PROTTEC

ADVANCING INNOVATION
AND KNOWLEDGE TRANSFER

Identification of and Improvement to Technology Transfer Best Practice

Work Package 2 - Appendix 2.1

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PROTTEC WP 2 Appendix 2.1

A France and UK assessment of evident best practice knowledge transfer strategies based on research and government literature

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Part One: Introduction

1.1 Introduction

This report focuses on evident best practice for knowledge transfer as part of PROTTEC Work Package 2, *Identification of and Improvement to Technology Transfer Best Practice*. It has been produced by the University of Exeter and highlights evident best practice for knowledge transfer from research and government literature from both the UK and France.

1.2 Understanding all forms of knowledge

One of PROTTEC's main aims is to improve the efficiency and effectiveness of knowledge transfer in both France and the UK and to highlight best practice and barriers to successful knowledge transfer. This requires an understanding of not only how and why knowledge is transferred, but also in what form it is conveyed.

According to Charles Dhanaraj, et al, (2004) knowledge is characterised along different dimensions using various terms (Foss and Mahnke, 2003, as cited in Dhanaraj 2004). 'Tacit knowledge is abstract and can be communicated only through active involvement of the teacher. Explicit knowledge is highly codified and is transmittable in formal, systematic language (Polanyi, 1966; Nonaka and Takeuchi, 1995). Whereas explicit knowledge provides the building blocks, tacit knowledge provides the glue and integrating mechanism in learning. Explicit knowledge is embedded in standardised procedures (Nelson and Winter, 1982; Martin and Salomon, 2003a, as cited in Dhanaraj 2004). Tacit knowledge develops from the transfer of context-specific knowledge embedded typically in non-standardised and tailored processes (Polanyi, 1966). Although tacit knowledge is arguably more valuable, explicit knowledge is easy to acquire and can be exploited quickly (Polanyi, 1966).

Dhanaraj states that: 'Different areas of knowledge can be categorised as relatively tacit or explicit. Generally speaking, quantifiable technologies and processes are more explicit and more easily transferred (Von Glinow and Teagarden, 1988). In contrast, managerial and marketing expertise is more tacit than product development, production, and technology (Shenkar and Li, 1999; Lane et al., 2001). Management and marketing skills are embedded and are not easily codified in formulas or manuals; they also cannot be reverse-engineered easily (Zander and Kogut, 1995)'.

Ray Reagans' and Bill McEvily's (2003) findings also demonstrate that it is important to distinguish between the types of knowledge being transferred. They highlight that it was more difficult to transfer tacit knowledge than codified knowledge, 'suggesting that tacit knowledge required more motivation, effort, and ability to transfer than codified knowledge' (Reagans and McEvily 2003).

Their findings indicate that an individual is more likely to exert greater effort to transfer knowledge to a close personal contact, and an individual who is surrounded by a diverse network is better able to transfer knowledge. 'Strong interpersonal connections within a dense network cluster ensure that knowledge will diffuse quickly within that cluster. A bridging tie between clusters enables diffusion across clusters. When knowledge is simple, the presence of a bridge is both a necessary and sufficient condition for knowledge to diffuse across it. Transferring simple knowledge does not require much effort, so a large number of individuals are willing to do it. Transferring simple knowledge also does not require much ability, so a large number of individuals are able to complete the transfer. In contrast, tacit knowledge is more difficult to transfer.

‘Tacit knowledge transfers across organisational boundaries more slowly than codified knowledge (Zander and Kogut, 1995, as cited in Reagans and McEvily’s 2003). Gaps in social structure, therefore, represent critical bottlenecks to the knowledge transfer process. Limits on the number of strong tie bridges and network range mean that tacit knowledge is more likely to remain embedded in local communities of practice. Unlike codified knowledge, tacit knowledge does not diffuse across a network. The process is more active. Tacit knowledge is more likely to transfer across a structural hole when the individual who bridges the structural hole either has a strong tie across the hole or has a diverse network. The knowledge diffuses across the structural hole either because the individual exerts more effort or because the amount of diversity in his or her network makes the transfer easier to complete.

Reagans and McEvily (2003) find that tacit knowledge transfer is more dependent on having the ‘right person with the right connection at the right place, ultimately limiting the number of people who can contribute to the process’.

They state that: ‘When knowledge is difficult to codify, not many are willing and even fewer are able to transfer it. By considering the tacitness of knowledge, we can gain important insights into the diffusion processes. Understanding how other properties of knowledge affect network-based models of diffusion is an important area for future research. For instance, recent research indicates that knowledge can be characterised according to whether it is public versus private and that the learning and transfer processes associated with each type of knowledge differs (Uzzi and Lancaster, 2003, as cited in Reagans and McEvily, 2003)’.

Polanyi (1966) explained the essence of tacit knowledge in the phrase ‘we know more than we can tell’ (as cited in Koskinen and Vanharanta, 2002).

Kaj Koskinen and Hannu Vanharanta (2002) found that tacit knowledge can play an important role in the innovation processes of small technology companies. ‘This is especially the case when consideration is focused on the beginning of the innovation process, namely on invention and product development’. They also found that the innovation process in small companies can be facilitated by engaging technology companies and their customers in interactive learning and effective sharing of tacit knowledge.

Part two: Knowledge transfer: channels, motivators and drivers

2.1 Channels for knowledge transfer

Acknowledging that knowledge, in its various forms, is transferred via different channels is another essential element when considering improvements to the knowledge transfer process. Although it recognises that there are numerous channels for knowledge transfer, for the purpose of PROTTEC, the University of Exeter has limited its research to the following:

