programme could contribute more strongly to:

- sustainable growth
- local/regional development

If the KK Foundation wishes to strengthen the regional dimension and sustainable growth (cf. KK-stiftelsen 1999 p.31), these goals could be considered more seriously in the knowledge exchange programme.41

The KK programme goals have been adjusted to include process results as well as end results. The goals seem appropriate both from the perspective of current innovation theory and from that of participants’ preferences. However, collaboration between universities, research institutes and industry needs not only to be strengthened in future growth areas of the economy, but in existing/traditional sectors also.

8.2 Programme appropriateness

Generally, the knowledge exchange programme offers a suitable response to perceived problems in the innovation system. The evaluation shows that there is a perceived need for the programme among participants. The appropriateness is indicated by:

- KK’s contractual conditions for the industrial research school programme are on the whole considered appropriate by the participants

---

41 How this could be done is of course another question, and one beyond the remit of this report.
• Most firms consider university knowledge/expertise very important to their survival and growth
• Firms generally think sub-programmes are appropriate
• The responsive and interactive approach to developing sub-programmes is one that is largely appreciated by participants.

Embedded weaknesses

However, not all participants think that the programme is appropriate. What could be viewed as programme strengths are not always perceived this way in practice. For example co-financing does not create a greater commitment for all firms. Thus there are some embedded weaknesses identified in the programme:

• Industrial research schools are a demanding and expensive form of collaboration: some firms prefer simpler projects/concepts
• 50-50 % financing is demanding for small firms and for firms mainly interested in project results. It is a weak incentive for supporting generic research areas
• Firms’ current need for graduates trained to doctoral level may be lower than expected (see Table 5, Appendix C, p.98)
• Inadequate account is taken of students’ split work situation
• Life after KK funding is unplanned.

Firms are satisfied if the research student leaves with a licentiat degree. Their current need for PhD level graduates is lower than for graduate engineers and master’s degree graduates. Even some firms with a large R&D budget indicate that their need for PhDs is low. Over time, however, the programme could be seen as creating demand for PhDs in industry.

Students worry about their ‘dual’ existence and career. The extra demand of meeting the high expectations of two quite different work environments (industry and academia) suggests that these students may take longer to complete their studies than students based in a single organization. To avoid the problems experienced by students owing to their ‘split’ existence, measures need to be taken. For example, academic and firm supervision/mentorship could be improved in order to become more effective.
Recommendations

The evaluators’ recommendation is continuation of the programme in the current direction, but with minor modifications. We suggest the following adjustments:

<table>
<thead>
<tr>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Funding terms:</strong></td>
</tr>
<tr>
<td>• more flexibility for SMEs (e.g. 25-50 % of the total amount)</td>
</tr>
<tr>
<td>• incentives to support generic research areas</td>
</tr>
</tbody>
</table>

**Strengthening KK’s capacity as a facilitator of knowledge exchange**

• promote learning from projects
• co-ordinate the dissemination of knowledge

**Recognize importance of sustainability and the regional dimension in innovation and growth**

• these qualitative aspects of innovation and economic growth should be made explicit in the goals of the programme

So far we have evaluated the knowledge exchange programme in relation to the national innovation system. However, also interesting from an evaluation perspective are the effects and consequences of the programme for regional development (independent of the Foundation’s perspective on regional issues) especially when the programme is analysed in the context of innovation theory. The regional dimension could thus be a focus in the second part of the evaluation – in the light, for instance, of recent discussion of ‘regional innovation systems’ (Braczyk et al. 1998).

The benefits and effects of the programme need to be understood in relational terms and in terms of non-linear knowledge exchange. Firms should not view themselves purely as recipients of knowledge, skills and ability if the desired effects of networking and collaboration are to come
about. In the knowledge transfer process all participants are both actors and collaborators.
References


Freeman, C. and Soete, L. (1997) *The economics of industrial innovation.* London and Washington, Pinter.


____________________

**Documents from the KK Foundation:**

*Project-contracts* for projects in the knowledge exchange programme.


www.kks.se
Appendices

Appendix A: Theoretical considerations

The knowledge exchange programme is considered in the broad context of innovation studies, and with the support of an evaluation framework. This appendix provides an introductory overview of the systems approach within innovation studies. It subsequently presents the evaluation framework.

Part 1: Innovation theory

The significance of technological innovation for economic growth

The observation that new technology is a significant factor accounting for the economic performance of firms, and therefore economic competitiveness is uncontroversial, even axiomatic. In their book on the economics of innovation, Freeman and Soete (1997) emphasize the significance of innovation as ‘an essential condition of economic progress and a critical element in the competitive struggle of enterprises and of nation-states’ (pp.2-3). Such an assertion is underpinned by a large body of empirical literature investigating the impact of technology on the economic performance of firms, industries, and countries.

