Commercialisation of University Research in Europe

FINAL REPORT

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Executive Summary

This study has undertaken a review of good practice approaches to the exploitation and commercialisation of research by universities in Europe. The study has revealed that:

- The growth and development of university-industry relations in Europe has lagged well behind that of North America. It was only in the mid 1980s that European universities effectively became concerned about developing commercialisation and industrial ties. Before this period, academics in many European countries were legally bound not to undertake research work for industry. There were also strong cultural and social attitudes against universities collaborating with industry.
- If European universities lagged behind in establishing links with industry, they were even further behind in terms of developing mechanisms and strategies that sought to exploit and commercialise research and intellectual property (IP; Section 3.3).
- Intermediary institutions and agencies have been set up across Europe to get around this by providing an interface between universities and industry. However, in a way, this has delayed universities and their staff gaining more direct involvement and experience with industry.
- Universities in Europe only effectively began to explore such exploitation issues in the late 1980s and early 1990s, with the notable exception of a number of property-led schemes. Up until this period, central or regional government agencies in many European countries had sole rights over university IP exploitation and commercialisation.
- Compared to North America, therefore, European universities are still only in the early stages of learning about, and developing techniques, for research exploitation.
- Because of these barriers, research exploitation and commercialisation by universities in Europe has been more associated with the role of universities in *facilitating* industry in the exploitation of their research output rather than in terms of exploiting their own research and IP. Universities in Europe are however now being encouraged to take a more proactive role in developing their own research for commercialisation.

- Many of the survey respondents admitted that obtaining information about research output and IP activity was still inadequate, therefore IP disclosure rates were lower than they should be. As a consequence, protection of IP and its commercialisation was well below the optimum that it should be (Section 4.2).
- Most spin-out companies originating from European universities appear to be informal spin-offs where the university has no ownership and legal ties and usually no knowledge of their existence. Monitoring of university spin-out remains extremely poor throughout Europe; the best data remains for individual universities over limited time periods (Section 4.3).
- In relation to other activities, European universities have been active in property-related mechanisms in particular in the formation of science parks (Section 4.4).
- Aside from the belief that it was not a university's role to be involved in the exploitation and commercialisation of research, the other major constraining factor in the growth of IP and commercialisation activity by European universities has been a lack of money (Section 5.2). ILOs (let alone Technology Transfer or Commercialisation Units within ILOs) have had very small budgets to work from, and still less to devote to IP exploitation.
- The biggest barrier towards IP exploitation has, therefore, been lack of funding. This can be centrally seen in terms of the provision of seedcorn or early stage venture capital funds by universities' themselves, but it is also evident in the wider problem of finding finance that is external to the university system.
- The analysis stressed that attention should be paid to the 'whole spectrum' of IP generation, protection, exploitation and commercialisation. This includes not only collecting information and data on research output and IP generation, but also providing a better and more proactive framework in which to facilitate research commercialisation (Section 5.3).
- In Europe attention is still being paid to establishing the foundations for research exploitation and commercialisation. This centred on creating what they saw as the fundamental frameworks for research exploitation and commercialisation rather than improving consequent practice and performance (Section 5.4).
- Establishing university-owned spin-out companies was generally seen as maximising the 'take' of the university, although all too often universities were forced into less desirable commercialisation routes associated with licensing or royalty income (Section 5.5).

- There was also concern that an increasing proportion of university research had its IP 'signed over' to industry and therefore the possible long term commercial benefits being lost to the university (Sections 5.2 and 5.5).
- Most of the good practice case examples are recent, having been established over the last five years. They have already gone through several changes and modifications though (Sections 6.2.3 and 6.2.7) and are likely to continue to go through continuous improvement and alteration.
- Some of the examples are associated with targeting commercialisation practices within a genuine two-way, interactive framework. These include new knowledge sectors (Section 6.2.4) as well as older industries (Section 6.2.5) and SMEs (Section 6.2.3).
- Universities across Europe are trying to confront new challenges within the knowledge economy and this is evident in the case examples. This includes improving industry outreach to cover the regional economy more effectively through the establishment of regional consortia, either between universities themselves (Section 6.2.6) or between universities and other intermediaries (Section 6.2.11), and in terms of a university's role as an investor in academic spin-offs (Section 6.2.8).
- Universities, as revealed in the survey, are also having to face an increasingly international agenda even in relation to research exploitation; pan-national networks of universities can help meet these challenges and share examples of best practice (Section 6.2.9).
- The report concludes with outlining some key issues that have relevance to policymaking in the Canadian context (Section 7.2). The study sought in particular to highlight the diversity of universities and their contexts.

Abbreviations and Acronyms

ACST	Advisory Council on Science and Technology
ANETTE	Academic Network for Technology Transfer in Europe
ANVAR	Agence National de Valorization de la Recherché
AURIL	Association for University Research and Industry Links
BERD	Business Expenditure on Research and Development
BIC	Business and Innovation Centres
BTG	British Technology Group
CASE	Co-operative Awards in Science and Engineering
CEST	Centre for the Exploitation of Science and Technology
COMETT	Community Action Programme for Education and Training for Technology
CVCP	Committee of Vice-Chancellors and Principals of the Universities of the United Kingdom
DGXII	Directorate-General for Science, Research and Development, Commission of the European Communities
DGXIII	Directorate-General for Telecommunications, Information Market and Exploitation of Research, Commission of the European Communities
DGXV	Directorate-General for Regional Policy, Commission of the European Communities
EEA	European Economic Area
EC	European Commission
ECU	European Currency Unit
ERDF	European Regional Development Fund
EPSRC	Engineering and Physical Sciences Research Council
EU	European Union
EVCA	European Venture Capital Association
FI	Fraunhofer Institute

FTE	Full Time Equivalents
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GOVERD	Government Intramural Expenditure on Research and Development
GRE	Government Research Establishment
HC	Head Count
HEFCE	Higher Education Funding Council for England
HEFCW	Higher Education Funding Council for Wales
HEI	Higher Education Institute
HERD	Higher Education Expenditure on Research and Development
HESIN	Higher Education Support for Industry in the North
ILO	Industrial Liaison Office/Officer
IPR	Intellectual Property Right
IRC	Innovation Relay Centre
OECD	Organisation for Economic Co-operation and Development
PNP	Private Non-Profit
PPP	Purchasing Power Parity
PRE	Public Research Establishment
R&D	Research and Development
RDA	Regional Development Agency
RTC	Regional Technology Centre
RTD	Research and Technological Development
SHEFCE	Scottish Higher Education Funding Council
SIC	Standard Industrial Code
SME	Small and Medium-sized Enterprise
TCD	Teaching Company Directorate
TEC	Training and Enterprise Council
TLO	Technology Licensing Office
TTO	Technology Transfer Office
TUT	Tampere University of Technology

UfI	University for Industry
UK	United Kingdom
UMIST	University of Manchester Institute of Science and Technology
UNICO	UK Association of University Companies
USA	United States of America
UT	University of Twente

1. Introduction

1.1 Aims and Objectives

Universities and other Higher Education Institutions (HEIs) across the developed economies of the world have been facing major changes during the last decade, particularly in relation to their roles and responsibilities in the national system of innovation. During this period key studies have drawn attention to the emergence of new types of relationship in the process of knowledge production (Gibbons *et al.* 1994). Key agents in the production of knowledge within advanced industrial economies are universities, and governments have been increasingly concerned about improving their knowledge performance in terms of the level and quality of research output from such institutions. However, it has been realised that improving the internal knowledge performance of universities is only one aspect of the process; nations and regions also need to be able to 'capture' the wider economic and social benefits of that knowledge productions.

This may seem a very utilitarian notion of universities in terms of what benefits universities may confer on their indigenous communities. It represents, though, one of the two 'souls' (Miller 1995, 58) of a university's mission. The 'professional soul' of universities has often viewed industrial collaboration with at best ambivalence, but frequently with disregard or outright hostility to industrial collaboration. Involvement with industry was often seen as not a 'proper' function of universities, or at the least a 'baser' side that was best kept quiet. However there has also been another 'soul' that has sought to nurture and encourage exchanges between industry and higher education. This side has indeed argued that such interchange had noble merits involving the wider integration of universities with society and in the acknowledgement that universities have a duty to involve and engage as wide a section of the community as possible, including industry and the working classes. Such a view was reflected by the establishment of the 'redbrick' universities in the industrial heartlands of Britain in the mid and late nineteenth century. These were founded on the

principle of industry and academia working together, both for scientific and technical advancement in an academic sense, and also for the benefit of local industry and the economy.
The ability of national and local communities to benefit from such interaction therefore depends on universities and their ability to defend, harness and commercialise their research and technical outputs. It should be noted, though, that the universities in turn need support and incentives from these communities in order to achieve these objectives. This support is not only in terms of financial funding, but also in terms of providing the appropriate institutional structures, both nationally and regionally (province-wide), to foster and encourage such commercialisation activities.

The focus of this report is to provide information and lessons from a European context on how Canada can maximise the social and economic returns from investment in university research. This is particularly important in the Canadian context given that HEIs account for over 20% of Canada's R&D total expenditure (Section 3.1). The lessons and findings derived in this study are based on a survey of selected universities and organisations across Europe (Chapter 2).

The principal objectives of the study are to provide:

i) a set of good practice examples in terms of the commercialisation of university research;

ii information concerning the barriers to successful university commercialisation practices; and to

iii) provide guidelines and advice on what set of practices, frameworks and strategies are required for these good commercialisation practices to be successfully adopted in the Canadian context.

1.2 Industry-Academic Links: Background

Although industry-academic links go back to the late nineteenth century and represented the main mechanism by which industry funded research (Sanderson 1972a; 1972b; Meyer-Thurow 1982; Liebenau 1984; Swann 1985; 1988; Barnett 1986), it has only been since the 1970s that their industrial and policy significance has become fully recognised. Much of this renewed interest came from the United States (see, for example, the review by Peters 1989) where a number of universities were seen to have developed close links with industry.

These linkages resulted from arguably four main mechanisms and sources:

- via informal contacts and spin-outs from university departments;
- from contract and collaborative research performed by universities on behalf of industry;
- as a result of property-led initiatives in the form of science parks; and,
- via the commercial exploitation of university research through the management and licensing of intellectual property rights (IPRs).

Europe in general, and the United Kingdom (UK) in particular, saw the United States (US) as being at the forefront of the growth and development of industry-academic linkages. New developments and mechanisms furthering university-industry links in the US were closely monitored and often adopted in Europe. The 1980s was a particularly significant decade where European universities, especially from the UK, sought to gain a share of the increasing market for research funding, and institutional mechanisms began to appear in the academic system. Thus, a survey in 1989 found that some 60 Industrial Liaison Offices (ILOs) in UK universities had been founded within the preceding five years (PREST 1989). The establishment of ILOs in most Danish universities indeed came even later than this (Kuhlmann and Christensen 1989).

Today it is taken for granted that universities and other higher and further education institutes have a role in supporting innovation and technology transfer in their local and national economies, but the existence of this relationship has also introduced tensions and challenges which have had to be overcome. The first group of tensions again go back to the nineteenth century, when some

academics were concerned that research collaboration with industry was against the central ethic of universities, namely undertaking fundamental research and the education of students. They feared that links with industry would detract from this overarching mission of universities and individuals working within them, and moreover could have undesired side-effects. These centred on restrictions and distortions in the free flow of information and materials between the academic community

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academics were concerned that research collaboration with industry was against the central ethic of universities, namely undertaking fundamental research and the education of students. They feared that links with industry would detract from this overarching mission of universities and individuals working within them, and moreover could have undesired side-effects. These centred on restrictions and distortions in the free flow of information and materials between the academic community. When individuals or departments within universities enter research collaborations with firms, they usually have placed upon them arrangements that constrain the type, amount and destination of information disseminated. Today this problem is also seen from the other perspective, that potentially valuable intellectual property may be damaged by premature disclosure of scientific discoveries.

A second major group of tensions arise from the possibility that staff in universities are distracted from their academic functions by too much industry-directed work (OECD 1970, 120). In the increasingly busy life of the academic in the late 1990s, competing demands upon time are a major constraint upon the ability to develop and maintain external linkages. As this study will demonstrate, the strongest and most productive relationships with industry are founded upon universities doing what they are best equipped to do, that is pursuing excellence in research and teaching, rather than attempting to duplicate the functions of industry. The necessary cultural shift comes in terms of being able to understand the needs of industry and providing an interface that allows the swift and effective flow of knowledge and people to their most productive use.

1.3 Policy Initiatives to Stimulate HEI-Industry Linkages and University Research Commercialisation

Policies to promote HEI-industry linkages can be seen as a cumulative process in which new models have been established and developed over the past three decades without necessarily displacing those which went before. Thus an initial situation of informal linkages and occasional bilateral contracts was supplemented by specific policy measures from the 1970s onwards. These included the concept of ring-fencing areas of research deemed to be of particular relevance to industry and promoting them with additional resources and management support. In certain countries, though, it was driven by fears that nationally-funded research in universities was being commercially exploited abroad. This was most apparent in Britain. Thus, right up to the end of the 1970s, most universities in the UK had little monitoring, let alone effective control, of the intellectual property that was being generated by their staff. Many real commercial opportunities were lost. Some were never exploited. Others were taken up by private companies that were, all too often it seemed, from overseas. Indeed this view was so strong, that it led to the setting up in 1980 of Celltech Limited with funding from the National Enterprise Board (NEB). This, in effect, established a *new* state-owned company under the premiership and direct authorisation of Margaret Thatcher[1], decidedly against any state-owned companies.