- **patents & licensing**
  Patent: An exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. A patent gives an inventor the right for a limited period to stop others from making, using or selling the invention without the permission of the inventor (Holi, et al, 2008).
  License Agreement: A formal agreement that allows the transfer of technology between two parties, where the owner of the technology (licensor) permits the other party (licensee) to share the rights to use the technology, without fear of a claim of intellectual property infringement brought by the licensor (Holi, et al, 2008).
- **joint ventures**
  A contractual agreement resulting in the formation of an entity between two or more parties to undertake economic activity together. The parties agree to create a new entity by both contributing equity, and they then share in the revenues, profits or losses, expenses, and control of the enterprise (Holi, et al, 2008).
- **contract research & consultancy**
  Contract research: Research arising from collaborative interactions that specifically meets the research needs of the external partners (Holi, et al, 2008).
  Consultancy: The provision of expert advice and work which, while it may involve a degree of analysis, measurement or testing, is crucially dependent on a high degree of intellectual input from the Higher Education Institution to the client (Commercial or Non-Commercial), but without the creation of new knowledge (although new understanding is the main desired impact) (Holi, et al, 2008).
- **spin-outs**
  From a Higher Education perspective, spin-outs are defined as companies set-up to exploit IP that has originated from within the higher education institute. From a business perspective, a spin-out occurs when a division of a company or organisation becomes an independent business. The newly formed company usually obtains the assets, intellectual property, technology, and/or existing products from the parent organisation (Holi, et al, 2008).
- **joint conference**
  A jointly conceived and hosted event where interested parties are able to attend and review research and/or industrial papers. Joint conferences are usually constrained by a particular subject or theme.
- **professional journal publication**
  The act of publishing novel ideas or outcomes of research and business projects, for example in periodicals such as scholarly journals, newspapers and magazines, or in books and websites. Publications can be peer-reviewed (for example in many academic journals), or not (Holi, et al, 2008).
- **networks**
  A social structure made of nodes (which are generally individuals or organisations such as

universities and businesses) that are tied by one or more specific types of interdependency, such as values, visions, ideas, knowledge, technology or financial exchange, or friendship (Holi, et al, 2008).

- **secondment**
  The detachment of a person from their regular organization for temporary assignment elsewhere, for example in industry (Holi, et al, 2008).
- **collaborative research**
  A structured research project that involves two or more partners in addition to the Higher Education Institution, where all parties work together toward a common goal by sharing knowledge, learning and building consensus (Holi, et al, 2008).
- **joint supervision**
  A contractual or informal agreement where two or more parties manage and oversee a person's or project's performance, development and/or operation.

2.2 Main motivations and drivers for knowledge transfer

It is also necessary to take into account the main motivations and drivers for knowledge transfer. The University of Exeter's literature review notes that some of the main motivations and drivers for knowledge transfer from universities are: to safeguard the university's intellectual property, while at the same time market that intellectual property to firms (Siegel, et al, 2003); the desire for recognition and papers in scientific community publications (Siegel, et al, 2003); grants (especially if untenured) (Siegel, et al, 2003); financial gain and a desire to secure additional research funding (mainly for graduate students and lab equipment) (Siegel, et al, 2003); technical and physical resources that would otherwise be unavailable (Matthews and Norgaard 1984); curriculum enhancement (Matthews and Norgaard 1984); access to industry projects and jobs for students (Matthews and Norgaard 1984); networking opportunities for student employment placement (Rahm, et al, 2000); and prestige (Slaughter and Leslie 1997).

In comparison, it found that examples of main motivations drivers for knowledge transfer from industries include: financial gain; the desire to maintain control of proprietary technologies (Siegel, et al, 2003); the provision of expertise in problems solving that the company does not possess internally (Grant 1996); the renewal or extension to technology (Brock & Yaniv 2007); contact with students who may become potential employees (Bommer & Jalais 2004); expanded pre-competitive research and increased leverage from internal research capacities that are enhanced by interaction with HEIs (Schartinger et al 2002, Allen 2004).

According to a French government report, *The promotion of research* (N°2006-M-016-01 & N°2006-82) (2007), which measures the first impacts of the 1999-introduced French law for innovation, there are three main drivers for knowledge transfer. It says that knowledge transfer is about the communication of research results to increase the level of human knowledge; the commercialisation of these research results to improve daily life; and to improve scientific excellence by attracting funds for laboratories to continue to innovate.

- Increasing the level of human knowledge by communicating innovation
  Disseminating knowledge can be can be done in several ways:
  1) communication to specialists through publications
  2) communication to the public domain through scientific popularisation
  3) communication to the users of the innovation by specialist training

- Improving the quality of life through the commercialisation of innovation

Marketing innovation makes research outputs available to the general public and consequently improves quality of life (e.g. the Internet was originally created for research purposes).
For a research laboratory, to provide the public with an innovation often involves a partnership with a company. It will handle manufacturing and marketing products or services incorporating innovation.

- Improving the excellence of the research area by attracting additional funds
  The commercialisation of innovation also helps to build on public investment and attract funding for research from industries. Public investment acts as leverage and facilitates convergence between laboratories and companies.

2.3 The role of the university in knowledge transfer: the commercialisation process

Over the last few years there has been a rapid rise in commercial knowledge transfers from universities to practitioners or university–industry technology transfer (UITT), through licensing agreements, research joint ventures, and start-ups (Siegel, et al, 2003).

However, this does vary from university to university and also from faculty to faculty. According to Doris Schartinger, et al, (2000): 'On the side of the university, even when controlling for size and knowledge proximity, faculties show significantly different interaction activities with industries. Natural sciences, technical sciences, agricultural sciences and economics have higher intensities of interaction than those in medicine, social sciences and humanities. Among the structural characteristics of science fields, the level of experience in contract research and scientific quality of research positively affect knowledge interaction with industry.

'On industry side, a high share of medium-sized firms in a sector, a high R&D intensity and high employment dynamics exert a positive influence on the propensity to engage in knowledge interactions with universities'.

Numerous studies have been conducted that look at the framework of knowledge transfer and within that consider the details of how this transfer can relate to benefits for companies and universities.

'The role of knowledge exchange and research co-operation between public research and the enterprise sector has received increasing attention in the analysis of innovation and technological change' (Schartinger, et al, 2000).

Adding: 'Apparently, universities and the industry use a variety of channels in order to transfer knowledge. The channels vary in the intensity of personal relations, in the types of knowledge transferred and in the direction of the knowledge flow. From the viewpoint of industry, the use of different channels represents varying strategies to ensure research efficiency, allows access to different types of scientific and technological knowledge and reflects differences in demand for knowledge in different stages of innovation. Sectors of economic activity and fields of science engage in different types of interactions. While technical sciences and R&D intensive manufacturing industries tend to use direct research co-operation more intensively, service industries and social and economic sciences rest more on personnel mobility and training related interactions. Joint research and contract research seem to be used for opposite needs as fields of science and economic sectors which are heavily engaged in one of these types of knowledge interactions tend to engage in the other type far below average'(Schartinger, et al, 2000).

Universities play three major roles within an innovation system (Smith, 1995, as cited in Schartinger, et al, 2000). ‘First, they undertake a general process of scientific research and thereby affect the technological frontier of industry over the long run. Secondly, they partly produce knowledge which is directly applicable to industrial production (prototypes, new processes etc.). Thirdly, universities provide major inputs for industrial innovation processes in terms of human capital, either through the education of graduates, who become industry researchers or through personnel mobility from universities to firms’.