However, the observation that innovative activity, and particularly process innovations, may have a detrimental impact on employment levels, highlights that innovations are neither uniform nor unambiguous in their economic effects.\textsuperscript{42} This in turn implies that a high rate of innovative activity \textit{per se} is not enough to support a healthy economy; the nature and direction of this activity is also of prime significance.

This raises the question of what types of innovation should be promoted to foster sustained (and sustainable) growth. Perhaps this question is best

\textsuperscript{42} There is some evidence that the positive impact of technological innovation on economic performance identified in studies, can conceal a negative impact on employment levels. For example Archibugi and Pianta (1996 pp.460-461) refer to the results of the first Italian innovation survey which indicated an overall negative impact of innovation on employment. This effect is ascribed to the dominance of process innovations in Italian industry. In only a few sectors did innovation appear to increase employment; these were design and engineering intensive sectors, as well as those with high shares of product innovations (ibid.).
addressed with reference to the concept ‘techno-economic paradigm’ (e.g. Freeman and Soete 1997 Chapters 1 and 13; Grupp et al. 1992). This concept has been developed by economists and economic historians as a means of understanding the relationship between technical change and different modes or phases of economic growth. The notion of techno-economic paradigm embodies the idea that the diffusion of clusters of radical technical innovations through the economy is accompanied by — indeed involves — associated changes throughout the economic system. As examples of what such ‘structural adjustment’ entails, Freeman and Soete list, ‘a ... new configuration of the capital stock, a new skill profile in the labour force, new management structures and work organisation, a new pattern of industrial relations and a new pattern of institutional regulation ...’ (1997 p.330). In other words, this type of technical change entails a pervasive systemic shift, which in turn means that ‘the economic and social potential of such technologies will only be realised over fairly long historical periods’ (ibid.).

It has been posited that over the last two decades or so, the industrially developed world has been entering a techno-economic paradigm characterized by, but not synonymous with, the new so-called generic, or basic technologies, the prime examples of which are biotechnology, information and communication technologies, and new materials technology (Grupp et al. 1992 p.5). These are ‘generic’ technologies because they have a wide range of potential application. Further, they are generally science-based. This latter observation, combined with the recognition that these high-tech fields are those ‘capable of ensuring economic growth, now and in the future’ (Grupp et al. 1992 p.5), partially accounts for the characterization of the modern economy as more ‘knowledge intensive’ than its precursor (e.g. Asheim and Isaksen 1996 p.7). In such an economic context, the science base gains considerable economic significance, which in turn implies that an innovation policy needs simultaneously to be a science policy.

A healthy economy then is one with not only a high rate of innovation, but also a spread of this innovative activity over a diversity of sectors, a significant proportion of innovation in high-tech sectors, and ideally a strong science base in the relevant hi-tech fields. A diversified industrial sector coupled with a strong knowledge base, and dynamic interaction between sources and users of knowledge, are the hallmarks of an adaptive economy with a strong and

---

43 As Grupp et al. report (1992 p.5), the growth strategy successfully implemented by the developed world during the 1980s (and which followed in the wake of the world economic crisis of the 1970s), may be conceived in the light of the central role played by the new high-tech sectors.
flexible capacity for innovation, and one which is therefore in a position to develop the economically important technologies of the future and remain competitive (e.g. see Grupp and Schmoch 1995 p.2).

Broad shifting trends within the economy to some extent characterize the emerging techno-economic paradigm. One such is grounded in widely acknowledged changes in modes of production, whilst another lies in the changing nature of the innovation process itself.

_Innovation as ‘interactive learning’_

Owing to shorter product life-cycles, fickle markets, and greater competition (Isaksen 1996 p.3), incremental rather than ‘radical’ innovations are assuming greater economic significance, and firms need to innovate at a faster rate to remain competitive (ibid. pp.2-3). According to the innovation literature, maintaining a high rate of innovation is achieved by networking and ‘interactive learning’ (e.g. Lundvall ed. 1992).

The recognition that networking, tacit knowledge (know-how), and learning are central to innovation, broadly explains why the innovation process is now widely conceived as systemic (e.g. Edquist ed. 1997, Lundvall ed. 1992, Nelson ed. 1993). The interactive learning between firms and their external environment defines the system of innovation (which some of the ‘geography of innovation’ literature maintains may be regional in extent) (e.g. Cooke et al. 1996). Such a conception quickly puts paid to the linear model of innovation – assuming it was ever more than (as Solow puts it) a ‘folk theory’ (1997 p.23).

In such a context, knowledge and learning, as constitutive of the innovation process, assume greater economic salience and networks become significant levels of analysis for understanding and fostering innovation. The emphasis on the centrality of learning processes for innovation has given rise to the

---

44 The dominant mode of production is reportedly shifting from Fordist to more flexible production methods (Isaksen 1996). This shift is also associated with a changing industrial structure - away from hierarchical firms, towards networks of smaller firms and supply-chain relationships (Isaksen 1996 pp.2-3, Cooke et al. 1996 p.17). These twin developments have implications for the nature of the innovation process, and open the way for networking to play a stronger role in technological development and diffusion.