During the 1980s, an increasing number of collaborative research mechanisms between universities and industry started to appear throughout Europe. They tended to, at least initially, rely on intermediaries, especially government agencies, to provide an interface between universities and firms (Sections 3.2 and 3.3) and a particular emphasis was placed on property-led schemes, such as science parks (Section 4.3). Governments began to introduce more novel schemes which also sought to tie in with more specific national or pan-national goals, such as the LINK programme in the UK, and more generally in the European Commission's Framework Programmes. The 1990s have, therefore, seen a broader effort to marshall academic research towards support for competitiveness and quality of life, as well as concern about universities being able to fully exploit their research output.

1.4 Report Structure

After a review of the methodology used to collect the information presented in this report (Chapter 2), Chapter 3 presents a brief outline of the European background to industry-academic links. Chapter 4 then outlines the main trends and structures revealed by the universities and organisations in the survey. This includes IP activity as well as spin-out companies and university-owned exploitation companies, science parks and incubator units, and company laboratories on campus. Chapter 5 then examines, using case study and survey evidence, university mechanisms, structures and policies that to seek to support linkages with industry and to effectively exploit university research. This includes frameworks and procedures for the management of intellectual property and spin out companies.

Chapter 6 then reviews and analyses in more detail good practices employed by the case study institutions in the whole field of exploitation and commercialisation that may be applicable to the Canadian university system. The report concludes in Chapter 7 with a discussion of the key issues arising from the study and an outline of some of the key issues that are seen as being most relevant to the Canadian situation.

Notes:

[1] What Margaret Sharp (1986, 30) has termed "a genuine aberration in terms of the Conservative government' s basic philosophy."

2. Study Framework and Methodology

2.1 Study Elements

To meet its objectives the study of European good practice in university commercialisation practices the study involved:

1. an initial exploratory phase that targeted a range of universities and related organisations across Europe that would both represent good practice in terms of research commercialisation but also have relevant implications for the Canadian situation;

2. undertaking a questionnaire and interview survey of selected universities and institutions; and

3. a wider secondary analysis of information and data on the European framework for industry-academic collaboration and commercialisation practices, as well as analysis and synthesis of the primary data collected from the survey phase.

The first phase of the study therefore involved a filtering process which consisted of scanning, identifying and then selecting appropriate universities and related organisations which could then be targeted for the main survey. Background information and contextual material was also collected during this first phase of the study, together with the construction of a questionnaire and a semi-structured interview guide. The second phase of the study involved sending out the questionnaire to the target institutions, arranging and completing the interview survey and then collecting, collating and analysing the material. The final phase involved collation of additional secondary material on the topic in addition to the synthesis of the material and completion of writing up the Final Report.

2.2 Scope of the Study

The focus of the study centred on the commercialisation and exploitation of university research and technical activity and the remit for this was clearly laid out. Appropriate indicators and information required to answer these questions were duly derived and incorporated in the questionnaire and interview guides (Section 2.3). More problematic was identifying those universities and organisations that would provide useful case analyses and comparators for the Canadian situation. In making the selection, the researchers sought to identify 'good practice' institutions that would provide examples of strategies and mechanisms that were successful and innovative regarding commercialisation and exploitation and that could have relevance to, and be applied to, the Canadian context.

On the basis of these criteria, being a major high profile research university was not a sufficient condition, since research output could be regarded as input to the process of what happens after the research has been generated, i.e. the commercialisation and exploitation phase (which is the focus of the study). Obviously this treats, to a certain extent, commercialisation and exploitation within a linear context[1]. Innovation and commercialisation is more complex, interactive and subtle than this. Nevertheless it is important to focus on the core issue. Commercialisation performance too was not necessarily a sufficient selection process if the basis of performance was dependent on highly informal or institutional processes that could not be replicated or not readily transferred to the Canadian context. A case in point here is the University of Cambridge where informal mechanisms, unique funding position and the highly institution-specific nature of the commercialisation and spin-off environment make it unreplicable even within the rest of the UK.

Thus the target universities that were finally selected (Table 2.1) were those that fitted the criteria of "examples of strategies and mechanisms that were successful and innovative regarding commercialisation and exploitation and that could have relevance to, and be applied to, the Canadian context". Universities may have started from a low base of commercialisation; what was important was the success it had in improving its performance and what mechanisms and strategies it had deployed to achieve this. All the institutions selected were universities.

Table 2.1

Case Study Universities

	Name	Country	Size		
			Students (FTEs)	Staff (FTEs)	Total Income MECU (M$C)
1.	Chalmers University of Technology	Sweden	7,300	2,200	190 (298)
2.	National University of Ireland, Cork	Ireland	10,800	2,215	101 (159)
3.	University of Glasgow	UK	16,500	2200	271 (426)
4.	University of Leeds	UK	18,000	2400	-
5.	University of Louvain la Neuve	Belgium	20,000	4,800	-
6.	University of Manchester	UK	17,000	2,500	10 (16.6)
7.	University of Newcastle upon Tyne	UK	11,500	1,900	-
8.	University of Tampere	Finland	6,000	1,200	-
9.	University of Toulouse	France			-
10.	University of Twente	Netherlands	6,000	2,500	115 (240)

Source: Compiled from PREST survey and web sources

During the initial stage of the study those universities that were on the initial target list were approached and institutional points of contact identified. In most cases the institutional points of contact were the Industrial Liaison Officers, Technology Transfer Directors or Commercial Directors who were also the best-positioned and competent persons to answer the survey questionnaires. Several respondents noted that the required information had to be collated from multiple sources within the institution. In some cases senior academic staff assumed overall responsibility for the institutional response. The study collected information for the academic year 1996-97.

2.3 Study Framework

On the basis of the above, the following instruments for data collection were used:

i) Questionnaire Survey

A questionnaire was sent out to the Industrial Liaison Officers, Commercial Directors or equivalent in the universities and organisations that were selected for study. The questionnaire sought to gain more direct data about the following issues:

- ***General Industry Links***: including number and size of research contracts directly commissioned by industry; type of research and services offered by the universities; the size of industry contributions; movement of staff; number and size of participation in schemes aiming to increase collaboration with industry; participation in local schemes and initiatives.

- ***Barriers and Opportunities in Commercialising University Research***: including motivations for entering into collaborative relationships with industry; barriers to forging new links with industry; problems most commonly associated with maintaining existing links; the role and importance of intermediary organisations and other factors for forming new research and consultancy links with industry.

- ***Exploitation and Commercialisation of University Research***: involving number of exploitation and spin-out companies and when these were set-up; turnover of the exploitation and spin-out companies (by company and year if possible); contact details for the exploitation and spin-out companies; mechanisms established for commercialisation of R&D results (incubators, participation in Science Parks); number of patents and licences filed and granted; organisation of IPR activity.

ii) Semi-Structured Interviews

The study also used a semi-structured interview guide for interviews with Industrial Liaison Offices, Technology Transfer Officers or Commercialisation Directors within the target

organisations and who are involved in managing industry links, commercialisation and IPR strategy for universities. These interview guides sought to collect more detailed information on issues already included in the questionnaire such as modes of institutional involvement in collaboration with industry; problems with commercialisation; information regarding the strategic views of present and future policies at an institutional level; and the way in which these are influenced by policies at a national or pan-national (European Union; EU) level.

iii) Direct Inquiries

In addition, in the course of the study a number of direct inquiries were made to bodies such as the European Commission (DGXII and DGXIII/D), the ANNETTE group and individual expert consultants within Europe and elsewhere.

Response rates to individual questions in relation to the questionnaire and semi-structured interview surveys were variable. In general closed questions and those requesting comments or opinions were answered better than requests for financial data which posed much greater difficulty for respondents. A number reported that they were unable to break down information in the ways requested because it was not recorded in an appropriate format. Others had no centralised records and were unable to retrieve it from their component departments.

Notes:

[1] This has parallels with the simple linear view of innovation more generally (Kline and Rosenberg 1986).

3. European Context of University-Industry Links

3.1 Introduction

There has been significant growth in the proportion of industrial funding of university research. In Germany, industrial funding of universities grew from 53MECU (95M$C) to 443MECU (795M$C)[1] between 1980 to 1995, corresponding to a rise as a percentage of total funding from 2% to 9% (BMBF 1996; see also Schimank 1990). In the UK, some 11% of total research grants and contract income came from UK industry in 1996-7, amounting to 271MECU (426M$C) (Howells *et al.* 1998). This figure of industry funding would be even higher if funding from overseas firms was included (raising the amount by approximately another 72MECU (113M$C) leading to an industry funding to total funding proportion of around 13%). Growth at current prices over three years, 1994-5 to 1996-7, for UK industry-funded research and contracts was 29.6% (with the highest growth coming from overseas industry funding).

However, although industrial funding of university research may be relatively high in the major economies of Europe, in more peripheral parts of the EU, industry-funded research is very much lower. In 1995, for example, industry-funded research in higher education only amounted to 0.8% of total Higher Education Expenditure on Research and Development (HERD) in Portugal (Pires *et al.* 1998), although the share of HERD to total Gross Expenditure on Research and Development (GERD) is one of the highest in the EU (Table 3.1). By contrast, HERD as a proportion of GERD is below average in France, Germany and the UK *vis-a-vis* the EU average and indeed that of Canada (Table 3.1).

Table 3.1

Higher Education Sector Expenditure on Research and Development (HERD) as a Proportion of Gross Expenditure on Research and Development (GERD) and Gross Domestic Product (GDP): 1995

Country	HERD ($ million at current PPP)*	HERD as a % of GERD	HERD as a % of GDP
Canada	2,327	22.7	0.37
Austria	799	35.0	0.52
Belgium	924	27.3	0.44
Denmark	527	24.5	0.47
Finland	420	19.5	0.46
France	4,518	16.7	0.39
Germany	7,255	18.9	0.43
Greece	222	40.7	0.19
Ireland	166	19.2	0.27
Italy	2,901	22.9	0.26
Luxembourg	-	-	-
Netherlands	1,835	28.8	0.60
Portugal	254	33.7	0.21
Spain	1,512	32.0	0.27
Sweden	1,304	22.0	0.79
UK	4,020	18.8	0.39
EU	26,821	21.0	0.39

Notes:

* Current 1995 prices at Purchasing Power Parities (PPPs)

\- Data not available

Source: Compiled from OECD data

3.2 University-Industry Links

It should be stressed that, up until recently, universities across Europe have been constrained in their ability to collaborate with industry and to effectively commercialise their research output. There have been major institutional barriers preventing universities to collaborate with industry or to commercialise research. In Greece, university staff were formally not allowed to work with industry. In Spain, the starting point for industry-academic links effectively only began with the promulgation of the Law for University Reform in 1984. This allowed, under Article 11, publicly-funded universities to perform contract research for firms for the first time.

In France, the problem of stimulating research contracts with industry has been hindered by the duality of the HEI structure in the country. On the one hand, the research-based universities, mainly funded by CNRS, undertake the bulk of high quality research but have had little contact with industry. On the other hand, the engineering schools were closely involved with industry in training the majority of management staff but were engaged in very little research and were mainly quite fragmented institutions. This group includes the 'grandes écoles' supplying elite graduates for upper management and the Civil Service (OECD 1986). In other European countries, the problems were more to do with cultural and social attitudes (and antagonism) towards industry. Collaboration with industry was simply not seen as part of a university's raison d'être or remit and was not seen as a something academic staff should be involved in.

In part to overcome these institutional, cultural and social barriers to industry and commercialisation, intermediary agencies and mechanisms were established. Thus in Spain, regional research centres, such as those funded by the Basque Autonomous Community, have been used to act as clearing houses and bridging institutions between universities and firms. In Greece a set of small, state-initiated research establishments have been established close to universities to provide a more flexible and entrepreneurial interface for industry collaboration. In Belgium there have been created national centres of excellence (Van Dierdonck *et al.* 1990, 553), such as the Inter-University Microelectronics Centre (IMEC) established by the Regional Government of Flanders in 1984 in Leuven (Van Helleputte and Overstraeten 1993). In Germany, a range of publicly-funded innovation centres have played a similar intermediary role between industry and universities (Sternberg 1990).

The UK has represented an exception to the general European pattern of former weak ties with industry. Institutionally it has always been one of the most open systems for research contracting and there has been considerable pressure to forge industry collaborations both politically, and also more directly in terms of funding. The shortage of research funding arising from the reduction in real government expenditure over time has been a major push factor for universities. However, industry involvement by universities has been associated with other factors as well. As noted in Chapter 1, the nineteenth century 'civic' universities in Britain have long had a core industry 'ethos' to their existence. UK universities have also had close links with US academia where industrial collaboration and entrepreneurial activity by university staff has been seen as a more 'natural' element in the functioning and role of higher education.

However, right across Europe there has been a 'seedchange' in terms of the way governments, society at large and universities themselves see industry-academic relations. Universities are now seen as playing a more pivotal role in the new knowledge economies of the twenty-first century. This includes a much stronger recognition of their duties towards industrial collaboration and research commercialisation.

3.3 Commercialisation of University Research

If Europe has been slow to develop industry-academic links, compared with the US, it has been even slower in developing effective strategies to protect and commercialise their research output. Moreover, those mechanisms that were in place were generally part of more centrally co-ordinated strategies to protect, commercialise and exploit government-funded R&D. In Spain, for example, the Spanish General Directorate of Scientific and Technical Research (within the Ministry of Education and Science) in collaboration with the general secretariat of the National Plan for Scientific Research and Technological Development has established a network of Offices for the Transfer of Research Results (OTR). These offices are located within universities and research centres, and are co-ordinated by a national Technology Transfer Agency (OTT). Thus the University of Aragon had an OTR established in 1986 to help stimulate technology transfer within the region (Sanchez and Tejedor 1995). The functions of this network are to encourage the external transfer of R&D results to industry, and to provide support and advice to researchers in the institutions on legal aspects of research and on gaining research funding, especially from the European Commission.