Schartinger, et al, (2000) assumes that universities contribute to industrial innovation not only by offering new kinds of technological development but via a variety of interactions.

Knowledge interactions between industry and university show a complex pattern (Schartinger, et al, 2000). ‘First, interactions are not restricted to a few industries and science fields. Rather, a large number of scientific disciplines and almost all sectors of economic activities exchange knowledge in the course of industrial innovation. Secondly, R&D resources in industry and orientation of science fields towards industry application do not prejudice the level of knowledge interaction. Both some traditional manufacturing and service sectors, and some basic research oriented science fields engage significantly in innovation-related knowledge interaction with universities and industry, respectively. Thirdly, industry and university use a large variety of channels for knowledge interaction. A restriction of the analysis of industry–university relations to only a few types of channels may produce misleading results as there are significant differences in the orientation on certain types of interaction by industrial sectors and fields of science. Looking only on one channel, say citations of university publications in firm patents or financial flows for contract research projects, fades out and leads to distorted pictures of industry–university relations.’

An important consideration for PROTTEC that Schartinger, et al, (2000) highlights is that indicators of university performance, in terms of technology transfer to industry, often concentrate on only a few types of interactions such as research contracts and patent applications. Their results suggest that these indicators should be widened to consider knowledge interactions such as training, personnel mobility, start-ups as well as other forms of personal contacts.

Table 1
Types of knowledge interactions between university and firms[a]

Types of knowledge interaction	Formalisation of interaction	Transfer of tacit knowledge	Personal (face-to-face) contact
Employment of graduates by firms	+/−	+	−
Conferences or other events with firm and university participation	−	+/−	+
New firm formation by university members	+	+	+/−
Joint publications	−	+	+
Informal meetings, talks, communications	−	+	+
Joint supervision of Ph.D. and Masters theses	+/−	+/−	+/−
Training of firm members	+/−	+/−	+
Mobility of researchers between universities and firms	+	+	+
Sabbatical periods for university members	+	+	+
Collaborative research, joint research programmes	+	+	+
Lectures at universities, held by firm members	+	+/−	+
Contract research and consulting	+	+/−	+
Use of university facilities by firms	+	−	−
Licensing of university patents by firms	+	−	−
Purchase of prototypes, developed at universities	+	−	−
Reading of publications, patents etc.	−	−	−

[a] +: interaction typically involves formal agreements, transfer of tacit knowledge, personal contacts; +/−: varying degree of formal agreements, transfer of tacit knowledge, personal contacts; −: interaction typically involves no formal agreements, no transfer of tacit knowledge, no personal contacts.

Table 1: Knowledge & Technology Transfer (Schartinger, et al, 2002)

According to David Demeritt and Loretta Lees (2005), the division between commercial, educational and scientific functions are blurred by the commercialisation of universities. 'Not only is higher education being managed and marketed as a commodity (Mitchell 1999, as cited in Demeritt and Lees, 2005), but in the new entrepreneurial academy, academics and their universities are directly involved in business ventures to capitalise on their own research results'.

They state that the policies to accelerate this commercialisation process plays a central role in government strategies for promoting regional economic development and enhancing national competitiveness and cite USHSC 1998; OST 2002; European Commission 2004a as examples.

Demeritt and Lees (2005) also note that these developments have had more of an affect on UK universities than those in other countries, because the system for funding UK universities is one of the most centralised in the world. They suggest that even relatively small shifts in government policy are likely to have a greater impact on the practice of UK universities and university researchers than in the more diversified higher education system of the United States, for example.

According to the Lambert Review (2003), which was commissioned in 2002 by the UK Government's HM Treasury (the then-Department for Education and Skills (DfES) and the then-Department of Trade and Industry): 'The main challenge for the UK is not about how to increase the supply of commercial ideas from the universities into business. Instead, the question is about how to raise the overall level of demand by business for research from all sources? It has found that, measured against other developed countries, the research intensity of British business is relatively low – and the position has been deteriorating in recent decades. This has had an adverse impact on the overall productivity of the UK economy'.

It says that the best forms of knowledge transfer involve human interaction. ‘Forums that bring academics and business people together are likely to increase the chance that people with common interests and goals will find innovative ways to develop partnerships’ (Lambert Review 2003).

As for universities’ roles in regional economic development, the Lambert Review (2003) finds that universities are playing an increasingly important role, building bridges between business and universities across the regions and nations. It recommends that the targets set for the English Regional Development Agencies should be changed, to give a greater emphasis to building such relationships.

The Lambert Review shows how universities are working together with local and regional agencies to develop their own science-based clusters. It suggests that the UK’s Department of Trade and Industry (DTI) should shift the pattern of regional support away from job creation schemes and towards more value-added programmes, including collaborative R&D projects with universities.

The Sainsbury Review (2007) also highlights improvements in the university-industry interface in the UK. It stresses that capacity and infrastructure in universities for business collaboration has continued to improve and that virtually all HEIs now have systems in place to engage with business and the benefits to the higher education (HE) sector have been tangible.

According to the Wellings report (2008), ‘Over the past 60 years there has been good evidence that research in universities adds demonstrable value to the economy and community and this has underpinned government’s investment in public “blue skies” research (Science as a Solution: An Innovation Agenda for the Next President. Association of American Universities, March 2008, as cited in Wellings 2008)’.

Despite these developments, the Wellings report (2008) states that to make more effective use of IP generated by universities and strengthen the UK’s higher education sector over the next two decades, some change is necessary. It stresses that not all of these changes are the sole responsibility of government, but that ownership should be taken up by a range of parties with a long-term interest in the success and vitality of the sector.

2.4 A cross-Channel comparison: funding

Different countries employ a variety of method for funding research. According to the Lambert Review (2003): ‘In the UK, the majority of government funding for research is allocated to universities through the dual support system. The Government also provides significant support for research direct to companies through the R&D tax credits. The perception is that the UK research funding system has tended to favour investment in basic research over applied research. Although a number of factors drive a country’s innovation performance, the statistics suggest that the UK is strong in basic research but less good at bringing ideas to the market’.

A similar situation exists in France, and is driven by the law on innovation and research that was introduced in July 1999 to promote the transfer of public sector funded research to industry and to create innovative companies. In addition to this, in 2007 the French National Research Agency (L'Agence nationale de la recherche), the ANR, was established to act as a funding agency for research projects. Its aim is to increase the number of research projects issued from the entire scientific community, and to provide funding based on calls for proposals and peer review selection processes. For the year 2007, the ANR had a total available budget of €825 million for research projects having a maximum duration of four years.