45 In broad terms, the linear model of innovation conceives the science-industry relationship as essentially a unidirectional flow of activities starting with basic research and passing consecutively through the stages of applied research, experimental development, production, and finally diffusion.
The emphasis in the newer literature on understanding innovation as an interactive process (e.g. Lundvall ed. 1992, Edquist ed. 1997) supports the notion that network developments are important for technological innovation (Freeman and Soete 1997 p.315). This conjecture is indeed supported by empirical findings. For example, as Archibugi and Pianta point out, studies of innovation flows in industrial districts indicate that small firms ‘create their own networks for acquiring and transferring technical information’ (a process which promotes the formation of regional clusters) (1996 p.458). Similarly, it is widely recognised that in line with the growing economic significance of science-based technologies, universities play a significant role in industrial innovation.

National systems of innovation

As this evaluation links the KK knowledge exchange programme to reform of the national system of innovation, a definition of the latter in order. After Edquist and Lundvall, a national system of innovation is here understood as: constituted by the institutions and economic structures affecting the rate and direction of technological change in the [sic.] society. (…) It (…) include[s] not only the system of technology diffusion and the R&D system but also institutions and factors determining how new technology affects productivity and economic growth (Edquist and Lundvall 1993 p.267).

A national innovation system thus comprises any number of sub-systems, such as sectoral systems, technological systems, the R&D system, and the intellectual property system.

Taking this definition as our departure, and following Douglas North’s insistence on differentiating the ‘rules from the players’ (1990 p.5) we conceive the national innovation system as comprising three main analytic components or elements: organizations (or actors); institutions; and resources. After Edquist and Johnson (1997 p.47), organisations (which may also be conceived as ‘actors’) are here defined as ‘consciously created’ ‘formal

46 Though as Tomlinson (1999 p.7) points out, the learning economy is not necessarily a high-tech economy. ‘The learning potential (…) may differ between sectors and technologies but in all sectors there will be niches where the potential for learning is high’ (Lundvall and Borrás 1988 p.35, cited in Tomlinson 1999 p.7).

47 It should be noted that this refers to an open rather than a closed system.
structures with an explicit purpose’ (North’s ‘players’). Examples of organizations involved in developing new or modified products/services and processes are: firms; universities; research organisations; regulatory agencies; bridging organisations; R&D funding bodies. These may of course have different motives and incentives for contributing to the innovation process, and do so in different ways. Innovation processes may be conceived as an outcome of interactions between such organisations/actors, and the way these actors interact within the innovation system is partially determined by institutions.

Institutions, as understood here, may - in contrast to organizations - develop spontaneously and are not necessarily associated with a specific purpose. They may be defined as

sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals and groups (Edquist and Johnson 1997 p.46).

and are thus broadly equivalent to North’s ‘rules of the game in society’ (1990 p.45). Institutions with important implications for innovation may be ‘formal’ (e.g. patent law; research funding rules; regulations of bank conduct; statutes of corporations and universities; trade regulations) or ‘informal’ (e.g. common law; traditions; work norms; norms of cooperation; conventions) (Edquist and Johnson 1997 p.50). Institutions are continuously changing, though are apt to do so sluggishly (North 1991, Knight 1992). Edquist and Johnson suggest that institutions play three main roles within an innovation system: they reduce uncertainty by providing information; they regulate conflicts and cooperation; and they provide incentives (1997 p.51).

Organizations and institutions mutually shape each other, and the ways they do so, along with the ways organizations interact, are strong determinants of the innovation performance of an economy (Johnson 1997 p.37).

Finally, resources are required if actors and organizations are to innovate. Important resources for innovation processes are capital, expertise and skills. Whilst financial capital is a relatively mobile resource, stocks of knowledge are perhaps less easily transferred, being to some extent embedded in actors/organizations.
Part 2: The evaluation framework

The overall aim of the evaluation framework is to facilitate practical and theoretical learning relating to the pre-conditions, processes and consequences of the knowledge exchange programme.

The evaluation of the knowledge exchange programme is conducted as a research-based stakeholder evaluation. The aspects and dimensions of the programme, which the evaluation will focus on, are shown in Figure 1. It also serves as a checklist for gathering data. The three components - pre-conditions, processes and consequences - serve the heuristic purpose of simplifying and structuring the work of the evaluation. In this mid-term evaluation, analysis focuses is on the pre-conditions and processes.