In the UK, although universities had considerable autonomy in industrial collaborations, the management and administration of university intellectual property rights was centralised under the control of one agency, the National Research and Development Corporation (NRDC), set up in 1949. This agency was merged with another agency, the National Enterprise Board (NEB, established in 1974) in 1981 to form the British Technology Group (BTG). This had a monopoly over the exploitation of publicly-funded research which lasted until 1985, although even for a while after this date, HEIs had to formally satisfy BTG that they had proper mechanisms in place for the identification, protection and exploitation of their intellectual property (Gourlay *et al.* 1997). Up until the end of the 1970s, therefore, very few universities in the UK gave any real consideration to IPR and exploitation issues. Although UK universities have been extremely active since that time and remain the most proactive in Europe in terms of commercialisation, their position is not as strong as their overall generation of industry research income suggests. In Germany Fraunhofer Gesellschaft, as a semi-public society offers a patent broker service to researchers in universities and public research laboratories, whilst Agence National de Valorization de la Recherché (ANVAR) offers a similar role in France.

Obviously, one indicator of commercialisation performance is the rate of spin-off from universities. These take two forms:

a) those 'formal' spin-offs that are wholly or partially owned by the university which the firm has spun-out of; and

b) all spin-offs, including 'formal' spin-outs and 'informal' spin-outs, companies established by former academic staff but where the university has no formal ownership ties.

Table 3.2 lists those studies that have sought to identify the volume of university spin-outs in Europe countries recently.

Table 3.2

European University and HEI Spin-Off Rates

Study	Country	Time Period	HEI Spin-Offs	Comments
Howells *et al.* 1998	UK	1994-97	94	Only university-owned spin-off companies
Kinsella and McBrierty 1994	Ireland	up to 1993	178	All spin-offs
Olofsson *et al.* 1994	Sweden	1970-90	550	All spin-offs
Van Tilburg and Hogendoorn 1997	Netherlands	1977-97	300	All spin-offs from University of Twente

3.4 Conclusions

Although the picture is changing rapidly, European universities have lagged a long way behind the experience and practices of US academic institutions in terms of industry collaboration and research commercialisation. Much of this has been due to the institutional and legal barriers that have often prohibited academic staff from working directly with industry. Social and cultural attitudes (based on perceptions about what universities' role in society should be) have also strongly militated against direct industry involvement. To some extent, intermediary institutions and agencies have been set up to get around this by providing an interface between universities and industry. However, in a way, this has delayed universities and their staff gaining more direct involvement and experience with industry. This is most evident in the UK, where British universities have, to a large extent, led Europe in industry-academic relations, but were restricted in their ability to exploit and commercialise their own research outputs because of the monopoly control of this process by BTG up until the mid 1980s.

This European picture of lagging behind in terms of university commercialisation and exploitation is now changing as universities and governments across Europe are exploring ways to more effectively 'capture' the benefits of university research and industrial collaboration. In addition, the European Commission has been exploring ways in which it can stimulate university commercialisation and foster 'best practice' methods across Europe. As part of this strategy it set up ANETTE (Academic Network for Technology Transfer in Europe) in 1991 to help universities across Europe share information and resources concerning the exploitation of university research. The network now has 11 members and is self-funding after four years of funding under the former SPRINT programme run by DGXIII/D of the European Commission. The Commission is currently exploring other mechanisms where it can support European universities to become more effective in their research commercialisation[2].

Notes:

[1] At 1980 constant prices, using 1995 exchange rate.

[2] An example of this is the Transfert project supported by the European Innovation Programme (outlined in Section 6.2.11).

4. University-Industry Collaboration, Exploitation and Commercialisation: Survey Trends and Perspectives

4.1 Introduction

This chapter presents information, data and interview material arising from the case study institutions. This analysis is particularly centred around trends and developments in the specific and 'visible' exploitation and commercialisation mechanisms and instruments namely:

- intellectual property rights, including patents, licenses and trademarks;
- spin-out and exploitation companies; and
- a variety of property-related mechanisms including science parks, incubator units and company laboratories on campus

A more in-depth contextual review of issues, barriers and strategies of university and other institutions towards exploitation and commercialisation is provided in Chapter 5. Chapter 6 then outlines the good practice mechanisms revealed by the survey.

4.2 IPR Activity

By the mid 1980s, with increasing degree of linkage between universities and industry in Europe, the tendency to view academic and public sector research as a free public good sponsored by government had begun to be replaced by a more complex model of public-private relations. This has been furthered by government, and other policy documents across Europe which have highlighted the need to improve intellectual property management and exploitation in the public sector, and universities more particularly.

There are three basic models of IPR operation within universities and HEIs[1]. First, there are pure publicly-funded research aimed at areas of fundamental science or research which is made available at little or no charge to the 'public' and which is essentially unprotected apart from copyright protection on publications derived from such research. In many areas of this type of research, no IPRs can be secured because basic scientific principles cannot be patented. A second mode of operation is the opposite extreme, namely, contract research paid for by a firm with full IPRs assigned to the firm or shared with the HEI. Between the two is a halfway stage most appropriately seen in the 'shared cost' model, whereby both university and industry enter a partnership to jointly share and exploit the ideas originating from the HEI (Section 5.5).

Even for general, public university research, however, there have been fundamental differences in Europe (and even between universities within the same country) on who owns the IP. In an increasing majority of European countries, including the UK, the IP formally belongs to the employer (university) in almost all cases, unless some agreement has been made to say otherwise[2]. By contrast in Sweden (through legislation instituted in 1949) and Finland, employees (i.e. the academics) have the rights to their own inventions in the absence, at least, of any other special agreement signed between the employer and the employee. However, in Sweden the employer is guaranteed a certain rights for the use of innovations made by employees, with appropriate, economic compensation (although this law only covers patentable inventions). Lastly, in some European countries the 'state', the national government or its designated agency, still retains rights over any IP generated by public universities.

As noted above, most countries appear to be moving over to the system that the universities themselves in the first instance own the IP generated by general academic research. Certainly in Sweden there is gathering momentum to alter their system. However, although most universities now accept that shifting all rights to the university may solve problems of control and ownership, it creates another problem in the form of lack of incentives to create and protect IP originating out of the university by the academics. This can be a real barrier to furthering commercialisation rates with the university (Section 5.2).

The survey revealed a highly variable pattern of patent, licence and other IP activity by the survey universities during 1996-7. In part this may reflect differences in disclosure rates and the ability of university administration to properly monitor IP activity within the institution (Section 5.1).

4.3 Spin-Out and Exploitation Companies

In relation to more direct commercial involvement, all the universities surveyed had a wholly or partially-owned company(ies) involved in exploiting the research generated by the institution. These companies can be basically divided between two types of company. Firstly, those firms often termed 'umbrella' organisations and are essentially holding companies for the exploitation of the university's IP portfolio and which remains under the direct, ongoing control of the university. Secondly, there are formal 'spin-out' companies from the university (Section 5.3) which are established to exploit the commercialisation of research results arising from a specific stream of research. The level of capital held by the university varies considerably and is usually determined on an ad hoc, case-by-case basis. However, even this appears to be changing, with all the universities noting that they were instituting more formal frameworks for allocating equity in spin-out companies.

Information collected from the case-study universities suggests that over 700 wholly or partially firms arose out of projects for commercially exploiting university research results. It should be noted though that whilst there has been a considerable growth in the number of firm's directly owned by universities, there is also a wide range of companies that have spun-off from universities where the university has no ownership ties[3]. Indeed traditionally, this has been a key aspect of academic entrepreneurship. Thus, like an iceberg, probably the most significant element in industry-academic links is via unrecorded, informal contacts, consultancy work and firm start-ups or spin-outs. This view was confirmed by those staff and senior academics interviewed for this survey, although by definition gaining solid information for informal spin-outs was extremely problematic.

As Charles and Howells (1992, 6) noted more generally in relation to firm-HEI-PRE links "it is important to stress the significance of informal mechanisms in technology transfer, although they are much harder to quantify or evaluate". A number of high profile (but exceptional) areas, such as Silicon Valley (Rogers and Larsen 1984; Saxenian 1985; 1994), Route 128 (Cooper 1971; Saxenian 1985) and the Cambridge area (Segal, Quince and Partners 1985), have all depended on their success and development on a dense network of informal, personal links and largely *informal* spin-out processes. Indeed much of the growth associated with the 'Cambridge Phenomenon' was associated with such informal spin-outs (Segal, Quince and Partners 1985). Certainly part of the

success of Cambridge and Oxford universities in the UK in terms of firm spin-outs has been the decentralised nature of the university system which has allowed a large amount of personal research and consultancy work.

4.4 Science Parks, Incubator Units and Company Laboratories on Campus

Although there are some early examples of science parks[4] in Europe - notably the Cranfield Institute of Technology (now Cranfield University; 1968), Leuven-Haasrode Research Park (1972), Cambridge Science Park (1972), Riccarton Research Park (at Heriott Watt University; 1974) and Parc Scientifique de Louvain-la-Neuve (1976) - it was the 1980s that saw the real emergence and growth of such parks. Most of these initiatives largely centred on individual property-led initiatives led by universities and centred around science parks and related research and technology parks.

In a number of EU countries, though, such initiatives have been centred around national-based centres, such as the Plassey Technology Park Limerick (Ireland) or the Technopolis Novus Ortus in Bari (Italy), where it has been acknowledged that there are fewer opportunities for new technology-based firms to emerge from universities. Thus in the European context at least, not all science parks have formal ties with universities. Those science parks that are established by universities endeavour to satisfy a multiplicity of objectives. These cover the following aims:

- to earn revenue;
- to more satisfactorily capture IP 'leaking out' of the HEI;
- to attract in companies who may then be customers for the HEI's research; and,
- to fulfil a wider economic regeneration role within the local economy.

However, other science parks have little or no involvement with universities, although universities may see a science park as a locus of potential consumers for their services, as well as offering a potential site for spin-out companies which the HEI may, or may not, have a financial stake in. Thus, in Germany the main stimulus for science parks came from key professional bodies such as Verein Deutscher Ingenieure (VDI) or Verein Deutscher Electrotechniker (VDE) in which members from industry, trade federations and learned societies established parks centred around specific technologies. As a result most German science parks tend to have common scientific disciplines. The earliest science parks were established in Aachen, Berlin and Karlsruhe in 1983. By the late

1980s, 20 science parks were established with a further spurt of growth created after the unification of Germany in 1990. By the mid 1990s there were some 180 science parks in Germany in alone.

Care should therefore be taken in not equating science parks as simply a mechanism to solidify industry-academic links in a locality. In their own context, most schemes have been successful. However in the UK, which has led Europe in science park formation, there has been a recent drop in the number of science parks which are members of the United Kingdom Science Park Association (UKSPA) from 51 in 1996 to 48 in 1997. There has been a slight increase, though, (47 companies since 1996) in tenant companies in these science parks, bringing the total to 1,414 companies employing 27,000 people (UKSPA 1998). However although some £656 million having been invested in these UK science parks up to 1997, universities have been the source of only 15% of the finance going into science parks in 1997 and only 22% of tenant companies have originated for a university or HEI. Just 3% of companies in UKSPA science parks are HEI-owned firms. This confirms Massey's *et al.* (1992, 134) survey of 183 establishments on UK science parks which found that only one in six (17%) were university start-ups.[5] Massey *et al.* (1992) argue that some of the claims for science parks, in particular the close and substantial linking of academia with industry and the crucial improvement in the performance of the economy, are in their view overblown (see also Macdonald 1987). This is echoed in an earlier study in Belgian by Van Dierdonck *et al.* (1990, 564) which found weak links between science park firms and universities. More generally, only between 20-25 science parks out of 180 in Germany have been considered as being genuinely successful (Konecny 1995, 108).

A newer development has been the creation of virtual science parks. One such example is at the University of Leeds in the UK, where a prototype Virtual Science Park has been developed which aims to meet the strategic goals of a conventional science park, but at a much reduced cost and independent of the need for co-location. At the heart of the concept is the provision of a virtual working environment (VWE) which allows people to use multimedia technology to interact using person-to-person communication, providing the user with the ability to:

- navigate quickly and efficiently around a directory of resources;
- communicate in real time;
- browse through information; and to

- interface to national information highways.

The VSP is seen as enhancing the University of Leeds' ability to interact with industry and to develop and enhance its applied research and workplace learning activities.

On a smaller scale, but still significant developments in their own right, are other property developments in the form of 'incubator units' which are usually located within, or adjacent to, the boundaries of the university's campus. Thus, Chalmers University of Technology created over ten years ago an incubator unit called 'The House of Innovation' which houses companies spun-off from the university and has a floorspace of 600 square metres. This has been very successful and in 1997 took over the converted Holterman Hospital to form the new Stena Innovation Centre with some 5,300 square metres, mainly funded by the Stena Line Group. The University of Manchester has a more sector targeted incubator unit, the Manchester Bioscience Incubator, set up in 1997 (Section 6.2.7). This represents an 26.6MECU (44.3M$C) development which has received 8.9MECU (14.8M$C) in European funding and aims to create more than 900 jobs over the next five years. The first phase of the Incubator will be housed in a new building offering some 7,000 square metres of laboratory and office space.

Another way universities and other HEIs can secure closer relations with industry is to allow firms to locate laboratories on the institution's campus. This mechanism allows close liaison between the funding firm and the university concerned. It creates a culture whereby academic staff are more directly confronted with the firm's overall objectives in the research field targeted (although this is generally basic, long term research work). In turn, the company's research staff can be moved to the laboratory to gain a more academic feel for their work and to 'refresh' and 'renew' their own individual competences. This pattern of co-operation in Europe has followed that of the US, whereby a whole stream of companies have laboratories based on American campuses.