Interestingly at around the same time, June 2007, the UK government established the Department for Innovation, Universities and Skills (DIUS) to drive forward delivery of the Government's long-term vision to make Britain one of the best places in the world for science, research and innovation.

2.5 A cross-Channel comparison: spin-outs

From a higher education perspective, spin-outs are defined as companies set-up to exploit IP that has originated from within the higher education institute.

In 2006, Philippe Mustar from the Centre de Sociologie de l'Innovation in France, gave a presentation, *Innovations in Policies to Foster the Creation of University Spin-Off Firms A European comparison: France and the United Kingdom* at the Technology Transfer Society Conference, in Atlanta, USA.

In it Mustar explains that since the end of the 1990s, spin-outs from universities and public research institutes have received growing interest from European policymarkers.

'In some countries, university spin-offs (USOs) have become central in research and innovation policy. Governments in Europe were very innovative to create measures, schemes, initiatives, programmes, laws, etc. to foster the creation of spin offs in Belgium, Germany, Sweden, Italy, France, UK in particular. The rationale for these policies reflects a European response to the capacity of US universities to generate high growth technological firms from Genentech to Google. On the 10th of February 1999, the French Minister for Research and Technology introduced his bill proposing a "Law on innovation and research to promote the creation of innovative technology companies" with the following sentence: "In the United States, a third of the economic growth results from the activity of innovating companies. Within Massachusetts Institute of Technology, which counts only 8,000 students, 800 companies are created each year…". This US capacity to transform research results into new high tech and high growth firms presents a model which many European governments are seeking to emulate.'

In essence, Mustar argues that policies to develop a US model of technological entrepreneurship are not new in Europe and that the current policies for research-based spin-out firms take place in the context of larger transformations of the landscape of research and innovation policies.

Mustar chose a France/UK comparison because: 'while some instruments in the two countries appear to be similar, a deeper comparison shows that convergence is some way off. Indeed, it is evident that we are confronted by two different conceptual frameworks and two different rationales for policy intervention. The results of these policies need to be appreciated according to the situation in which they are embedded. The theoretical and practical consequences of these differences are explored.'

Mustar notes that: 'In the UK, support for academic spin-off firm forms part of a larger policy which tries to develop knowledge transfer between the universities and business and society. These schemes are part of a Knowledge Transfer Policy that constitutes third stream activities of universities.' In comparison, he notes that, in France they are part of a Technological Entrepreneurship Policy. 'The public research system is at the heart of this policy but the measures are not exclusive for university spin-offs: firms who are not USOs can take part to the National competition, they can present a request to the Seed Money funds. These instruments are built on two different rationales. In the UK they aim to fill two gaps: a financial one (University Challenge Fund to bridge a "market failure") and a knowledge one (Science Enterprise Challenge, Higher Education Innovation Fund, Public Sector Research Exploitation Fund). In France, a more systemic approach has been adopted: spin-off creation is seen as a process (from the lab to the market) and public intervention covers each stage (i.e., it addressed "systemic failures"). In the UK, emphasis is placed on the knowledge gap (in terms of number of measures or of amounts of money). In France, the emphasis is on financial issues (the competition, the seed money funds and even the incubators bring money to the spin-off).

'The recipients of these measures are different in the UK and in France. In the former, funding is for universities and is managed by the Universities (or by a wholly-owned subsidiary of the university). The goal is the integration of third stream activities into the decision making structure of the universities rather than them being an add-on function. In contrast, in France, funding is for spin-offs (the Competition) or for the creation of new intermediaries institutions (incubators, seed money funds who give the money to spin-offs). These new intermediaries are more or less "independent" from universities (they are various shareholders).'

Mustar also highlights that, in the UK, universities can be shareholders in spin-out companies and can therefore bring the university supplementary income. In France, universities usually do not have shares in their spin-outs.

'While UK initiatives are characterised by the fact that they bring money to the higher education institutions, French initiatives do not. The UK has placed the universities at the heart of policies aimed at the creation of spin-offs, this not the case in France. In France, it is surprising that with so many facilitators academic spin-off activity has not been stronger. Indeed, there has been a small and decreasing number of USOs. To explain this result it is important to raise the issue of public policy. What is a public policy? The latest research in this field suggest that public policies are not used to solve problems. But, they define legal environments and frameworks in which the actors themselves can invent arrangements and solutions. In the UK, it seems more or less easy for the universities to invent these new configurations. In France, it seems particularly difficult for the universities to find breathing spaces and to create new organisational configurations. This problem arises particularly because policy expectations are constructed on the basis of an outstanding trajectory: from the lab to the stock market,' Mustar (2006).

Despite the differences in approach, Mustar finds that the majority of spin-outs, both in France and in the UK, 'remain very small and few achieve a stock market listing. The underestimation of the difficulties to go from research results to the market, the underestimation of the time scales from funding incubators or competition and outputs, the underestimation of the learning process of new established structures and management staff and underestimation of the difficulties in changing attitudes and culture in old-established organisations like universities can largely explain the current situation.'

Part three: Factors affecting success

Funding is almost always suggested as an issue that affects success, and although true in many examples, it is perhaps more helpful to identify exactly why this might be the case and also highlight other factors that could affect the success of an activity.

3.1 Understanding the market

John Stevens and John Bagby (2001) found that a major determinant of success is how universities interact with relevant business contacts and individuals who understand the 'market'. 'Researchers flourish in an atmosphere of openness, knowledge sharing, and consensual advancement. Nonetheless, universities have eagerly institutionalised the role of knowledge transfer to business. The knowledge production and transfer system is enormous politically and economically, but there are no cumulative findings or coherent propositions regarding the distribution of returns to key stakeholders. Legal barriers to purely economic transactions between universities and businesses exist, but federal policies positively validate and sustain the transfer of knowledge to business. Conversely, serious dilemmas involving other stakeholders such as students, state governments, citizens, other countries, and competing businesses exist.'

Dominique P Martin, in collaboration with Lionel Pujol, (2008) questioned: 'Why some universities are able to sell to some of their patents private companies and others not?' From fifteen technology transfer case studies, managed by Bretagne Valorisation – which acts as an interface between researchers and industry partners and is leading the PROTTEC project – the complex process that occurs from the development of an invention to its actual sale to a business was investigated. Martin took into account the characteristics of each project, their team profiles and the type of companies involved. The research found that it was the skill and the actions of individual project leaders that were the main keys to the successful exploitation of public research (Martin 2008).