The pre-conditions, the first category, provide the structure and direction of the evaluation. To begin with the Swedish innovation context and the problem situation is analysed briefly. Next, the programme goals, potential goal-conflicts and the programme logic are scrutinised, followed by the institutional rules and resources. The key-actors perception of the problem situation, their motives for participating in the programme, their criteria of success and expectations are also unfolded. On the whole, the pre-conditions will serve as a baseline in the evaluation. However, it should be emphasised that in ongoing processes the pre-condition could change, implying that the pre-conditions might not be the same when the programme was launched compared with when it is half way through. Evaluation questions include:
1. What characterises the Swedish innovation context?
2. How is the problem situation perceived?
3. What are the goals and logic of the programme?
4. What institutional rules and resources does KK offer?
5. What are the participants motives, expectations and success criteria?
The processes are analysed from the various stakeholders’ perspectives; on the one hand from the KK-foundation’s perspective, that is from the top and down, and on the other hand from a field or bottom-up perspective. Particular attention is paid to the participants’ learning, knowledge exchange and collaboration. Focusing questions include:

1. How is the knowledge exchange programme implemented?
2. What challenges emerge, and how are they addressed?
3. What are the experiences in the field?
4. What do the participants learn?
5. What knowledge exchange takes place?
6. What collaboration takes place? And how is it valued?

The consequences include the outcomes and the implications of the programme. The consequences are evaluated according to the programme goals and the various success criteria of the participants. Insofar as the programme aims do contribute to the renewal of Swedish industry, institutional change is a key outcome. Likewise, the relevance of the knowledge exchange programme for the Swedish innovation system will be assessed. Any immediate effects are identified at this stage. However, it is too early to say anything about the intermediate and long-term effects of the programme. Finally, the programme appropriateness and the implications for the Swedish innovation system will be assessed. Evaluation questions that highlight consequences include:

1. To what extent are the goals achieved?
2. Does the programme meet other success criteria?
3. What are the benefits for the participants?
4. What is the early impact of the programme?
5. How can this impact be explained?
6. Is the programme appropriate to the problem situation?
7. What are the implications for the Swedish innovation system?

The consequences of the programme are assessed in relation to the pre-conditions and processes. If the programme is successful or not and why these consequences turn up are interpreted in relation to the pre-conditions and the processes. Success or failure shall also be interpreted in terms of the validity of the programme logic and how the implementation process has evolved.
## Appendix B: Table of the KK-Foundation’s Industry Research Schools by host organization and research profile

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Host organization and its location</th>
<th>Research profile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industrial research schools hosted by a university</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Karolinska (KI)</strong></td>
<td>Center for Medical Innovations, Karolinska Institute, Stockholm</td>
<td>Biotechnology with an industrial focus</td>
</tr>
<tr>
<td><strong>Linköping</strong></td>
<td>Department of Computer Science, Linköping University</td>
<td>Applied IT and software engineering</td>
</tr>
<tr>
<td><strong>Fenix</strong></td>
<td>Institute for Management of Innovation and Technology (HHS, Stockholm and CTH, Göteborg) and Chalmers University of Technology, Göteborg</td>
<td>Management of industrial R&amp;D; Executive PhD in R&amp;D project leadership</td>
</tr>
<tr>
<td><strong>Luleå</strong></td>
<td>Luleå University of Technology</td>
<td>Mining and mineral processing</td>
</tr>
<tr>
<td><strong>Lund</strong></td>
<td>Lund Institute of Technology, Lund University</td>
<td>Building and indoor environment (air quality and acoustics)</td>
</tr>
<tr>
<td><strong>MARCHAL</strong></td>
<td>Chalmers University of Technology (Material Research School at Chalmers), Göteborg</td>
<td>Materials research</td>
</tr>
<tr>
<td><strong>NMK</strong></td>
<td>Göteborg University</td>
<td>Natural materials, environment and conservation</td>
</tr>
<tr>
<td><strong>Industrial research schools hosted by an industrial research institute</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SIK</strong></td>
<td>Swedish Institute for Food and Biotechnology (SIK), Göteborg</td>
<td>Industry research students at SIK and orientation towards food and biotechnology SMEs</td>
</tr>
<tr>
<td><strong>IOF/ACREO</strong></td>
<td>Advanced Centre for Research in Electronics and Optics, Stockholm (formerly Institute of Optical Research)</td>
<td>Optics (mainly fibre optics)</td>
</tr>
<tr>
<td><strong>Trätek</strong></td>
<td>Swedish Institute for Wood Technology Research (AB Trätek), Stockholm (also Skellefteå and Växjö)</td>
<td>Wood processing and IT applications for effective management of the product chain</td>
</tr>
<tr>
<td><strong>IMC/ACREO</strong></td>
<td>Advanced Centre for Research in Electronics and Optics, Norrköping (formerly Industrial Microelectronics Center)</td>
<td>Electronic design</td>
</tr>
<tr>
<td><strong>Industrial research school hosted by an industrial association (a group of firms)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>KIF</strong></td>
<td>Association of Swedish Chemical Industries, (coordinated from BIM Kemi AB, Göteborg)</td>
<td>The Chemical Industry’s Research School (KIF AB), SMEs</td>
</tr>
</tbody>
</table>
Appendix C: Tables