There are a number of examples of such schemes, especially in the UK. They vary from significant financial support of existing laboratories in return for research work to dedicated company laboratories. Most of these company laboratories have been situated at campuses of the older and larger universities. Thus, in the former case, Mitsubishi Chemical announced in 1998 that it will spend several million pounds on financial support for a new Genetics Therapies Centre and for the existing Process Systems Research Centre at Imperial College London. In the latter case, Eisai set

up its own laboratory at University College London. Pfizer from the US, who has its main European R&D centre in Sandwich, has also announced it is establishing a laboratory in the Department of Chemistry at the University of Kent where it will employ some 20 staff to work on synthetic organic chemistry. Interestingly British-owned firms (at least within the UK) have been more reluctant to directly fund dedicated research laboratories on campus, instead preferring specifically funded research projects. A recent exception to this has been the recent announcement by Unilever to base a Unilver centre in the Department of Chemistry at the University of Cambridge. The centre will cost 19.2MECU (32M$C) and will research into drugs that can tackle the so-called 'superbugs'. British Petroleum is also expected to invest 28.9MECU (48M$C) into creating a BP Institute at the University of Cambridge to carry out environmental and industrial research into oil, gas and water. This BP Institute will be located at the 'west Cambridge' campus near to the M11.

4.5 Conclusions

It is evident from a number of primary and secondary resources that European universities have increased their IPR, spin-off, science park and commercialisation activity throughout the 1990s, albeit from a small base. Concern and interest about fully exploiting the commercial opportunities of university research has come late to Europe; legal barriers to such activity in some cases only being removed in the mid 1980s. The picture presented from the survey institutions is flattering to the majority of European universities as the universities selected for study represented good practice institutions in at least part of their exploitation and commercialisation activity. However, even in these institutions many of the respondents admitted that obtaining information about research output and IP activity was still inadequate and therefore IP disclosure rates were lower than they should be. As a consequence protection of IP and its commercialisation was well below the optimum that it should be.

Most spin-out companies originating from European universities appear to be informal spin-offs where the university has no ownership or legal ties, and usually no knowledge of their existence. This is in part because most European universities have had no formal mechanisms to establish spin-out firms; those firms that were created under the partial or whole ownership of the university were exceptional, created on an ad hoc basis. It also goes back to the case that academics were effectively blocked from effectively commercialising their research output. Monitoring of university spin-out remains extremely poor throughout Europe; the best data remains for individual universities over limited time periods.

In relation to other activities, European universities have been active in property-related mechanisms in particular in the formation of science parks. Some of these have been long established dating back to the early 1970s and in the UK alone there are fifty science parks with some 1,400 tenant companies. However not all science parks have been successful whilst only a relatively small proportion of science parks tenants are university spin-offs. Equally science parks do not themselves increase the propensity for new firms to be created (Britton and Gertler 1986).

A growing number of universities have established on-site incubator units, such as that established by Chalmers University of Technology. Company laboratories on campus have been more

exceptional and recent phenomena. Although it is difficult to determine why this type of property-related initiative has been adopted much later, it may reflect some ongoing reservations about parts of the university physical infrastructure not effectively being part of the university and run instead under a hybrid, more commercial form of governance system, running against the perceived European ethos of what a university was about.

Aside from the belief that it was not a university's role to be involved in the exploitation and commercialisation of research, the other major constraining factor in the growth of IP and commercialisation activity by European universities has been a lack of money. ILOs (let alone Technology Transfer or Commercialisation Units within ILOs) have had very small budgets to work from and still less to devote to IP exploitation. Some of the key issues involved with this and the implications for IP and commercialisation management will be explored more fully in Chapter 5 below.

Notes:

[1] Charles and Howells (1992, 175-6); although it has been pointed out that the third, halfway stage mode was more appropriately the 'shared cost' model and has been duly changed to reflect this comment.

[2] There are notable exceptions to this rule even in the UK. Thus at UMIST, Manchester the university has signed over the IP to the researchers, although there is a clause in the contract that allows the university does get some share of the commercial returns on any patent/licence

[3] In certain literature those companies which have no formal links with their former HEIs are termed 'spin-outs', as distinct from the term 'spin-offs' which are seen as covering firms having formal ties with HEIs. However, since such a distinction is not widely accepted the term 'spin-out' and 'spin-off' is used interchangeably throughout the text.

[4] The word 'science park' is used throughout the report as a 'catchall' for all major property-led initiatives involving research and high technology activities, including research incubators, research parks and technology parks. Indeed technopoles incorporate many of the same aspects of these schemes except that their scale is much larger.

[5] Indeed Cambridge Science Park had one of the lowest percentage of academic start-up firms, whilst Aston (Birmingham) had one of the highest.

5. University Mechanisms, Strategies and Implementation Practices for Exploitation and Commercialisation

5.1 Introduction: Managing Commercialisation

Most European universities acknowledge that they have been poor at scanning and screening research projects undertaken in their institutions. Disclosure of research output has therefore been poor. Mechanisms to evaluate potential applicability of research for exploitation and commercialisation - and how research output should be handled if it merits commercialisation - have also been partial and in most cases ad hoc (unlike the commonly used and standard technology evaluation protocols and manuals that appear to be employed in many Canadian and US universities; Murray 1997, 7-8).

Although this is changing, European universities have clearly lagged behind in developing mechanisms and strategies for research exploitation and commercialisation compared with North America. It should therefore be stressed here that this chapter presents European experience in this field and what European universities (and more particularly the universities in this survey) view as good practice in relation to research commercialisation, not necessarily what internationally may be 'best practice'.

5.2 Key Barriers in Exploitation and Commercialisation

In relation to the most frequently mentioned problem noted in terms of the commercialisation of research results, the survey universities most often cited a lack of seedcorn or early stage venture development funds. This would normally be used for taking the initial idea to proof of concept, at which point venture capital finance could be sought. Closely related to problems of finance but also encompassing marketing and development capabilities was the second most frequent problem, finding the right partner or licensee, particularly within a reasonable time frame (Section 5.5). This was not necessarily the same organisation as a research partner but rather a commercial champion who could take up, develop and market the technology. Almost equally cited was a collection of issues around the problems of IPR, including the problem of prior disclosure of results in publications preventing rights being established and confidentiality requirements.

There was also the problem of securing a sufficient time commitment from academic staff in the face of other priorities and the lack of expertise in business generally and obtaining sound advice in how to commercialise research more especially. Lack of entrepreneurship among academics was also mentioned as a key barrier. Slowness of action was one manifestation of this. However, this lack of entrepreneurship may be due to the problem of lack of incentive structures for academics. This is clearly an area where UK universities have been experimenting to try and create enough incentives for academics to be encouraged to develop and exploit the research they are working on (Section 6.2.2). The other barriers mentioned were an excess of risk or uncertainty in the face of accountability requirements, the cost of IPR protection and difficulty in doing sufficient market research to establish whether commercialisation was a viable prospect.

Aside from the issue of IPR disputes acting as a barrier to industry-academic relations overall, the issue of IPR exploitation was seen as a significant overall problem. This was not seen so much as a barrier hindering industry relations, but as a lost opportunity in the sense that the university felt it did not have the adequate capacity, and more particularly funds, to commercially exploit or defend its IPR.

A more specific problem mentioned by universities within the UK was what may be termed the 'preemption' of IP rights by the universities. This was related to the general concern that

universities were signing away IP to companies in order to gain industrial funding for R&D. Although on one level, this was accepted as a 'natural' given that the firm was funding the research (Section 5.5); there was disquiet that as this type of industrial research grew, an increasing proportion of a university's IP 'output' was being externally captured. Thus the short term desire to gain funding for research activity, may actually be leading in the longer term to smaller IP 'cake' left for the university itself to develop and benefit from (Section 5.5). It was difficult to gain any specific evidence that this was happening on a widespread scale, but it was certainly seen as a potentially significant issue in relation to commercialisation activity and generating wider economic development derived from university activity.

5.3 Good Practice Procedures for IPR and Technology Management

The management of IPR and technology within a university can be seen as covering the whole spectrum of intellectual property and innovative activity, namely in the:

1) effective *monitoring* of research/inventive activity that is being generated by the university or HEI (i.e. to gain comprehensive disclosure of IP across the university);

2) accurate *identification and selection* of research/inventions that are seen as valuable and worth protecting in terms of the generation of future income;

3) *take-up and negotiation* of the selected research/invention with the research team for the protection and defence of the research involving the establishment of appropriate incentive and exploitation schemes;

4) *selection and establishment* of the appropriate legal IPR defence mechanisms for the research/invention;

5) decision on the *length and extent* of IPR protection for the research/invention; and the

6) appropriate decision on the long term IPR *exploitation and development* route of the research/invention.

It should be noted that many of these activities are not sequential and linear but run in parallel and involve close feedback loops. Nonetheless the range of these IPR activities provides a spectrum of what is involved in the proper management and functioning of the IPR system within HEIs.

The problem of adequate monitoring and management of IPR is especially difficult for small and/or new universities that are not able to lever the full value out of the intellectual property generated from research in the university. Such universities cannot afford to run an IPR office because it is simply too expensive and therefore they cannot properly monitor and defend their intellectual property rights across the globe especially against large firms. The idea of a number of these

smaller universities on a local/regional (Section 6.2.2), national or indeed international (Section 6.2.11) basis coming together to pool their resources to gain sufficient size is being actively considered by a number of university administrations across Europe.

Universities in Europe have also employed intermediaries to overcome this problem, but with variable success. These intermediaries, such as a research or technology corporation, have often introduced technology audits whereby they trawl departments for exploitable ideas. Other universities have introduced formal mechanisms so that staff are now made fully responsible for coming forward with ideas they think are patentable *prior* to publication or conference presentations.

Even once a national patent, for example, has been taken out, the university then needs to probably take out further European and US patents to properly defend it and then seek an industrial partner to use or further develop the invention. This can be extremely expensive, both in terms of searching for partners and continuing to defend the patent whilst a partner is being sought. Then there may be problems with industrial partners once they have been sought. Again small universities felt at a disadvantage against large multinationals with large legal departments, and considerable experience of 'working the system'. Once a contract was signed, monitoring its use could also be virtually impossible. Certainly universities across Europe felt that, although they had come a long way in developing their IPR strategies, they were still highly constrained in what they could do with the limited budgets they had available for IPR management. Against this, there were also firms who operated wholly honourably and had established good, long term working relations with universities. High levels of rapport and trust between the firm and university have sometimes been established, leading to deeper collaborative relations (Section 6.2.8), such as a joint venture.

Certainly universities in Europe are developing more sophisticated and formal arrangements for handling IPR arrangements with industry and this trend will undoubtedly continue.

5.4 Good Practice Procedures for Managing the Formation of Spin-Out Companies

Although the universities in the survey acknowledged that the basics to good practice as regards managing spin-outs companies was fairly obvious, they were still in many cases trying to properly implement these 'basics'. These basic elements were:

- Providing clear and transparent guidelines to all university staff who may be wishing to set up a spin-off company, so that the prospective entrepreneurs have a solid framework *before* they make their judgement about whether to proceed with setting up the company and how this should be done.
- The university, once contacted, should also proactively provide information, contacts (for example with venture capitalists) and support on how to *establish* a company.
- If the university owns the IP which protects the innovation or technology which forms the basis for the company, it needs to *jointly* discuss and decide at the outset with the academic inventors/prospective entrepreneurs whether setting up a company is the best option.
- Prospective entrepreneurs should be allowed to remain on a part time research or teaching position with the university if they so desire; there should be a clear *demarcation of responsibilities* and practices between the two jobs.
- Provision of advice to prospective academic entrepreneurs on what is required to effectively *operate* and run the company and what additional manpower expertise may be needed to be recruited to fill in gaps (often here a financial director).
- Associated with this, help potential founders set up *business plans* to define clear commercial goals for the new company as well as addressing market research and sales strategies.
- To quickly decide whether the university will provide all or some *seed capital* or venture funding for the new company and to facilitate contacts with other venture capital organisations.

There are also other options and additions that may form a 'wish list' for good practice including, for example:

- Prospective entrepreneurs who want to leave the university employ should be offered a *transition* employment period, starting with continuation of the payment of a full university salary and gradually shifting to self-employment as the company takes-off and with an option to return to an academic at a later stage.[1]

All the universities questioned felt they could improve their *decision-making criteria* about whether to support the formation of spin-off company. However this in a sense highlighted an even bigger issue from the basis of a European standpoint. Universities in Europe have had to be highly selective, rejecting many schemes which they felt deserved funding and which would be successful, because of funding restrictions. Thus all those questioned felt that the key issue was the major funding constraints which severely restricted universities being able to support company start-ups. Indeed some respondents felt that by improving other areas of good practice in helping the potential formation of a company, it merely created a bigger *bottleneck* at the final stage when the academic entrepreneurs were seeking seedcorn and venture capital funding.

Most universities in Europe only have limited seedcorn funding which means that very few company start-ups receive university funding and have to seek external venture capital funders. In theory this would be alright if potential academic entrepreneurs could be redirected to external seedcorn and venture capital financiers, however in practice Europe has lacked sufficient venture capital backing for new firm start-ups. There have been a number of EC and national government schemes set up recently to overcome these venture capital funding problems, but they will only provide a solution to this problem in the long term.[2]

5.5 The Successful Management of Exploitation and Commercialisation

There were a number of measures which respondents considered crucial to good practice management of university exploitation and commercialisation activity. These were:

- Clarity in the frameworks and procedures of exploitation and commercialisation policy.

- Transparency in decision-making concerning exploitation and commercialisation activity.

- Streamlined decision-making procedures.