Martin's main conclusions were that the competency profile of the project leader appears to be a central element in the effective capacity to transfer a patent along with the profile of the project team and the type of knowledge being transferred. Also, the competitive market position of company interested in the information was a significant factor in the successful transfer of knowledge.

3.2 Role of relationships, network ties and social identity

Linda Argote and Paul Ingram (2000) state that people play the most critical role in the success of technology transfer.

Building on this finding, Linda Argote, Bill McEvily and Ray Reagans (2003) note that: 'Social relationships matter for knowledge creation, retention, and transfer. When properties of units, properties of relationships and properties of knowledge fit or are congruent with each other, knowledge retention, and transfer increase. Knowledge creation, by contrast, may be stimulated by a lack of congruence or parts that do not fit together. Experience can be structured to promote learning outcomes in firms. Where boundaries are drawn matters for knowledge creation, retention, and transfer. Features of the external environment affect learning outcomes in firms. And embedding knowledge in transactive memory systems, short-hand languages, routines, technologies, and other knowledge repositories can promote knowledge retention and transfer in firms'.

An area of increasing interest is relational embeddedness and how this affects the success of knowledge transfer. According to Brian Uzzi (1997) ‘Research on embeddedness is an exciting area in sociology and economics because it advances our understanding of how social structure affects economic life’.

Brian Uzzi’s (1997) findings indicate that within some industries, Japanese auto and Italian knitwear as cited examples, ‘network relationships are characterised by trust and personal ties, rather than explicit contracts, and that these features make expectations more predictable and reduce monitoring costs (Dore, 1983; Asanuma, 1985; Smitka, 1991; Gerlach, 1992)’.

Uzzi’s (1997) basic conjecture is that embeddedness creates economic opportunities that are difficult to replicate via markets, contracts, or vertical integration. He emphasises the importance of trust and says that it develops when extra effort was voluntarily given and reciprocated; stating ‘respondents viewed trust as an explicit and primary feature of their embedded ties’.

Other findings from Uzzi’s (1997) paper include that information exchange in embedded relationships was more proprietary and tacit than the price and quantity data that were traded in ‘arm’s-length’ ties. Embedded ties also entail problem-solving mechanisms that enable actors to co-ordinate functions and work out problems “on the fly” (Uzzi 1997).

Uzzi (1997) suggests that part of a company’s success was due to a degree of embeddedness. In summarising his findings, Uzzi notes that the: ‘best way for an organisation to link to its network is by means of embedded ties, which provide better access to the benefits circulating in the network than arm’s-length ties. The optimal network structure to link to is a mix of arm’s-length and embedded ties, because each type of tie performs different functions: embedded ties enrich the network, while arm’s-length ties prevent the complete insulation of the network from market demands and new possibilities. This suggests two propositions: organisational performance increases with the use of embedded ties to link to network partners; network structures that integrate arm’s-length and embedded ties optimise an organisation’s performance potential; network structures comprising only arm's-length ties or embedded ties decrease organisational performance potential’.

Uzzi (1997) used the New York clothing industry to find plausible evidence for these propositions using data on network ties among contractors and manufacturers over an 18-month period (Uzzi, 1996). ‘I found that contractors had a significantly lower failure rate when linked by embedded ties to their network partners and that being connected to a network comprising an integration of embedded ties and arm’s-length ties, rather than a network comprising either embedded ties or arm’s-length ties, significantly decreased the failure rate even further’ (Uzzi 1997).

These findings also support the idea that trust is important in alliances and joint ventures because no contract can cover all the variations and conditions that can occur (Dhanaraj, et al, 2004). Trust allows access to resources and a willingness to work things out through mutual problem-solving (Uzzi, 1997).

Dhanaraj, et al, (2004) also show the importance that tie strength, trust, and shared values and systems play in the transfer of tacit knowledge, especially for mature international joint ventures. Their 2004 findings were consistent with Uzzi’s tenets: tacit learning is accumulative, assists in explaining explicit knowledge, and is enhanced by social embeddedness (Uzzi, 1997). In addition, Dhanaraj, et al, (2004) suggest that the influence of transferred tacit knowledge on international joint venture performance stems principally from its indirect effect on the learning of explicit knowledge.

Linda Argote, et al, (2003) found that social status and identity has an effect on knowledge transfer. They found that knowledge was more likely to transfer from a rotating member of staff to a recipient group when both shared a superior social identity. Knowledge was also more likely to transfer from a rotating member to a recipient group when the rotating member possessed a superior rather than an inferior routine. Results also revealed that these higher social groups adopted a production routine of when it was superior but not inferior to their own, whereas groups that did not share a similar high-ranking social identity with the rotator, generally did not adopt the rotator's production routine, even when it was superior to their own and would have improved their performance (Argote, et al, 2003). These findings were also supported by a previous study conducted by Aime Kane, Linda Argote and John M. Levine in 2002.

Kane, Argote and Levine (2002) conclude that a shared social identity is an important condition that promotes knowledge transfer. 'The experience of a shared superordinate identity increases the ability of group members to recognise and utilise high quality information that their members possess'.

3.3 Barriers to successful knowledge transfer activities

The above-mentioned findings demonstrate that numerous factors are at play during successful knowledge transfer activities and suggest that some are more important than others. Barriers to success also exist.

Following a research project that considered 98 structured interviews of key university-industry technology transfer stakeholders (defined as university administrators, academic and industry scientists, business managers, and entrepreneurs) at five research universities in two regions of the US, Siegel, et al, (2003) concludes that there is considerable room for enhancing the effectiveness of commercial knowledge transfers from universities to companies.

Siegel, et al, (2003) found that organisational and managerial behaviours and skills are critical factors in facilitating the university-industry technology transfer process. The paper specifically highlights that universities wishing to foster commercialisation need to consider the following organisational and managerial factors:

- eradicating cultural and informational barriers that impede the university-industry technology transfer process
- designing flexible university policies on technology transfer
- improving staffing practices in the technology transfer office
- devoting additional resources to university-industry technology transfer, if that is consistent with the university's mission
- enhancing the rewards for engaging in university-industry technology transfer
- encouraging informal relationships and social networks

Table 2
Stakeholder perceptions of the barriers to university–industry technology transfer (UITT)

Barriers	Type of stakeholder		
	(1) Managers/ entrepreneurs	(2) TTO directors/ administrators	(3) University scientists
Lack of understanding regarding university, corporate, or scientific norms and environments	90.0	93.3	75.0
Insufficient rewards for university researchers	31.6	60.0	70.0
Bureaucracy and inflexibility of university administrators	80.0	6.6	70.0
Insufficient resources devoted to technology transfer by universities	31.6	53.3	20.0
Poor marketing/technical/negotiation skills of TTOs	55.0	13.3	25.0
University too aggressive in exercising intellectual property rights	80.0	13.3	25.0
Faculty members/administrators have unrealistic expectations regarding the value of their technologies	25.0	40.0	10.0
"Public domain" mentality of universities	40.0	8.3	5.0
Number of interviews	20	15	20

The values presented in columns (1)–(3) are the percentages of respondents who identified a particular item as a barrier to UITT.