Table 5: Firms’ estimated need for university level qualifications

<table>
<thead>
<tr>
<th>Level of qualification</th>
<th>in significant numbers</th>
<th>in small numbers</th>
<th>not needed/no answer</th>
<th>No.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civilingenjör</td>
<td>29</td>
<td>14</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>20</td>
<td>16</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Licentiat degree</td>
<td>9</td>
<td>28</td>
<td>11</td>
<td>48</td>
</tr>
<tr>
<td>Doctoral degree</td>
<td>15</td>
<td>28</td>
<td>5</td>
<td>48</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>10</td>
<td>35</td>
<td>48</td>
</tr>
</tbody>
</table>

*No. of respondents

Table 6: Number of research students reporting that they contribute to knowledge exchange, by research school

<table>
<thead>
<tr>
<th>Research school</th>
<th>were the link between academia and industry</th>
<th>contributed to academia due to their industrial affiliation</th>
<th>contributed to industry due to their academic affiliation</th>
<th>Added value %*</th>
<th>No. respondents</th>
<th>No. students enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>KI</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6:27=.22</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Linköping</td>
<td>11</td>
<td>12</td>
<td>9</td>
<td>32:42=.76</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Fenix</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>21:24=.88</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>SIK</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>13:24=.54</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>IOF/ACREO</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2:6=.33</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Trätek</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>13:18=.72</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Luleå</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>10:15=.67</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Lund</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>8:15=.53</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>MARCHAL</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>18:21=.86</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>KIF</td>
<td>9</td>
<td>5</td>
<td>8</td>
<td>22:27=.81</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>46</td>
<td>48</td>
<td>73</td>
<td>88</td>
<td></td>
</tr>
</tbody>
</table>

*Note: The estimated added value is arrived at by adding the three variables and dividing the sum by the number of respondents (multiplied three times) for each school.
Table 7: No. of firm representatives who reported that collaboration had grown stronger as a result of participating in the programme

<table>
<thead>
<tr>
<th>Research school</th>
<th>universities</th>
<th>research institutes</th>
<th>estimated added value*</th>
<th>other firms</th>
<th>No. respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>KI</td>
<td>5</td>
<td>6</td>
<td>11:12=.92</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Linköping</td>
<td>9</td>
<td>9</td>
<td>18:24=.75</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Fenix</td>
<td>2</td>
<td>3</td>
<td>5:6=.83</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SIK</td>
<td>1</td>
<td>3</td>
<td>4:8=.50</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>IOF/ACREO</td>
<td>1</td>
<td>1</td>
<td>2:6=.33</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Trätek</td>
<td>2</td>
<td>2</td>
<td>[4:4=1.0]</td>
<td>1</td>
<td>[2]</td>
</tr>
<tr>
<td>Luleå</td>
<td>1</td>
<td>1</td>
<td>1:6=.17</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Lund</td>
<td>4</td>
<td>1</td>
<td>5:8=.63</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Marchal</td>
<td>2</td>
<td>0</td>
<td>[2:4=.50]</td>
<td>1</td>
<td>[2]</td>
</tr>
<tr>
<td>KIF</td>
<td>6</td>
<td>4</td>
<td>10:16=.63</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
<td><strong>30</strong></td>
<td><strong>63:96=.65</strong></td>
<td><strong>13</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

*Notes: Added value is based on the first two columns divided by respondents multiplied two times. Brackets indicate research schools where less than 2 firm representatives have responded.

Table 8: Firm representatives who reported that collaboration with universities had grown stronger as a result of participating in the programme

<table>
<thead>
<tr>
<th>Research School</th>
<th>Yes</th>
<th>To some extent</th>
<th>Not at all</th>
<th>Unsure</th>
<th>No. respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>KI</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Linköping</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Fenix</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>SIK</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>IOF/ACREO</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Trätek</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Luleå</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Lund</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Marchal</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>KIF</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>
Appendix D: From Research Schools to the Entrepreneurial University:
The International Advisory Group (IAG) Report

Henry Etzkowitz, Luke Georghiou and Luigi Orsenigo

Abstract

This report provides guidelines for extending the evaluation of the KK Foundation sponsored research schools into broader issues of university-industry relations. An assessment of initial accomplishments is followed by a discussion of research issues, innovation models and a taxonomy of policy measures, based on international experience.

The second stage of the evaluation

The purpose of the KK industrial research school programme is to enhance university-industry relations. It is indeed part of a broader programme aiming at strengthening the flows of knowledge between academia and firms. The first phase of the evaluation concentrated on the process of organizing the schools and the internal process of the schools as a channel from university to industry and vice versa, from the perspective of the students, coordinators etc.

The first stage of the evaluation identified some difficulties and some successes in the design and in the implementation of the programme. Among the difficulties, there have been delays in negotiating, preparing and writing the contracts and, as a consequence, in getting the programme started. This outcome should come as not too big a surprise. In fact, notwithstanding the sheer management problems arising in these activities both within the KK Foundation and the universities, it should only be expected that the process of defining the rules governing new types of relations takes time and effort and also creates new problems. The development of new routines is indeed a crucial part of the process of inventing and developing new organizational forms.