- Effective decision-making criteria in respect of:
  - deciding which exploitation and exploitation *route* to take; and
  - if IPR protection route selected, how long the time period of protection should be afforded.

- Flexibility in decision-making as different technologies and circumstances favour different routes to commercialisation and timing.

- Comprehensive technology auditing to pick up non-disclosure of IP being generated by academics and owned by the university.

- Good information and contact provision to academic personnel regarding IP and commercialisation procedures.

- Establishment of a seedcorn and venture capital fund owned and run by the university.

The biggest issue in successful commercialisation strategy centred on taking the right decision as regards what exploitation and commercialisation route should be taken for a particular IP generated by the university. This, in turn, went back to lack of funding resources. Most universities acknowledged that the most effective economic and commercial leverage of IP was via company

spin-offs owned in part or in whole by the university. The US study by Gregory and Sheahen (1991) has may have helped shape perceptions here.[3] The study found that the probability of producing significant patent income through licensing was only 1.5 parts in 10,000 per person-year of research effort and 7 parts in 10,000 for any income. This compared with the probability of producing a significant spin-off company income was considerably greater at 5 parts in 1,000 per person-year of research effort for significant income and 13 parts in 1,000 for any income.

However, although company spin-outs may be the preferred route of exploitation they lead back to the problem of inadequate seedcorn or venture capital financing noted earlier (Section 5.4). Lack of venture funding then shifts the desired route for commercialisation (and the decision-making it necessitated) towards either finding external venture capital, again a problem (Section 5.4) or deciding what IP protection was best so that the IP rights could then be sold off for commercial benefit. However, even if IP protection was selected, this could be costly and there was only a small annual budget made available for such purposes. Indeed, one UK study has revealed that some British universities had no budget at all and for others it was less than 58KECU (91K$C) a year (Gourlay *et al.* 1997, 14).

Much of the commercialisation practice in European universities is not about doing what is 'best', but rather what is the 'least cost' route that will aim at least to salvage some benefit for the university. Achieving the 'best' in the sense of leveraging the maximum long term financial and commercial return for the university, is a rare event for most universities in Europe and not unexpectedly is reserved for a tiny number of elite projects considered likely to do very well commercially. For these exceptional projects, the most likely preferred exploitation route will be via a company start-up if the academic inventors are happy to become entrepreneurs. Even here though, outside venture funding will be required to support such an initiative.

For the rest, exploitation will be via execution of IP protection through patenting, copyright, trademark or other IP mechanism. However, even under this route, resources are tight. Patenting may be the preferred option but this can be costly to operate on an international basis. The 'whole-life' costs of a patent in the UK have been estimated in 1996 at between 86-123KECU (149-213K$C) (AURIL/CBI 1997, 38). These figures, moreover, ignore any cost of defending a patent, if the patent is infringed or challenged. For many universities only a short 'window of opportunity' is provided for finding licensing arrangements (usually a year) which, if secured, can then fund the

IP protection costs and subsequently provide a commercial return. Where the technology has a long development horizon, patents are often considered too expensive (unless the commercialisation benefits are seen as being very large) and trademarks are seen as a cheaper, but less desirable form of IP defence (Section 6.2.2).

However much of the discussion so far has been on the presumption of the university owning outright the results of its research. Increasingly universities enter agreements with firms funding research which share the IP or indeed allows the firms to own all the IP. A whole stream of different options might prevail over IP ownership rights *vis-a-vis* firms in respect of commercialisation. A range of possible (but not exhaustive) options is given below:

1. The firm owns the IP but allows the non-owning university user rights and benefits.
2. The firm initially owns the IP, but ownership is transferred to the universities if it is not commercially exploited within a given period (or for some other criteria).
3. The firm initially owns the IP, but the ultimate disposition of ownership is decided after a technology audit is undertaken at the end of the project.
4. Ownership of IP is only determined after the project has generated any IP to negotiate.
5. Any IP is jointly owned.
6. The university owns the IP, but the ultimate disposition of ownership is decided after a technology audit is undertaken at the end of the project.
7. The university initially owns the IP, but ownership is transferred to the firm if it is not commercially exploited within a given period (or for some other criteria).
8. The university owns the IP.

Within this there is also a range of non-owner user rights and benefits which further complicates the picture[4]. In many instances the decisions about what university's do with research generated by academic staff is constrained by a priori agreements with industry. Much depends on the time horizon involved, the length and cost of development and the type of firm involved. In sectors such as pharmaceuticals and biotechnology the cost of clinical trials and other development activities together with marketing and production investment demands means that companies prefer owning the IP originating from a research partnership with a university. Development times for pharmaceutical compounds can therefore take ten to twelve years; a period which precludes any university in terms of the requirements it places on financial resources and the risks involved.

For new and small universities particularly, there is a temptation to always go for gaining up-front research costs and for always allowing company's to take full IP ownership. Moreover, if the price of the project reflects at least the full cost and that the price is paid by the industrial partner, it is indeed not unreasonable to argue that all the results and any associated IP should be owned by the firm, which should also control what happens with regard to IP protection and publication. The problem with this strategy is that although the universities will receive 'up front' and full payment on the research it undertakes, it will never realise the full commercialisation benefits of its activities if industrial partners always control and own those benefits (Section 5.2).

5.6 Conclusions

Aside from lack of interest or intention towards developing commercialisation strategies by universities in Europe, the biggest barrier towards IP exploitation has been lack of funding (Section 5.2). This can be centrally seen in terms of the provision of seedcorn or early stage venture capital funds by universities' themselves, but it is also evident in the wider problem of finding finance that is external to the university system. Europe overall has chronically been underprovided in terms of venture, and more particularly seedcorn, funding[5]. Other issues of a more general nature were also stressed; lack of entrepreneurship being one although this may relate to inadequate (or non-existent) incentive structures for academic researchers to commercialise their research.

In relation to management issues, the analysis stressed that attention should be paid to the 'whole spectrum' of IP generation, protection, exploitation and commercialisation. This includes not only collecting information and data on research output and IP generation, but also providing a better and more proactive framework in which to facilitate research commercialisation (Section 5.3). However, this 'whole spectrum' approach may throw up additional problems. Improving the 'flow', or relieving the bottleneck, in one part of the IP activity/commercialisation system (for example, improving disclosure) may only highlight problems elsewhere (generating more projects which have commercial value but which cannot gain funding).

The survey universities felt their decision-making criteria about commercialisation in general and in the support of spin-off companies could be further improved (Section 5.4), although financial problems were still a major problem here. In Europe attention is still being paid to establishing the foundations for research exploitation and commercialisation. This centred on creating what they saw as the fundamental *frameworks* for research exploitation and commercialisation rather than improving consequent practice and performance. This was rooted in establishing procedures that were clear and transparent, but which allowed flexibility in application.

Good information and contact provision, comprehensive technology auditing and the establishment of a seedcorn or venture capital fund run by the university were other priorities (Section 5.5). Establishing university-owned spin-out companies was generally seen as maximising the 'take' of the university, although all too often universities were forced into less desirable commercialisation

routes associated with licensing or royalty income (Section 5.5). There was also concern that an increasing proportion of university research had its IP 'signed over' to industry and therefore the possible long term commercial benefits being lost to the university (Sections 5.2 and 5.5).

Notes:

[1] Indeed the French government has recently instituted just such measures for researchers in public research institutes.

[2] These include both the creation of venture capital funds such as the UK 'University Challenge' Fund worth 59.2MECU (98.4M$C) and funded by the UK government, 29.6MECU (49.2M$C); the Wellcome Trust, 26.6MECU (44.3M$C); and the Gatsby Charitable Foundation, 3MECU (5M$C) set up in 1998, as well as schemes which provide an interface between new, technology-based firms and venture capitalists. An example of this is the Information Relay Centre (IRC) Innovation Financing Initiative set up by IRC North Germany which is initially targeting support for new biotechnology companies, setting up a Biotechnology Investment Forum.

[3] Some respondents referred directly to the study.

[4] See AURIL/CBI (1997, 39) for discussion on this issue.

[5] Even as late as 1980 it was estimated by the EVCA that only a dozen or so venture capital providers existed in the whole of Europe; most of these were based in the UK.

6. Commercialisation and Exploitation of University Research: Survey Evidence of Good Practice

6.1 Introduction

As noted in Section 2.2 in relation to making the selection process of 'good practice' institutions overall, the researchers then focused down on specific examples of strategies and mechanisms that were regarded *both* by the institution and the researchers as being successful and innovative in terms of commercialisation and exploitation. Not all of the institutions that were surveyed yielded examples of 'good practice' mechanisms or practices. Equally two universities formed the basis of more than one case study. Thus Chalmers University of Technology generated two case studies (Sections 6.2.3 and 6.2.8), whilst the University of Newcastle upon Tyne formed the basis of one good practice example on its own in relation to its exploitation strategy (Section 6.2.2) but was also involved in three other examples (Sections 6.2.5, 6.2.6 and 6.2.7).

The phrase 'good practice' rather than 'best practice' is employed throughout the study in part as deference to the fact that this study is limited in scope and cannot suggest that it is full and comprehensive evaluation of all European university exploitation and commercialisation schemes and mechanisms. On a final, but important note, the selection criteria for 'good practice' included the notion of transferability and applicability. There were schemes and mechanisms discovered in the survey that were successful, but were not included because they were dependent on a highly specific set of circumstances. As such, their unique character meant that were probably difficult to replicate and transfer to other situations, most notably to the Canadian context. As noted earlier in Chapter 2, the main criteria therefore for selection was based on selecting and representing those "examples of strategies and mechanisms that were successful and innovative regarding commercialisation and exploitation and that could have relevance to, and be applied to, the Canadian context."

6.2 Case Study Examples

6.2.1 Introduction

The study selected the following good practice examples for highlighting and review:

1. Exploitation Revisited: University of Newcastle upon Tyne
2. Chalmers School of Entrepreneurship: Training the Entrepreneurs of the Future
3. Digital Media Institute: An Interface between University and Industry
4. RCID: Sectoral Targeting through Institutional Networking
5. HESIN: Regional University Consortia to Gain Scale and Research
6. Knowledge House: SME Targeting and Outreach
7. Chalmers, Volvo and Materials Science: Long Term Relational Collaboration
8. Vuman: University Exiting Strategy from Company Investment
9. Embryonic Network of University Good Practice: ECIU and the University of Twente
10. University of Twente at the TOP: Supporting University Spin-Offs
11. University-Intermediary Co-operation to Stimulate Spin-Offs

The good practice examples are in no particular order, although they follow a broad linear sequence from creating the right environment to exploit research through to managing such activity and finally to exiting from the research commercialisation process.

6.2.2 *Exploitation Policy Revisited: University of Newcastle upon Tyne*

Background:

The exploitation and commercialisation aspects of the University of Newcastle upon Tyne are coordinated by its Technology Transfer Office (TTO) which operates within the University's Research Services Unit. As for the UK as a whole, ownership of any intellectual property generated by university staff vests with the employing organisation.[1]

Good Practice Case:

Unlike most North American universities, universities within the UK have only recently tried to formalise and codify their intellectual property exploitation policies. The University of Newcastle upon Tyne case is an example of good practice via its more stringent focusing on three aspects of its exploitation strategy, namely:

1) through more effective scanning of intellectual property that the university's researchers are generating;

2) its more formal incentive structure to encourage the production and development of inventions and technical developments; and

3) its decision-making procedures about whether the intellectual property is worth defending and, if so, how it should be defended.

1) Scanning: Although the university had been increasing its commercialisation of research output this had largely been done on a reactive or 'word-of-mouth' basis. The university's officers had largely waited for academics to announce that they had something valuable to exploit commercially. Although this generally did yield the key IP output of the university, an audit of several departments highlighted the fact that there was still valuable research output that had commercial worth which was simply not being disclosed. This IP was therefore not being exploited by the university; or left to the industrial partner to surreptitiously exploit the IP, even though the university may have had equal or even greater rights to the IP. To counter this loss of IP potential, technology audits were put in place across the university as well as formal annual reviews at

departmental or faculty levels. However this was shown to cause resentment amongst academics who felt that they were constantly being monitored and not allowed to get on with the research. Over time a more informal approach has been made by the TTO by contacting senior academic staff and meeting individual staff or project team members. Although in terms of contact the approach is informal, just as much attention is paid to ensuring that a full 'sweep' of the university is made and better relationships can be engendered with the staff. As a bonus, potential areas of future IP conflict can be dealt with and monitored through this scanning process.

An 'education' programme has also been instituted to make academic staff more aware of IP management issues and to improve their understanding of industry needs and concerns. Nonetheless, IP scanning and identification remains a time consuming process and it has been realised that more effort needs to made for IP identification at the outset of a project at the project planning stage.

2) Incentive Structures: Although the university formally has all rights over any IP generated by academic staff this provides little incentive for academics to consider the exploitation and commercial benefits of the research they undertake. University of Newcastle upon Tyne had for many years considered whether and how academics should benefit from the IP they generated on an ad hoc basis. Although in some ways this was necessary because of the wide range of different IPR circumstances to each case it led to an opaque system that caused resentment. As a result a more formal structure was introduced (Box 6.1) that has been fine tuned over the years.