Table 2: Stakeholder perceptions of the barriers to university-industry technology transfer (Siegel, et al, 2003)

One such barrier was discussed by Uzzi (1997) when he considered the issues that effect a company when it becomes too embedded, he noted the following paradox: 'The same processes by which embeddedness creates a requisite fit with the current environment can paradoxically reduce an organization's ability to adapt… Three conditions that turn embeddedness into a liability: (1) there is an unforeseeable exit of a core network player, (2) institutional forces rationalise markets, or (3) overembeddedness characterises the network'(Uzzi 1997)'.

He cites the following example: 'a contractor may become highly skilled at working with a manufacturer's fabric, production schedule, and design specifications. If that manufacturer closes shop or migrates offshore, then the embedded relationship that had originally benefited the contractor may now put it at a higher risk of failure than if it had diversified its ties, because it is likely to lack the resources needed to transition to a replacement partner (Romo and Schwartz, 1995)'.

In their 2005 paper *How to Improve Efficiency in Transfer of Scientific Knowledge from University to Firms: The Case of Universities in Taiwan*, Der-Juinn Horng and Chao-Chih Hsueh identified three barriers to university/industry technology transfer: including inflexible bureaucracy, poorly designed reward systems, and ineffective management of technology transfer offices. They found that these factors resulted in a failure to maximise opportunities to transfer technologies, which has a negative impact on companies and ultimately consumers. Horng and Hsueh (2005) suggest the following to improve the university/industry technology transfer:

- designing flexible university policies on technology transfer

- improving staffing practices in the technology transfer office
- devoting additional resources to university/industry technology transfer, if that is consistent with the university's mission.
- enhancing the reward for engaging in university/industry technology transfer
- encouraging informal relationships and social networks

Siegel, et al, 2003 suggest the following university and firm-based improvements to the university-industry technology transfer process:

- universities need to improve their understanding of the needs of their true 'customers' i.e., firms that can potentially commercialise their technologies
- adopt a more flexible stance in negotiating technology-transfer agreements and streamline university-industry technology transfer policies and procedures
- hire licensing officers and technology transfer office managers with more business experience
- switch to incentive compensation in the technology transfer office
- hire managers/research administrators with a strategic vision, who can serve as effective boundary spanners (tie to boundary spanning literature)
- devote additional resources to the technology transfer office and patenting
- increase the rewards for faculty participation in university-industry technology transfer by valuing patents and licenses in promotion and tenure decisions and allowing faculty members to keep a larger share of licensing revenue (as opposed to their department or university)
- recognise the value of personal relationships and social networks, involving scientists, graduate students, and alumni.

Siegel, et al, 2003 also suggest the following firm-based improvements to the university-industry technology transfer process:

- be proactive in their efforts to bridge the cultural gap with academia
- hire technology managers with university experience
- explore alternative means for tapping into university-industry technology transfer social networks.

Andreas Riege and Michael Zulpo (2007) note that successful transfer of knowledge, particularly tacit knowledge, implies a universal meaning and homogeneous context within companies. 'In practice, however, this assumption rarely holds,' states Riege and Zulpo (2007). They highlight that knowledge-transfer difficulties between knowledge communities are often a result of differences in their language, practical experience, situational and sub-cultural understandings, social behaviour, occupational contexts, network position, and absorptive capacity (Bechky 2003 & Tsai 2001, as cited in Riege and Zulpo 2007).

Another barrier to successful knowledge transfer that Riege and Zulpo (2007) cite is lack job-specific experience.

The UK Government's Lambert Review (2003) outlines a number of barriers to knowledge transfer, particularly highlighting collaborative research as an example. It found that when establishing collaborative research partnerships it is important to determine at the outset the ownership and exploitation rights for any intellectual property (IP) that may be generated. This is because both businesses and universities have reported that negotiations on the terms and conditions of IP ownership and exploitation can be extremely lengthy and costly.

It also suggest that smaller companies may be deterred from establishing research partnerships because of the high legal costs and time involved. The Review recommends that this problem could be addressed by making a small set of model research collaboration contracts available to businesses and universities to be used on a voluntary basis.

In 2007, a report to the UK Funders' Forum on university/business interactions identified three barriers to commercialisation activities and the effectiveness of UK universities in assisting industry and the wider economy:

- an over-emphasis on IP when universities and businesses work together on collaborative research projects;
- a lack of clarity on the primary aims of collaborative research, allowing uncertainty as to whether the aim is to generate a direct income for the university or a wider benefit for the economy;
- a rather variable implementation of aspects of good practice in the process of negotiation.

These were similar to the findings of the Lambert Review (2003), which noted that IP was often strongly contested and disagreement over ownership was often a barrier to research collaboration.

Like the Lambert Review in 2003, the Wellings report in 2008 makes a number of recommendations; all of which are designed to improve the effectiveness of interactions between higher education institutions and industry.

It emphasises the fact that the past decade has seen a significant improvement in the way that universities translate research into economic impact, and note that this is driven by the professionalisation of technology transfer and the availability of venture funding.

'Over the coming years, universities will face increased demands to demonstrate the wider economic value they create, not least as science and technology research funding remains protected amid widespread spending cuts. With this in mind, it is in universities' interests to build a strong case for their wider social benefit, not least their impacts in delivering economic growth,' (Wellings, 2008).

The Wellings report stresses that to strengthen the university sector in Europe the European Commission has suggested that universities and/or governments in member states should:

- ensure that knowledge transfer forms part of the strategic mission of the institution;
- publish procedures for the management of IP;
- promote the identification, exploitation and protection of IP with a view to maximising socio-economic benefits;
- provide appropriate incentives to help staff play an active role; and
- build critical mass in knowledge transfer by pooling resources at local or regional levels.