In the same vein, among the successes, the most interesting result lies, in our view, in the suggestion that new, unexpected networks of relationships have been created as the result of this industrial research school programme. Again, in the differentiated processes that have led to the development of the new educational programmes within the research schools, the evaluators have observed the emergence of all the typical tensions that one would expect between academics, companies of different sizes and active in different
sectors, and students with different interests, objectives and preferences. In this respect, the evaluators noted that whilst the results obtained so far by the programme were in some instances somewhat less successful than expected, there were other cases where results have been better than expected, often in unexpected areas (e.g. collaborations among firms).

It is precisely on these kind of issues that we suggest the next stage of the evaluation should focus. Indeed, it had already been agreed that the second stage of the evaluation should broaden its focus to university-industry relations and to other activities of the KK Foundation’s knowledge exchange programme. The evaluators’ report on the research schools (prepared in May 2000) noted that some research schools were based on existing networks that had been activated for the purpose of organizing research schools. Other research schools were based on new networks created for the purpose of organizing a research school.

Within this context, however - and as it had been pointed out by the IAG in agreement with the evaluators in earlier stages of the evaluation process - we believe that the degree of success of the project will have to be assessed to a substantial degree on the basis of the unexpected initiatives that will be generated through the current form of collaboration. Relatedly, the evaluation should emphasize the ‘dynamic’ outcomes of the project, in addition to the direct results.

The outcome of the first stage of the evaluation strengthens, if anything, this suggestion. A new level of research question can be: What other forms of academic industry relations are taking place through the new networks that have been stimulated by the KK Foundation programme? It would be especially interesting to compare the old networks with the new ones in this respect. Did the research schools instigate new activities in the activated networks, the issue of ‘additionality’? Were some of these older networks re-activated by the process of organizing a research school or were they ongoing? Have the research schools provided the basis for networks that have gone beyond their original purpose or have they remained limited to the conduct of the research school?

It could be useful to relate a typology of university-industry mechanisms to the different types of networks as the basis of a research design for the second phase. Tracking the schools should naturally continue, but we suggest that a broader focus would produce additional significant data on the schools themselves, as well as providing a window on the application of other mechanisms of university-industry relations. This could be analyzed by
sector. It might also be interesting to establish a control group, and if relevant, inquire into why research schools were not organized in certain sectors.

In a rather different vein, the evaluation should start to tackle more directly other sets of issues that will become possible to analyse as the project unfolds over time and nears its completion. These issues have mainly to do with the ‘efficiency’ of the project in relation to other possible ways of trying to achieve the same results. For example, in the later stages of the evaluation, attention should be given to the relationship between the nature and financial size of the incentives that are introduced by the programme and the costs that implementing the programme generates for the participants. If the incentives create higher costs, a serious distortion of the incentive mechanism might take place.

**University-industry linkages and innovation models**

We are all familiar with the linear innovation model in which research is conducted at the university, published, disseminated and then taken up by industry and put to use. It was expected that publication would be enough to allow take up by others to use the research; it has since been realized that there must be help along the way to make this model work. Thus, a variety of ways have been invented to encourage the transition of research to industrial use. The process of technological innovation can also be triggered by social and economic needs. Thus, it is well recognized that innovation can also move in a reverse linear direction.

A prototypical example of the reverse linear model is the improvements to telegraphy developed by Thomas Alva Edison. He came to New York from Boston in the late 19th century because he needed financing for his inventions, and he went to work for the finance industry. One of this industry’s needs was for a better way to transmit information about the stock market, and so Edison made improvements in telegraphy in order to transmit information faster and more reliably. He started from a need in the market, in the finance industry, and developed his invention in order to meet the need, rather than starting from a research idea and making something practical from the research (Israel, 1998).

The reverse linear model is the basis of New York’s Silicon Alley. Multimedia software firms start from problems in the market place and use technology to address those problems and to create businesses (Heydebrand, 1999). The New York model works in the opposite direction to the science
and technology push model which is common to the origins of Silicon Valley and Route 128. In these latter cases, innovation has tended to start from basic research and then move towards the marketplace. Each of these models, linear and reverse linear, are part of a full picture of an interactive innovation model, with both science push and market pull mechanisms working simultaneously.

University-industry linkages originally implicitly followed the linear model. However, there has been a revolution in university-industry relations, in the classic sense of revolving or turning around and going in both directions. This approach is exemplified by the NSF Industry-University Research Centers and Engineering Research Centers which are formed in cooperation with a group of firms in a productive sector, and where the professors and representatives of firms decide on, and often undertake, projects jointly. Such centres implicitly follow an interactive innovation model, with research and ideas from the university meeting the issues of the firms, going in both directions simultaneously.