Box 6.1

University of Newcastle-upon-Tyne's Intellectual Property Exploitation Policy

Exploitation by Licensing or Assignment:

- Revenue shared between university and inventor(s)
- After legal costs, first £5,000 of intellectual property (IP) income goes to the inventor(s)
- The next £200,000 of IP income is split the following way: 50% to the inventor(s); 25% to the department(s) of the inventor(s); and 25% to the university

Exploitation via Start-Up Company:

- Inventor(s) can take equity in the company
- Inventor(s) involvement subject to the university's company directorship policy

3) Screening and Selection for IP Protection: The improved scanning process outlined in 1), although successful led to the creation of a new problem in that more IP cases were now being generated which the university had to review for exploitation and defending. Where the university has the rights over the invention, or has been granted them, decisions have then have to made over the costs and benefits of protection. Different valuation approaches are used in relation to intellectual property including sunk cost valuations, direct financial return accounting and models providing for a wider recognition of indirect benefits associated with proceeding with protection. The university still realises, though, that IP exploitation benefits may not be obvious and that schemes are being rejected which should have been allowed to go ahead. With a potential protection gap (from idea/results through to launch of a commercial product and service) period ranging from 1 year through to 15 years, the university has to consider the appropriate mechanisms to decide about defending, how long 'protection gap' will be and how much it will cost. There are various sources of money to fund the idea to product gap. If the decision is to exploit the invention via IPR, the University of Newcastle upon Tyne itself only has a very small patent protection budget (58KECU (91K$C) p.a.) and therefore the TTO usually allows only a 12 month 'window' from patenting something for it to then find a royalty income or licensing deal with a company which will then secure the funding of protecting the invention for the rest of its life.

It may be that if the technology is really ahead of its time and that the innovation may still not be properly developed after its 18th year, the university has increasingly sought to take out a trademark which may have a life of anything between 50 to 70 years. This secures the protection of the technology in terms of a wider envelope and creates a 'brand awareness' for the technology. For inventions which the university decides it wants to commercialise itself it has its own venture capital company Newcastle University Ventures Limited (NuVentures Limited) which can seek to support the new venture on a medium to long term basis.

6.2.3 *Chalmers School of Entrepreneurship: Training the Entrepreneurs of the Future*

Background:

Chalmers University of Technology was founded in 1829 and has a long history of collaboration with industry. Over the last twenty-five years, Chalmers has also gained a reputation for its track record of producing 10 to 15 spin-off firms per year. One estimate in the early 1990s suggested that the university's spin-off companies contributed a 113MECU (178M$C) to the local economy each year (McQueen and Wallmark 1991). However, of the network of over 200 Chalmers spin-off companies that still exist, only around 40 are substantial businesses that have been built up to more than just a few staff. Some 8% of the university's income comes from industry-funded research (Table 2.1).

Good Practice Case:

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

Now in its third year, Chalmers School of Entrepreneurship aims to 'teach' entrepreneurial skills to final year Masters students. The course has been heavily oversubscribed since the outset, and has had to be designed to accept only the strongest, most driven students selected according to the results of external psychometric testing, and extensive interviews with the School's board. The School had 12 students in its first year, and has added another three students to its intake in each subsequent year. The students are grouped into teams of three, and matched with a new technology and its university inventor. The students then undergo a year of intense real-time, live case-study in which they must develop an appropriate strategy for the new technology to be developed into a start-up firm by the end of the training. Teaching is done as modular workshops that are relevant to the position of the business to date. Groups meet their other peers to discuss successes, and assess

their strategies for 'their' businesses; although the students are actively discouraged from having any ownership stake in the company until they have completed their course. The School has had a good rate of success with the course, and has only this year had to build in an element to discuss failure in a positive way.

Another feature of good practice in Chalmers is the facility for start-up firms to be helped at each step of the process. The School of Entrepreneurship only captures a small number of the technologies available for development/exploitation. In general, though, the process of commercialisation is as follows. Once a researcher has an invention, he/she can approach Chalmers Innovation (Chalmers Foundation owned unit) to discuss whether this idea should be patented or developed as a spin-off company. If patenting is the chosen route, Chalmers Innovation has links with a group called Research Patents-West (partly owned by Chalmers Foundation and Göteborg University). Research Patents-West will assess the invention to determine the return from patenting, and should it go ahead, will direct the inventor toward a specific patent attorney

If it is decided that a start-up company should be formed, Chalmers Innovation has links with Chalmers Invest. This organisation, owned by the Chalmers Foundation, has 3.4MECU (5.4M$C) at its disposal for early, equity investment in start-up companies (although the maximum investment per company is 115KECU (180K$C)). Chalmers accept that it would be better if other actors were available to provide funds at this early stage, and that its lone role at this stage may be a weakness. However, this early stage investment is only for a very short period (generally one year), in which time the firm must develop a business plan to attract venture capital. If firms fail at this stage, the funding from Chalmers Invest is not repaid to the Foundation. This therefore encourages Chalmers Invest to back only those companies that will succeed.

Firms are encouraged to approach external venture capitalists for funding. However, the majority of firms from this system approach a firm called Innovationskapital, a venture capital company which participates in newly-established, high-tech companies. This private finance concern aims to build growth in the early years of these firms, which can then be returned from the sale of its shares in the firm at a later date.

Throughout this process, Chalmers Innovation provides low cost services and equipment to the start-up companies. It also provides advice and training throughout the build up of the firm.

However, Chalmers Innovation only envisages firms being situated in their premises for a maximum of five years. They believe that at the end of this period, potentially successful businesses will survive on their own. The companies are encouraged to seek new premises outside the university. This is contrary to the popularly conceived model of spin-offs re-locating to a university science park (however see Section 4.4). The University of Chalmers does not see the science park as being the most appropriate location for spin-off companies since high rents are prohibitive and are intended to be affordable only by those large national/multinational companies based there.

6.2.4 *Digital Media Institute: An Interface between University and Industry*

Background:

Tampere University of Technology (TUT) is one of Finland's three universities of technology and was founded in 1965 with just 112 students. Since its inception the university has developed rapidly and gained a significant position in the Finnish higher education system. In the early years the university grew slowly adding about a hundred new students per year until 1971 (when there were still only 700 students in TUT). After that date, student number grew annually by between 100 and 400. However in 1990s growth has been even greater. In 1991 alone the number of new students increased by one thousand. By 1995, there were about 6000 students in TUT, including postgraduate students, and it has continued to grow since then (Table 2.1).

By focusing on a set of key technology and technical sciences it has formed a clear strategic profile, with some areas achieving worldwide international renown. The most important of these are materials technology, semiconductor technology, and signal processing. TUT offers certain programmes which are not available elsewhere in Finland, these include: textile and garment technology, automation engineering, and materials engineering. There is also a department specialising in environmental technology. TUT is an active member in the EC RACE, COST, COMETT, ESPRIT and EUREKA programmes. Characteristic of TUT is its close connection to industry, which can be seen in the substantial amount of industry-commissioned research that it has undertaken throughout the years since its establishment.

TUT has long and established co-operation with local industry. This comprises services such as basic and applied research, planning and product development, tests and measurements, Master's theses being made for firms' purposes, and customised education and training. Although charged for, these services are also within a reach of most of the SMEs. Compared to 1984, the finance from external sources in 1994 was over five times larger than ten years earlier. In 1994, external incomes were 19MECU (31M$C) of which finance from TEKES, funds, ministries, the Academy of Finland and other sources were 7.7MECU (12.5M$C) and 11.9MECU (19.4M$C) from industry. However, the fact is that TUT serves not only industry in the region but in the whole country and increasingly foreign firms. Tampere University of Technology nevertheless remains firmly rooted in its regional client base.

The reasons for this close co-operation are many. First, the region has a clear sectoral agglomeration in the field of mechanical engineering, where firms have a similar kind of technology base. Secondly, the guiding principals of TUT has always been open and positive towards co-operation and they have directed research and services to those areas strongly represented in the region. Thirdly, and unusual for Finland, is that very many of TUT professors have gained experience first within industry. As such, professors usually have many ongoing contacts with industry, 'they speak the same language', and they have a common understanding on the development issues. After becoming independent in 1972 TUT recruited a couple of young, active and well qualified professors who were free of old-style traditions that were dominant in the Finnish higher education system up until then. At the same time, TUT formulated its key strategic goal developing close co-operation with industry.

Good Practice Case:

The Digital Media Institute (DMI) is a separate research unit of Tampere University of Technology (TUT). The Institute was founded in 1985, when it was called the Institute for Research in Information Technology. In 1994 the research activities of the Institute were directed to the area of the digital media and it was renamed as the Digital Media Institute. Most researchers deal with digital media technology, but there is also close co-operation with marketing, communication, sociology, information research, mathematics, psychology and educational studies. In these areas, a very important co-operation partner for the DMI is the University of Tampere.

The organization of the institute is extremely light. Currently the institute employs about 120 researchers. The researchers are located in the premises of the laboratories involved in the operation of the Digital Media Institute. The research projects are coordinated by the senior staff (professors, associate professors and project managers) of the laboratories belonging to the Digital Media Institute.

The operation of the Digital Media Institute is very international. So far the DMI have researchers from about 18 different countries. The DMI is also involved with several EU funded projects (ACTS, BIOMED, ESPRIT, ESSI, RACE and TELEMATICS). The Academy of Finland chose the DMI as a new centre of excellence of research in 1996.

There was about 60 research projects in DMI in 1996. The budget of the institute for year 1996 was over 5.1MECU (8.9M$C). Funding of the projects comes from Finnish industry (41%), the Technology Development Centre of Finland (17%), the Finnish Academy (18%) and other sources (30%). EC funding is increasing rapidly as an important source of funding.

The TUT laboratories most involved in DMI activities are listed below:

4) Signal Processing
5) Telecommunications
6) Electronics
7) HypermediaLab/Mathematics
8) Software Systems
9) Information Technology

6.2.5 *RCID: Sector Targeting through Institutional Networking*

Background:

In 1996 three universities in the North East of the UK, University of Northumbria, University of Sunderland and the University of Newcastle upon Tyne, established the Regional Centre for Innovation in Engineering Design (RCID) together with 10 SMEs in the region. The new centre was established with the support of the national government's office in the North East, ERDF funding, the Tyneside Training & Enterprise Council (TEC), the collaborating companies and the University of Newcastle.

Good Practice Case:

The mission of RCID is "to create a collaborative research and development environment in which SMEs can develop methods and processes to enhance product development and improve their business performance."

RCID seeks to provide the following range of services to locally-based firms:

10) generic research and development programmes;
11) high calibre team of design engineers;
12) access point for SMEs to the regions' innovation and design capability;
13) support for supply chain development activities; facility for identifying best practice in the product design process; and
14) technology transfer activities.

Even over its short history RCID has helped over 300 businesses in the region and has helped attract inward investment. RCID has also become a strategic model for technological development in the North East region more generally and this has been recognised through its commendation into the UK National Inquiry into Higher Education. It should be acknowledged though that although RCID is a novel mechanism for Europe, exhibiting much of what best practice should be about, it appears to have remarkable similarities to a mechanism described as operating in Canada some twenty years ago.[2]

6.2.6 *HESIN: Regional University Consortia to Gain Scale and Reach*

Background:

Universities across Europe are seeking to form collaborative networks particularly to act as pressure groups based on the age, status and sectoral interests of the universities concerned. However, increasingly they are combining in terms of regional interest groups and these often have a strong industrial collaboration dimension. This can be seen in an increasing number of local, regional or national groupings of universities in the UK. One of the longest running is the Higher Education Support for Industry in the North (HESIN) which was established in the Northern Region to support wider frameworks for HEI-industry links in the region.

Good Practice Case:

HESIN was formed in 1983 as a local industry-academic consortium. HESIN's constituent bodies were five HEIs in the Northern region: the University of Newcastle upon Tyne, the University of Durham, the former polytechnics of Newcastle, Sunderland and Teesside together with Northern region office of the Open University. HESIN has set up several training schemes in collaboration with industry. The two most notable have been a EC-funded COMETT project and an integrated graduate scheme.

NEPTUNE was a COMETT-initiated university enterprise training enterprise which co-ordinated individual submissions from HEIs in the Northern region. It is a partnership between the six HESIN members, the Regional Technology Centre[3] (RTC North), the Northern Development Company and three private sector organisations. The integrated graduate development scheme is a new training programme for graduate engineers working in industry within the region, which offers a Masters degree in short-term course modules.

Although HESIN has been very successful in stimulating collaboration in training and another new areas of technology transfer (such as the Knowledge House; Section 6.2.6), the universities remain fiercely independent and still pursue very different exploitation strategies.

6.2.7 *Knowledge House: SME Targeting and Outreach*

Background:

In 1996, the Knowledge House was set up as an initiative to provide for local industry a single point of contact to the HESIN group of universities (Section 6.2.5). Based in the North East of England. The scheme is specifically targeted at SMEs who otherwise would not consider contacting or searching for university-based expertise and it is partially funded by European Regional Development Fund (ERDF) money.

Good Practice Case:

By acting as an interface connecting the universities and industry in the region, the task of the Knowledge House is to encourage local SMEs to take advantage of the combined resources located within the six North Eastern universities. The Knowledge House functions as a centrally coordinated enquiry and response service providing local industry with a single point of contact for advice guidance and support on a range of technology and management related issues. RTC North acts as the Central Coordinator of the Knowledge House, with additional managers based at each of the universities.

The central aims of the Knowledge House in terms of providing research services to local firms are to:

15) provide a rapid and confidential response services;
16) offer a free initial search and diagnosis package;
17) 'source' local assistance wherever possible (i.e. to the nearest available university);
18) arrange initial introduction between the firm's staff and the university personnel; and
19) monitor the progress of the delivery of the service once specified.

Contact by firms can be made either through the Central Coordinator at RTC North or to individual Knowledge house managers which operate at each of the six universities. Where necessary, assistance is provided by defining the exact nature of the enquiry; often an important issue for SMEs who are not used to using external research or technical assistance. This service is provided free of charge by the Knowledge House team. The enquiry is then confidentially

circulated throughout the Knowledge House network and sources of assistance and expertise are then identified. In order to achieve a high and even standard of service, once a proposal and a contract is agreed the progress of the project is then closely monitored by the Knowledge House team.