In 2007 D'Este and Patel also challenge two aspects of government polices directed at university–industry interactions. Their results show that much of the public scrutiny – devoted to measuring rates of patenting and spin-out activities – may have the negative effect of obscuring the presence of other types of university–industry interactions. These other types of interactions may have a much less visible economic pay-off, but can be equally (or even more) important, both in terms of frequency and economic impact (D'Este and Patel 2007).

Their findings suggest that policies that are mainly targeted towards universities are likely to have a limited impact on encouraging university–industry interactions, unless they take a better account of the characteristics of the individual researchers engaged in such interactions. They state: ‘This would imply that future research should be aimed at identifying the common features among researchers who actively engage with industry, and investigating the ways in which they have managed, for instance, to establish a stable network with the wider community of potential users of their research’(D’Este and Patel 2007).

Part four: Strategies for improving knowledge transfer and innovation uptake

Both the UK and France have made considerable strides in improving the effectiveness of knowledge transfer activities over the past few years.

4.1 The UK

The Lambert Review (2003), the Sainsbury's Review (2007) and the Wellings report in 2008 all offer suggestions that should improve knowledge transfer success. Another source is the Public and Corporate Economic Consultants (PACEC) report that summarises the existing round of higher education funding for innovation (Higher Education Innovation Fund, HEIF 4) for the period 2008-2011.

HEIF 4 is a joint initiative from the Higher Education Funding Council for England (HEFCE) and the UK government's Department for Innovation, Universities and Skills (DIUS). It provides funding to higher education institutions (HEIs) in England to support a broad range of knowledge exchange activities resulting in economic and social benefit to the UK. The University of Exeter is one the UK's 129 HEIs receiving HEIF funding.

The PACEC report demonstrates knowledge transfer initiatives that are adopted within higher education institutions and how successful these strategies are.

According to the PACEC report, knowledge exchange appears to be embedding itself within the fabric of the UK higher education sector, and that social and economic development are important aims for HEIs. It states that: 'Most HEIs appear to have taken knowledge exchange on board as a significant dimension of their overall portfolio of activity, extending well beyond the long-standing areas of the commercialisation of available technologies. They conduct a wide range of activities from entrepreneurship and enterprise education, both at the staff and student level, to consultancy, contract and collaborative research, to training staff, business development and participating in networks. However, there was little mention of exploiting the capabilities locked in the alumni base'.

The PACEC report explains that HEIF 4 funding helps HEIs implement their knowledge exchange strategies in a number of ways. 'Firstly, it can help HEIs focus their strategic thinking and provide a campaign around which to organise their knowledge exchange strategies. It has led HEIs to become more demand led, creating a much more co-ordinated, flexible and integrated delivery mechanism. Importantly, the funding has stimulated a greater integration of teaching, research and knowledge exchange. It has helped HEIs further embed a culture that embraces knowledge exchange as an important activity'.

Over 50 per cent of HEIF 4 funding (£207 million) will be allocated to dedicated knowledge exchange staff. 'Such staff play a variety of roles within the HEIs, typically relieving the administrative burden and other support-related burdens of knowledge exchange engagement. They play a very important co-ordination role, ensuring that knowledge exchange engagements progress smoothly from inception to completion. Moreover, knowledge exchange staff are increasingly becoming the medium through which best practice is shared, both within the HEI and throughout the sector as a whole'.

The report highlights that a recent survey of academics suggests that the time available for them to undertake knowledge exchange is one of the major constraints to increasing engagement. As a result, approximately £60 million is being allocated to support for staff engagement, which includes the buy-out of academic time. Interestingly, the report also notes that a lack of engagement by academics was the most frequently cited internal risk to HEIF, while a lack of demand from industry was an important external risk.

Collaboration appears central to most knowledge exchange strategies although HEIs still find it difficult to engage with small and medium-sized enterprises, says the PACEC report. 'HEIs still find it difficult to collaborate or partner with small and medium-sized enterprises (SMEs), despite SMEs being a key target organisation type in HEIs' knowledge exchange strategies. A number of large HEIs claim that while their knowledge exchange focus is on large corporations and larger institutions, their knowledge exchange activities have an impact on SMEs through the supply chains of these corporations. For example, a large corporation creating a presence on an HEI's science park will likely attract SMEs from its supply chain to the area, where they will also benefit from the knowledge diffusion from HEI to the larger corporation'.

The report says that workshops and other forms of training and staff development are also important mechanisms for increasing staff engagement in knowledge exchange. It notes that, while the sharing of best practice was not important for increasing staff engagement in many HEIs, it was a very important mechanism for improving knowledge exchange performance. 'This is greatly facilitated by both the dedicated knowledge exchange staff funded through HEIF and the inter-HEI collaborative networks encouraged through HEIF and other funding sources' .

The Lambert Review (2003) makes several recommendations designed to encourage communication between business people and academics. One such recommendation calls for the Universities UK (UUK) and the Standing Conference of Principals (SCOP) to establish a list of academics with relevant qualifications who are interested in becoming non-executive directors on company boards, and should arrange training for them in this role.

In the UK, intellectual property (IP) is administered by the UK Intellectual Property Office (UKIPO) (formerly the Patent Office). This body is responsible for the award, registration and enforcement of IP in the UK. It also has a key role in policy formulation and responsibility for raising awareness of IP issues (Sainsbury Review 2007).

UKIPO covers all four of the main forms of IP: copyright, trademarks, registered designs and patents, the Sainsbury's Review found that each of which is of benefit to different parts of the UK economy and to different sorts of activity.

According to the findings of the Lambert Review (2003): 'UK universities have a strong science base, and there is significant potential to transfer this knowledge to business in the form of IP. These transfers take a range of different forms and have been growing at a rapid pace in recent years. Most universities have developed technology transfer offices, and staff numbers are rising rapidly. However, there are a number of barriers to commercialising university IP.

'One is a lack of clarity over the ownership of IP in research collaborations. This makes negotiations longer and more expensive than otherwise would be the case, and it sometimes prevents deals from being completed' (Lambert Review 2003).

The Lambert Review (2003) also suggests that research collaborations might be made easier to agree if model contracts could be developed on a voluntary basis to cover the ownership and exploitation of intellectual property (IP).

Much has changed since the Lambert Review in 2003 and the Sainsbury Review (2007) notes progress since then. Essentially, it says that the agenda to improve effective business–university collaboration in the UK has become increasingly important as the UK's future international competitiveness rests more than ever on the development, dissemination and application of knowledge and ideas.