However, the initial linear format of university-industry relations, going a step beyond publications to move knowledge from the university, involved the establishment of a liaison office. The purpose of the office was to learn what university researchers were doing, and then invite firms to engage consultants at the university, the university playing a role in the transfer of knowledge. The second level of development is to embody that knowledge in a technology, going in a linear direction from research produced in the university and moving it out. This typically involves the development of a technology transfer office which identifies technologies of potential commercial significance, and patents, markets and licenses them to industry.

The third organizational format of the linear model is the incubator, where the knowledge and technology is embodied in a firm and is moved out of the university by an entrepreneur. Instead of being licensed to an existing firm, the technology is transferred in the form of a company. University incubators originally adhered to a linear model of starting from academic research but soon also followed a reverse linear model. When incubators were established, there were often not sufficient academics interested in starting companies to fill the facility. Engineers and technical entrepreneurs, learning about the incubator from local publicity, asked if they could join the incubator. They were often former employees of nearby large companies who were starting their own firms. Some of these entrepreneurs were simply interested in moving their firms out of their homes to a prestigious location; others were primarily interested in the common support services (secretary, photocopying,
reception etc.) and the easier access to university facilities, faculty and students, afforded by membership.

The transformation of university-industry linkages from a linear to an interactive innovation model can especially be seen in the evolution of the university business incubator from an isolated to a networked entity. The incubator has evolved into a support structure for innovation, a broader purpose than the original concept of developing firms from academic research (Rice et al., 1995). Incubators have also been utilized to develop business ideas into an array of firms and to form research centres by bringing together heterogeneous R&D entities from university, government and industry (Etzkowitz, 2001).

The KK Foundation’s Programme in a broader context of policy options

One way of assessing the KK Foundation’s portfolio is to benchmark its activity against the wider range of policy options available for the promotion of linkages. Figure 2 shows a recent taxonomy of such measures. Not all are realistic options for KK as some require governmental action. Nonetheless, it is useful to review these in turn.

a) Training and mobility

Beginning with the category in which the industrial graduate schools are situated, there is a group of policies which are targeted at the production of graduates with skills of relevance to industry, or else at promotion of the interchange of people between academia and industry in the expectation that this will produce a cohort who can transcend the two cultures and assist others in communicating and working together. Secondments, sometimes with salary subsidies to bridge differentials, are the normal means to proceed. However, these can suffer from the usual inhibitors of such mobility, including dual family careers and concerns about getting out of the mainstream in the original employers’ career structure.

Educational goals in this area are quite varied. One trend is for students to be taught management or interpersonal skills whatever their main area of study. There is an increasing tendency for industry to have some influence on the curriculum. In the extreme case companies have been founding their own ‘universities’, usually in a virtual mode through compilation of a portfolio of courses or experts from existing institutions, with the aim of providing tailor-made packages for their employees. Linkages for research students include initiatives where industry influences the topic for research and/or provides
facilities and co-supervision. The KK research schools sit in a group of initiatives where participants are clustered in graduate schools. The involvement of intermediary organisations as brokers for the schools is also found elsewhere.

Figure 2: *A Taxonomy of Policies for Promotion of Industry-Academic Linkages*

Source: L. Georghiou, New tools for optimising the transfer, sharing and joint generation of knowledge, Joint German-OECD Conference, Benchmarking Industry-Science Relationships, 16-17 October 2000

b) Research linkages

Also very common are policies to promote linkages in research (or research consultancy). The simplest format is that where a firm contracts research from a university, or with an individual academic to provide consulting advice based upon expertise gained through research. One traditional motivation for this was the opportunity to make use of advanced scientific equipment held by the university. This may still be true for small firms, but the rising
sophistication and cost of equipment now means that often the reverse situation applies, whereby academics use industrial facilities.

Public policies tend to concentrate more on stimulating linkages in longer-term more generic research than that which is typically the subject of exclusive contracting arrangements. The earliest policies tended to identify priority areas considered to be of interest to industry and to ring-fence funding for these. These priority programmes also could be more directed, through the participation of industrial representatives on Steering Committees or in the project selection process. Stepping up the level of interaction is the well-known instrument of collaborative research. Typified by the European Union's Framework Programme, this involves public co-financing of research performed both in academia and industry. Often the academic partner works on a next-generation option within a consortium, or else on testing and validation.

New institutional structures have also emerged to facilitate linkages. One form is that of the research centre where scale, and sometimes interdisciplinarity, form the basis of an improved interface. The KK research schools could also be seen as creating a critical mass for collaboration but this is dependent upon interaction within the group as well as with the industrial partners.