The Knowledge House has been received several accolades in the UK. It also has been commended and promoted in the UK National Inquiry into Higher Education. Its initial enquiry and revenue targets have been exceeded and crucially SME repeat business has been achieved. Second round ERDF funding has also been secured. However, staff associated with the Knowledge House recognise that have the desired 'reach' to SMEs substantial public support (subsidy) is required to get 'first-time' (i.e. who have never used a university for research or technical services before) small firms to use the scheme.

6.2.8 Chalmers, VOLVO and Materials Science: A Long Term Relational Collaboration

Background:

Chalmers University of Technology has a long history of collaboration with industry (Section 6.2.3). It also has a well established science park, Chalmers' Science Park, situated adjacent to the university campus. One measure of the success of Chalmers Science Park is that it already has a number of companies vying to be situated on the, as yet unbuilt, extension to the facility. However, the majority of the facilities based at the science park are the research units of large national and multinational firms like Volvo (see below), Ericsson and SKF.

Chalmers has a range of schemes to facilitate industry collaboration as well as exploitation and commercialisation mechanisms. These include: continuing professional development programmes; technology support schemes for SMEs; high-tech firm collaboration mechanisms; and university firm spin-offs programmes (Section 6.2.3).

Good Practice Case:

Volvo needed a flexible and skilled workforce that had specific competences that were relevant to Volvo's technology requirements and approached Chalmers to provide this training. These specific competences were in the fields of: aerodynamics, sheet forming, automated assembly, noise reduction, tribology, combustion, exhaust catalysis, corrosion control and use of light alloys.

As an initial way in to tap into this expertise, Volvo agreed to invest in equipment, personnel and laboratory space that would allow Volvo staff together with Chalmers academics to work jointly on the study of surface technology and develop training courses for work into this field. Such work particularly focused on tribology and mechanical and corrosive wear. Laboratory space was taken at Chalmers' Science Park, microscopes and other laboratory equipment was purchased, together with the hiring of Chalmers' graduates to man the operation. A number of staff work for Volvo and Chalmers on a 50:50 basis.

The co-operation has benefited both parties, aside from just the specific collaboration. For the university the collaboration has more generally allowed:

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

21) feedback by Volvo on the quality of its graduates;

22) Volvo personnel to work with university staff and students; and

23) use of direct examples from Volvo of modern engineering design problems and issues as teaching tools.

For Volvo it has allowed the firm to:

24) to obtain preferential access to the university's research base more generally;

25) use of other specialist equipment and instruments housed in Chalmers; and

26) to use the university as a 'listening post' for wider developments in science and technology related to Volvo's activities.

The recent divestment of the automotive side of Volvo to Ford has prompted some concerns for the future of the unit's research on Chalmers' Science Park. Universities, by seeking greater collaboration with industry, are more likely to be subjected to the wider impacts of everyday business practices such as the restructuring or take-over of the firms with which they collaborate. It should be noted though that the Chalmers' does not foresee any radical changes in the short or medium-term perspective.

6.2.9 *VUMAN: University 'Exiting' Strategy from Company Investment*

Background:

Vuman Limited was set up in 1981 by the University of Manchester to act as the university's technology development and exploitation company and has had a chequered history. Vuman is responsible for the protection of IPRs, licensing and the transfer of technology, including the establishment and management of spin-off companies. The University of Manchester is the UK's fourth largest university in terms of research output and not unexpectedly Vuman has grown over time and is now a parent 'umbrella' company for some 20 spin-out firms; with about 14.8MECU (24.6M$C) worth of assets under its control amongst companies whose total worth is 29.6MECU (49.3M$C). Vuman also works with Campus Ventures and the Manchester Biosciences Incubator (MBI). Campus Ventures was set up in 1995 to attract monies form local industry to help establish new high technology enterprises, some created from within the university and some which have emerged from the local economy. Some 24 companies have been supported so far. The MBI was established in 1997 to provide an incubator units for new bioscience companies (Section 4.4).

Good Practice Case:

Interest in Vuman is not so much in terms of its commercialisation and new formation rate but rather in its experience and role in corporate parenting and in the decision framework over disposing of university controlled companies. Although from the outset, Vuman did not want to be a long term holding company, it had no clear strategy of when and how to dispose of assets that would meet the following criteria:

a) benefit the university;
b) benefit the long term prospects of the spin-off company and its employees; and
c) aid the long term growth prospects local and/or national economy.

Through a slow process of evolution and trial-and-error Vuman has settled on four strategies regarding exiting strategy. They are:

1) *Retain:* Vuman has realised that in some instances that some university-owned will never be disposed of, or at least not for a very long time. This is essentially because such companies would find it very difficult to stand alone because of their very closely integrated with parts of the University and/or because of their heavy reliance on University staff or facilities. Examples include Manchester Informatics Limited which acts as a focus for the commercial activities of the department of Computer Science and Flow Science which depends on using the facilities of the University's Goldstein Laboratories.

2) *External Investment/Partial Disposal:* In relation to this option, a financial institution (usually a venture capital company) invest substantial funds into a university company, whilst the University retains a (sometimes substantial) share in what effectively becomes an independent company from the University. Examples here include Kestra Limited, an industrial inspection company that grew out of the Medical Biophysics Wolfson Image Analysis Group and where the University still retains a 25% stake, after a 1.8MECU (3.1M$C) was received from external investment. In the case of Semantic Technologies Limited only 360KECU (600K$C) funding was required and the University retains a 37% stake.

3) *Trade Sale:* This is where a company is sold to a larger firm already well established in a particular business. Thus Predictive Control Limited was recently sold to Siebe plc a major UK-owned international engineering controls and filters company. Reasons for trade sales centre on a set of related factors: needing access to a large-scale marketing and/or financial base; where high growth rates may also need financial muscle to continue such growth targets; and in sectors which make it difficult for small firms to compete effectively on their own.

4) *Management Buy-Outs (MBOs):* Under this option, the management of the firm, sometimes strengthened by additional management expertise and often supported by external financiers, seeks to purchase the whole of the business form Vuman. Thus Vuman Lasers Limited, a medical laser company was brought by its management team under Dr. Andy Charlton. The context for this option is that Vuman often responds to approaches relating to MBOs and the management team is confident of its independent future. Gaining external backing both in terms of finance and management expertise, is important in allowing the MBO option to go ahead.

Although Vuman is trying to develop a more systematic method for deciding alternative exiting routes for the university companies it accepts that it has to allow certain flexibility in the decision-making based on the individual circumstances, whilst selecting the 'right time' for disinvestment still remains problematic.

6.2.10 University of Twente at the TOP: Supporting University Spin-Offs

Background:

The University of Twente (UT) is located in the eastern part of the Netherlands, near the border with Germany. The university was founded as a university of technology in 1961 in order to increase the number of university-educated engineers in the Netherlands. The transfer of know-how, expertise and technology to the broader community is one of the university's top priorities. The results of that transfer are of major importance to the practical activities of commerce and industry, and public authorities responsible for a wide range of social, environmental, educational and health care functions.

Companies and other organisations regularly enter into contracts with the university's scientists to realise their research objectives, either independently or as part of European research programmes. The University of Twente actively promotes contact with both the business community and public authorities, and has developed structured ways to help individual entrepreneurs to find their way around the resources the university has to offer. The university's Industrial Liaison Office (ILO) was established in 1979 to build an effective bridge between the needs of industry and the university's research effort. The ILO was subsequently transformed into the Liaison Group (LG) which acted as a more focused 'university gateway' to education and training for the business community and the public sector. Lastly, and most significantly here, the university has also been centrally concerned about helping stimulate the creation of new enterprises in the locality.

Good Practice Case:

As part of this initiative to help new university-based spin-offs, UT created its TOP (temporary entrepreneurial post) scheme. This scheme is interestingly centred on new graduate engineers and seeks to provide a 'bridge' or support scheme for the key transition period when the new graduate is still setting up the company and testing the market for his/her new ideas. To do this the university offers a part-time research assistant post to the potential entrepreneur to provide the entrepreneur a basic income as well as to allow at least some spare time for him/her to set up the new company. The potential entrepreneur is supported by grants to help set up the company itself (through the University, which replaced original funding from the Dutch Ministry of Economic

Affairs, and the European Social Fund; ESF) and advise and guidance is also provided, together with information and introductions to necessary venture capital firms.

More specifically the support package involves:

- a part-time post in one of the departments of the UT;
- expert advise and support by colleagues in the department;
- the use of UT facilities, such as laboratory and test equipment;
- basic accommodation and some office facilities within the university;
- a risk-bearing loan without interest (maximum 30,000 Kf);
- use of the university's prestige and image and contacts within its wider network;
- possibilities of acquiring orders through the Liaison Group within the university;
- business management support and practical guidance by an experienced entrepreneur or mentor; and,
- support in the further development of a business plan via the TSM Business School course in entrepreneurship.

The University of Twente offers 20 such posts for these prospective entrepreneurs and is open to UT graduates as well as from other universities and higher education institutes and those within industry who wish to seek to develop a product idea with the aid of the university. The university estimates that some 300 spin-off companies have been created over the last two decades via this route, with a drop out rate of less than 25%.

6.2.11 Embryonic Network of University Good Practice: ECIU

Background:

As a way to further develop these aspirations concerning industry links and research exploitation (outlined in Section 6.2.10 above), the University of Twente with other like-minded universities across Europe helped set up the European Consortium of Innovative Universities (ECIU) in 1996. The ECIU specifically was set up to develop new practices and continuous improvement mechanisms to promote industrial liaison and commercialisation activities by universities.

Good Practice Case:

The founding institutions in the ECIU are:

1. University of Strathclyde (UK);
2. Aalborg University (Denmark);
3. University of Warwick (UK);
4. University of Joensuu (Finland);
5. University of Dortmund (Germany);
6. Technische Universitaet Hamburg-Harburg (Germany);
7. Universidad Autonoma de Barcelona (Spain)
8. Chalmers University of Technology (Sweden);
9. Universidade de Aveiro Campus Universitario de Santiago (Spain); and
10. University of Twente (Netherlands).

These universities have several characteristics in common. All have academic strengths in engineering and social science; all are relatively young, entrepreneurial, and progressive; and all have close ties to industry and to the regions in which they are situated. The ECIU is committed to developing and implementing new forms of teaching, training, and research; to assuring an innovative culture within our walls; to experimenting with new forms of management and administration; and to sustaining and nurturing internationally minded staff. The immediate goals of the Consortium are the design and advancement of several international programmes affecting curricula, research and regional development. These include: a joint European master's programme

in innovative management: European doctoral programmes; advanced technological short courses; joint research projects that map onto the Fifth Framework Programme of the European Union; joint SME/university schemes for regional development; joint recruitment of non-European students.

As it develops, the Consortium expects to:

- form enduring partnerships with business, industry, and government;
- promote co-operation between science parks and to encourage spin-off companies of international scope;
- enlarge the reach of continuing education and life-long learning beyond national borders;
- establish criteria for the certification and validation of ECIU courses and the exchange of credits;
- generate the income necessary to support its programmes; and,
- extend its operations and influence outside Europe.

Although the ECIU is not wholly centred on research commercialisation, it has three interesting aspects, which are worth highlighting. These relate to the consortium's commitment to:

1) developing new, innovative practices;
2) its underlying adhesion to continuous improvement amongst the team's working practices; and,
3) its international focus, which acknowledges the increasing global, dimensions to a university's activity, including in particular here industry links and IP exploitation.

In terms of this latter aspect, it is conceivable that in the long term this international network could help an individual university in the network to win and deliver industry-funded research to a large multinational company by being able to use overseas university partners to undertake some of the work in their home country. Such network partners who help monitor and protect a partner university's IP in their own country.

6.2.12 *University-Intermediary Co-operation to Stimulate Spin-Offs*

Background:

The University of Louvain La Neuve located in Belgium has some 20,000 students and 4,8000 staff and has some 10 faculties and 50 departments. The university has a long established science park and has had a good track record in fostering industry-academic links. In 1993/4 it played a central role in winning funding from the European Commission to run a project entitled 'Transfert' that brings together the university with intermediaries (Business and Innovation Centres; BICs) involved with developing industry-academic links from four European regions[4].

Good Practice Case:

The R&D Liaison Unit of the University of Louvain La Neuve, together with the project's coordinator, Promotech, a BIC located in the Nancy region of France, have sought to develop a project which uses intermediaries to help the commercialisation of university research to help the local regeneration of depressed regions. The two other partners are: RIZ, based in the Neiderosterreich Sud region of Austria and BIC Zwickau, located in a former East German region. All the main partners bring in a second tier of institutions and agencies including most notably other universities as well as other intermediaries, technology transfer centres, business incubators and venture capital organisations in their four respective regions.

One of the aims of the project is to enable the two junior partners, RIZ and BIC Zwickau, to learn from the experiences of the University of Louvain and Promotech in terms of providing advice and support on university commercialisation and technology transfer. One particular area is in providing a link between potential university spin-outs and venture capitalists. Speed is important here as a university spin-outs may locate outside the region or not 'get off the ground' if it takes too long to put together a financial package to set up the company. If the university and potential seedcorn or venture capital providers already know each other, things can happen very much quicker with a greater likelihood of success. In Nancy Promotech has helped establish Saarlorlux Seed Capital Fund to provide early stage investment to company spin-offs originating the four universities located in Nancy. These universities on their own would not be able to support such a fund but together they have the critical mass to establish and sustain such a fund.

Other areas of co-operation and learning between the partners are in:

- the field of effective project identification;
- to determine the most effective exploitation and commercialisation route for universities research; and,
- in improving patent and licensing services.

The project has also helped to develop a wider and more supportive regional framework for university research commercialisation, which has allowed to the university to better interact with a range of local business and technology agencies and intermediaries. Funding for the project from the European Commission has now ended and it will be interesting to see whether this pump-priming exercise will succeed in the long term without support and subsidy. However, collaboration between the four partners is still continuing.

6.3 Conclusions

This chapter has reviewed a number of good practice measures that have emerged from universities across Europe in relation to exploitation and commercialisation of research. Most of the schemes have only been running a few years so proper evaluation of the mechanism and policies has not been possible. For most European universities the focus has been on 'catch up' in terms of establishing general links with industry, rather than being concerned about capturing the benefits from such links or the exploitation of their own research effort. Those schemes that centred on commercialisation were associated with basic infrastructure-related mechanisms, especially science parks, and through the creation of Technology Transfer or Commercialisation Offices; small sub-units within longer established Industrial Liaison Offices.

The good practice examples presented here are however centred on more disembodied procedures, mechanisms and institutional arrangements. Even though most of the examples are recent (with the exception of HESIN, Section 6.2.6), they have already gone through several changes and modifications (such as the Chalmers' School of Entrepreneurship and The Knowledge House; Sections 6.2.3 and 6.2.7) and are likely to continue to go through continuous improvement and alteration. Some of the examples are associated with targeting commercialisation practices within a genuine two-way, interactive framework; these include new knowledge sectors (DMI; Section 6.2.4) as well as older industries (RCID; Section 6.2.5) and SMEs (Knowledge House; Section 6.2.3).

However, the examples also include universities trying to confront new challenges within the knowledge economy. This involves improving industry outreach to cover the regional economy more effectively through the establishment of regional consortia, either between universities themselves (HESIN; Section 6.2.6) or between universities and other intermediaries (Transfert; Section 6.2.11), and in terms of a university's role as an animateur and investor in academic spin-offs (VUMAN Section 6.2.8, TOP Section 6.2.10). It also centres on the issue of universities having to face an increasingly international agenda even in relation to research exploitation; pan-national networks of universities can help meet these challenges and share examples of best practice (ECIU; Section 6.2.9). Lastly, most if not all of these examples combine both the aims of furthering the university's own exploitation and commercialisation objectives as well as helping the local or regional economy within which they are situated.

Notes:

[1] This right is vested under the UK Patents Act 1977 and the Copyright, Designs & Patents Act 1988.

[2] Namely, University-Industry Research Centres (UIRCs; Anderson 1986) although the RCID appears to have a broader approach, especially on a sectoral level, than most of the UIRCs outlined in the Canadian report 'University-Industry Research Centres: An Interface between University and Industry' (Anderson 1986).

[3] In 1987 Regional Technology Centres (RTCs) were set up by the DTI, the then Department of Education and Science and the former Manpower Services Commission. The aim of the RTCs was to establish a system of local collaborative ventures or consortia which offered a range of technology transfer services based on training and related delivery mechanisms on a self-financing basis. The RTCs are either:

i) university-based;

ii) industry-based; or

iii) agency-based (such as being located a regional development agency).

In the North East the RTC was awarded to the HESIN consortium and is located in Washington, County Durham.

[4] The regions are either designated Objective 1, regions whose development is lagging behind, or Objective 2, who are areas seeking economic conversion to overcome industrial decline.

7. Conclusions and Policy Implications

7.1 Overview

This study has undertaken a review of good practice approaches to the exploitation and commercialisation of research by universities in Europe. The study has revealed that the growth and development of university-industry relations in Europe has lagged well behind that of North America, and that it was only in the mid 1980s that European universities effectively became concerned in developing commercialisation and industrial ties. This late arrival into the world of industrial links in many European countries was the result of legislation which actually prohibited, or made extremely difficult, for academics to work on industrially-funded projects. However it is important to recognise that there were also strong cultural and social constraints; for many, establishing links with industry was seen as an anathema to the central ethos of universities.

If European universities lagged behind in establishing links with industry, they were even further behind in terms of developing mechanism and strategies that sought to exploit and commercialisation research and IP (Section 3.3). Universities in Europe only began to explore such issues in the late 1980s and early 1990s, with the notable exception of a number of property-led schemes. In part this was because a number of European governments tried to centralise commercialisation practice through central bodies as the BTG in the UK, or via a more decentralised framework of agents or intermediaries under central (or regional) government control, such as ANVAR in France or the OTR and OTT networks in Spain. As a result, universities in Europe have experienced autonomy or control over exploitation and commercialisation only for a relatively short period (ten to fifteen years at most).

Compared to North America, European universities are still only in the early stages of learning about, and developing techniques, for research exploitation and commercialisation. As a consequence, this will undoubtedly limit how far Canadian universities will find European university 'good practice' in relation to commercialisation particularly novel or refined (i.e. through long term trial-and-error adjusting practice and mechanisms to fit the task in hand).

Nonetheless, European experience may reveal new and different perspectives to research exploitation and commercialisation that have not been considered in relation to Canada or North America more generally. This point moreover raises a vital contrast between a European and a North American view concerning the role of universities in relation to exploitation and commercialisation. In North America, research exploitation and commercialisation by universities appears to be predominantly seen in relation to commercialisation of the university's *own* research and IP output. In Europe, research exploitation and commercialisation by universities has been more associated with the role of universities in *facilitating* industry in the exploitation of their research and IP output. This difference in emphasis and perspective by European universities was undoubtedly a reflection of all the institutional and cultural barriers that prevented universities from taking a more proactive and entrepreneurial approach towards its own research output. Commercialisation of its own research was simply not seen as a university's mission. It was industry's duty to pick up the 'crumbs' of universities research and for industry to develop it, not the universities. Where European universities did feel they had a role to play in commercialisation it was as a facilitator; helping industry to research, develop and refine what scientific and technical projects it wanted. Even here, though, it was in a largely passive sense; industry came to universities, universities did not proactively seek out industry.

The last five to ten years in Europe has seen a fundamental shift away for this view of a university's commercialisation role. There has been an acceptance that the exploitation and commercialisation of science and technology must not just be left to industry; universities have a crucial role to play in the whole process. More particularly, there has been a realisation that much research undertaken in universities will be not be exploited if it is left to industry alone. Universities in Europe are now being encouraged to take a more proactive role in developing their own research for commercialisation. But the historical legacy of what European universities 'were about' undoubtedly has had a profound impact on the commercial ambit and trajectory of universities.

7.2 Key Issues and Conclusions

It is not appropriate here to specify direct policy proposals and mechanism to the Canadian context. However, hopefully, the study has yielded some insights and contrasts to the Canadian system which may prove valuable. Certainly there are a number of issues that arise out of this analysis of university research commercialisation and good practice mechanisms in Europe that are worth highlighting here. These are listed below.

1) From a broad perspective a striking feature of the review and analysis has been the *diversity* of university practices and frameworks in Europe. This is not unexpected between universities from different countries, but it was also strongly apparent between universities within the same national system. This point is important, because it has important policy implications since there can be expected to be no one single set of best or good practice mechanisms that will necessarily suite all universities within a country. Different mechanisms and approaches will suite different types of university and their situation.

2) More particularly, not all universities should be expected, or more particularly be able, to follow the approaches that a small, *elite* number of universities will be able to follow in any one national economy. All too often policies and mechanisms devised for universities are derived from the experiences of these select few and are then handed down to others with little appreciation or thought about their own situation or the major barriers they face in adopting best preactices. Many universities will simply not have the scale, the expertise, the prestige, the resources or the wider institutional support available to them to achieve the success that their larger brethren have been able to gain. As such there is no single solution or 'best practice' rather a multiplicity of repertoires of good practice that individual universities should seek to apply and mould to their own circumstance.

3) Even the staff within the ILOs, TTOs or commercial units of the universities selected for study admitted to adopting (at least until recently) a '*pipeline approach*' to commercialisation, i.e. simply waiting for suitable research projects to come to them. They are all now seeking to improve IP exploitation and commercialisation practice right throughout the research and commercialisation process in a more systematic fashion. This

involves a more proactive approach which involves scanning the research activity of the whole university and then going through the appropriate route to successful IP exploitation and commercialisation, if this is thought necessary.

4) All the universities surveyed were concerned about improving their *decision-making* so that they could make the right decision about what projects to select for commercialisation and in selecting the right IP exploitation route for them. Few universities, until recently, had kept good records of past histories of decision-making and still did not have a good appreciation of where their own university's practices tied in with the practices of other universities, particularly in terms of their immediate peer group (i.e. universities with similar size, research income, age, location and scientific/technological specialisms).

5) In addition, little or no *evaluation* has been made of the outcomes of their decision-making. Universities have also wanted to moved away from ad hoc decision-making to a more formal systematic set of procedures that were clear and transparent to academic staff but which were also flexible to cope with individual circumstances.

6) Lack of *finance* was a clear problem for most European universities in terms of research commercialisation. It may seem an obvious and broad ranging issue, but it was directly evident in terms of the size of ILOs, TLOs, TTOs and commercialisation units and more specifically in the budgets they could devote to IP protection and exploitation. Many opportunities were lost because there were insufficient funds to protect and exploit all the projects that were coming forward.

7) Associated with this problem, was the lack of *seedcorn* and venture capital funding available for university spin-offs in Europe. Although some universities had set up their own funds, these were still limited. External funds were also limited, more especially in early stage, seedcorn funding. Although more venture funds are being established, the situation in Europe still lags behind the North American situation.

8) As a response to some of these funding problems, a number of European universities have established local, regional, national and international *co-operative networks* to gain benefits of scale and reach. These networks also allow good practice to be spread between

partners, and can help provide a more cohesive coalition to interface with government, industry and other local and national agencies.

9) There was a general perception that the creation of *university spin-offs* where the university held all or part of the share capital of the spin-off company, maximised the commercial benefits of university research. However, in practice lack of university funding limited this option and other, less preferred routes were then selected; often in turn restricted because of lack of money. If a spin-off option was not possible, or desired, there was usually only a short (one year maximum) 'window of opportunity' to secure an appropriate exploitation route through licensing or other IPR arrangements.

10) In a number of European countries, especially the UK, universities had allowed the IP on their research to go their industrial sponsor as a condition to gain funding. Although in some circumstances this was the best option, some of the universities admitted that they had gone for the *short term* option to gain funding which was excluding them from gaining longer term commercial opportunities (Sections 5.2 and 5.5). Competitive pressure between universities was also allowing their industrial sponsors to gain ever more favourable IPR treatment by the universities. Universities in this situation wanted to devise strategies which could break them out of this seemingly short term, dependency culture.

11) Most European universities see a direct responsibility to help SME in their technological development and commercialisation process. Chapter 6 has described a number of schemes that have sought to achieve this objective. The problem remains, however, that most SMEs which are not high technology spin-offs themselves, have a very different research horizon and profile to that of universities. Small firms have very limited budgets, very short time horizons and most of their tasks centre on overcoming highly applied technical problems. However willing universities may be to help such firms, this work is very unappealing to most academic staff and generates little or no income. The universities surveyed accept that in most cases, *ongoing long term funding to subsidise* SME university support is required by supra-national (EU), national and regional government. Simple 'pump priming' exercises are seen as ending (when the funding money runs out after the designated time span) with universities gradually reverting to larger firms with larger projects associated with longer time horizons and more basic, pre-competitive research.

12) A number of the good practice cases in the study have highlighted the importance of seeing universities working within the context of a wider institutional framework of other regional and technology agencies, government departments, public research laboratories and other education and training institutes. Universities must not been seen in *isolation*. To be effective they must co-operate with other institutions which can support them and help them overcome barriers to commercialisation. In turn, universities can offer a wide range of benefits and links to these agencies and units to help them achieve their own objectives in for example economic regeneration, training and technological advance.

13) Some universities admitted that they wanted more support and *guidance* in taking a balanced view over simply gaining the maximum commercial benefit for the university on its own or taking a wider view on commercialisation which sought to benefit the university *and* its local community. Marginal shifts of what was best for the university it was felt could have quite large effects on the local/regional economy. The difference between a short versus a long term perspective was also important here. Thus how far should a university stray from gaining a short term optimal exploitation route for a particular IP to help the longer term industrial development of its local economy? This may suggest opportunities for policy intervention here which could be used to benefit the local or provincial economy more fully for marginal additional cost.

14) Universities increasingly operate within an *international* arena. This has a number of implications which are growing in importance.

i) There is increasing *competition* between universities internationally. Major multinational companies have increasing flexibility about where to commission and place contracts with universities.

ii) Universities are seeking to *co-operate* with each other on a international basis (see 8 above) to gain global reach, to share information and knowledge and to act as local agents in their home country.

iii) The economic *benefits* of research commercialisation may no longer reside locally or nationally as major industrial partners may seek to develop the technologies they own

(through negotiation with the university) in a different country to the one where the university which undertook the research is located.

This latter issue is important in a European context as most EC-funded Framework Programme projects on science and technology have to be open to a set of different national partners from industry, HEIs and public research laboratories. This has caused problems for the UK where its universities have been the most successful in securing EC funds, but which have had a 'shadow effect' on UK firms participating in such schemes because only rarely are two organisations from the same country allowed to work on the same project. The UK has therefore been faced with basic research and IP from UK universities being taken up and developed by other European firms. Although the UK does allow non-UK firms (mainly with high research and/or manufacturing presence) to participate in many high profile national schemes, such as the LINK programme, it still does cause concern amongst policy analysts[1].

Notes:

[1] Foreign participation can also be extremely high in individual university-run schemes. Thus the Glasgow University a unit within the Department of Electronics and Electrical Engineering, called the SPEED Laboratory. The Scottish Power and Electronics and Electric Drives (SPEED) consortium has a membership of 50 companies worldwide with an objective to supply industry with the most advanced CAD software for electric motors and drives. It derives over 80% of its business from overseas..

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