At the highest level are policies designed to change the mission of the entire academic institution. Recent years have seen the emergence of the so-called ‘Third Mission’ for universities. This term is applied to support for the community and industry as distinct from the original missions of teaching and research. From a policy point of view this change can involve legislation or financial incentives.

c) Co-location

Co-location measures are premised upon the assumption that spatial proximity is likely to stimulate transfer or commercialization of ideas. The longest-established approach is that of the science park, where facilities for companies likely to have linkages are provided adjacent to a university or public laboratory. Normally there is a restriction on the type of firm and/or business which may be conducted. A looser restriction is placed in a similar set-up – the technology park. More recently, companies have sought closer contact, seeking the ‘coffee break conversation’ available by being right on campus. Company laboratories on campus or joint centres are used to effect this goal.
d) Networking

In one sense, all policies discussed here are promoting networking, but some policies are strongly focused upon network-building. Research clubs may be formed as information exchange media to provide access to research results and in some cases to commission research on behalf of a group of members.

A policy which has spread internationally during the 1990s is the establishment of a national foresight programme. While this to some extent exists to establish research priorities at a national level, many programmes also promote networking through development of a common vision of the future between academia and industry.

e) Commercialization

In the knowledge economy the concept of technology transfer has been supplemented or in some instances even supplanted by the desire to commercialize knowledge created in an academic context. Intellectual property is at the core of this activity and this may be licensed directly to firms. In countries where IPR belongs to the institution, holding companies may be created to manage the process. Alternatively, specialised companies may undertake IPR management on behalf of the holders.

The creation of new firms has received a great deal of publicity in recent years. These spin-offs are normally dependent upon external finance (see below) and the institutions and inventors normally retain a part of the equity. The promotion of new firms is supported by a variety of measures, the most prominent being the provision of incubators which provide premises and business services tailored to start-up companies.

f) Information/Brokerage

One category of policy is founded upon the analysis that information failures are preventing collaboration. Measures which seek to remedy these failures include the construction of databases which locate either technological or business capabilities. Patent databases are also being exploited in this way. These measures may be located in technology transfer offices which may be specific to an institution or perform a more general regional function. Personal interaction is achieved through promotion of brokerage events and demonstrator facilities.
g) Finance

Financial promotion measures are probably the principal incentive by which the other policies listed here are implemented. Sometimes the core funding of an institution may be wholly or partly linked to obtaining a proportion of funding from industrial contracts (conditional finance). Cooperation may be supported by grants or loans or by fiscal incentives. Some newer schemes seek to stimulate the creation of seed capital funds targeted at technology-based start-up companies.

h) Legal/regulatory reform

The last category of measures discussed here concern the removal of barriers to linkages which are embedded in the legal system or administrative culture. These include reform of arrangements for the ownership of intellectual property rights arising from publicly-funded research. Lowering the cost of securing and defending IPR is a closely-related item. Where research is carried out by civil servants, reform is often needed to permit individuals to be involved in commercialization activities.

Conclusion: Towards the Entrepreneurial University

The university increasingly drives the creation of new intellectual and industrial paradigms such as biotechnology and nanoscience. Scientists who want to achieve recognition from original results also see that they can have practical results and participate in the rewards that can be generated from research, without the two objectives necessarily interfering with each other. Regulatory procedures have been introduced into academia to manage conflicts of interest. Academic researchers can think about forming a company based upon their findings and the university can be an industrial entrepreneur through its technology transfer activities.

Entrepreneurial science arises through a conversion of roles and a collapse of time frames. It no longer takes generations between original basic research and utilization. In molecular biology and computer science it can occur at one and the same time, making it more likely for the same people to be involved in both activities. Entrepreneurship is also built into the nature of the research university in systems where professors have to seek their own research funds. The entrepreneurial academic model is spreading as funds are increasingly given out for academic research through competitive processes instead of research funds supplied as a matter of right with the professorship.
A broad spectrum of academic institutions are engaging in entrepreneurial activities. Ancient foundations such as Uppsala and Lund Universities have their science parks, whilst a recently founded university such as Linkoping sponsors an Entrepreneurship Center and Karlskrona Rönneby a Soft Centre. The university is also changing its relation to society as it becomes involved in firm-formation not only from its research findings but increasingly in connection with its teaching role, through the establishment of distance learning enterprises. The university can no longer be viewed as a knowledge conservation, producing and dissemination institution, apart from its emerging entrepreneurial roles.

References:


____.(2000) ‘Towards the Entrepreneurial University’ Presentation at The Engelsberg/Avesta Conference August


Academy-Industry Collaboration

The Knowledge Exchange Programme is a large initiative funded by the KK Foundation at 1.2 billion SKr, excluding co-financing. The Programme has been launched successfully according to the terms established by the Foundation, and has injected the Swedish innovation system with a new source and form of funding. Projects were largely functioning well and in line with intentions. The organizational complexity of the programme concepts themselves and the implementation problems that follow from this account for a slower start than anticipated. The Foundation's strategy of refining the programme in an interactive trial and error approach to programme development is also conducive to a gradual start.

The programme has contributed to new networks and collaboration patterns across the academy-industry border. In particular the programme has made an important contribution to the creation of industrially relevant, interdisciplinary research schools in Sweden. The findings suggest that the research students themselves constitute a key link in knowledge transfer between sectors, by initiating and maintaining new informal networks both within academia and spanning the academic-industry divide.