The Sainsbury Review (2007) suggests that the best way for the UK to compete in a globalised economy is to focus on high-value goods, services and industries. It states that: 'An effective science and innovation system is vital to achieve this objective. The UK is internationally renowned for its research base and this status requires continued support. The Review recommends more effective ways to exploit our investment in research. Government policy has typically focused on the supply-side factors affecting innovation; some of these areas need continued attention. The provision of innovation support is fragmented and a new leadership role for the Technology Strategy Board (TSB) will co-ordinate across Research Councils, Regional Development Agencies (RDAs) and government departments. A major campaign to improve science, technology, engineering and mathematics (STEM) teaching in schools is needed'.

The Sainsbury Review (2007) recommends increased support for early-stage technology companies and building on the success of knowledge-transfer initiatives in four key areas:

- more support through HEIF to business-facing universities, incentivising them to perform more knowledge transfer with small and medium-sized enterprises
- drive up the knowledge transfer activities of Research Councils
- increase the number of Knowledge Transfer Partnerships
- encourage further education colleges to undertake more knowledge transfer.

Sainsbury Review (2007) also outlines the progress with many of Lambert's recommendations, including:

- the code of governance developed and adopted by universities
- the development of a dedicated 'third stream' of funding in England (the HEIF)
- the R&D tax credit is now worth over £600 million per year to business
- guidance material and model contracts have been developed to cover intellectual property issues in five different collaborative and contract research scenarios, and these are now being used by a wide range of firms and universities; a further set of model agreements covering consortia arrangements is under development
- the Higher Education Funding Council England (HEFCE) has announced that £60 million of the QR scheme will be used to reward applied research
- UK technology-transfer organisations have developed close links with their US counterpart, the Association of University Technology Managers (AUTM)
- Regional Development Agencies (RDAs) and the Devolved Administrations are taking an increased role in facilitating business–university links.

It also notes positive developments including the 2007 launch of the Institute for Knowledge Transfer (IKT), which provides a focus to improve the quality of knowledge transfer professionals across the UK and to bring university, business and government KT professionals together.

4.2 France

In response to increasing competitiveness within the global economy, in 2004 France took the step to create competitiveness clusters that combine key factors for competitiveness into its new industrial policy. The French government states that the most significant of these factors is the capacity for innovation.

For any area in France, a competitiveness cluster is defined as: an association of companies, research centres and educational institutions, working in partnership (under a common development strategy), to generate synergies in the execution of innovative projects in the interest of one or more given markets (French Rebublic, Ministry of Higher Education and Research).

The aim of its industrial policy is to encourage, then support, projects initiated by the economic and academic players in a given local area. The French Government notes that there are four success factors for each competitiveness cluster: implementing a common economic development strategy that is consistent with the area's overall development strategy; creating extensive partnerships between players for specific projects; focusing on technologies for markets with high growth potential; and reaching sufficient critical mass to acquire and develop international visibility.

By building a network of players at the forefront of innovation, the end goals of the new policy are the creation of new wealth and jobs in local areas.

Industry is a growth driver for the French economy: it is the primary source of innovation (90 per cent of R&D expenditures) and competitiveness (80 per cent of exports) (www.competitivite.gouv.fr).

The national government states that French industry is currently facing two-fold major global economic developments: the globalisation of trade and production processes resulting in an increasingly competitive environment; and the arrival of a knowledge-based economy, where innovation and research (the intangible, or intelligence) are the primary drivers of growth and competitiveness (www.competitivite.gouv.fr).

'This is why it became necessary to instigate a new industrial policy, combining local areas, innovation and industry more effectively than in the past. Bringing together the industrial, scientific and academic players in a given local area to form competitiveness clusters provides a source of: innovation (proximity stimulates the circulation of information and skills, thus facilitating the creation of more innovative projects); attraction (the concentration of several players in a local area offers international visibility); and encouragement for companies to remain in the area (their competitiveness is tied to their local roots, thanks to the presence of skilled individuals and profitable partnerships)' (www.competitivite.gouv.fr).

Since 2005, aside from the creation of competitiveness clusters, French research and innovation has undergone major reforms: the creation of the National Agency for Research (ANR); the Agency Assessment of Research and Higher Education (AERES); universities becoming independent; and the provision of support for public/private partnerships including the tax credit for R&D, and Carnot institutes (*National Strategy for Research and Innovation* (2009) Ministry of Higher Education and Research). Their objective, to increase performance, visibility, international outreach and promotion of French research.

In the 2009 *National Strategy for Research and Innovation* report, five guiding principles and three research priorities were identified.

Five guiding principles (*National Strategy for Research and Innovation* 2009):

- basic research is essential to any society of knowledge. It must be promoted in all its dimensions, particularly in the context of very large research infrastructure. It is a political choice.

- opening research to society and the economy is the key to growth and employment. The imperative of competitiveness that is necessary for our country means to renovate, in sense of confidence and enhanced cooperation, the link between public research institutions and businesses on specific targets, medium and long term. This vision means promoting an innovative society in which innovation is not only accepted but boosted by the community of citizens
- better risk management and enhanced security are particularly important in our society and must be measurements of preferred innovation, social and cultural as well as technology
- social sciences should have a major role in all priority axes and they specifically help build interdisciplinary interfaces in all key areas
- multidisciplinary is essential to enable the most innovative approaches and the best adapted to the challenges of our society.

Three research priorities (*National Strategy for Research and Innovation* 2009):

- healthcare, well-being, food and biotechnology
- the environmental emergency and environmental technologies
- information, communications and nanotechnology

The report highlights that these five guiding principles and these three priority areas of research constitute the reference for the allocation of resources of the state budget and programming thematic research in France. 'The identification of clear guidelines will encourage simplified co-ordination of research actors for a more efficient and more competitive approach. It will enhance public-private cooperation for research that irrigates better business circles,' (*National Strategy for Research and Innovation* 2009).

According to the report, in terms of territory attractiveness, France is in a middle position relative to its European partners. It states: 'There is a significant disparity between the academic achievements of French research and the practical benefit that the community takes in terms of innovation and economic development. Fragmentation of research system, lack of the private sector investment in research and development (R&D), modest presence in areas with intensive R&D like biotechnology or nanotechnology, loose coupling between management training of public research and that of corporate executives (duality universities - graduate schools) are all factors that explain the situation.'

Strengths and weaknesses of research and innovation in France	
5th power in the world for science and technology, on all fields of basic research as finalized areas of excellence (agronomy, nuclear, space, mathematics, archaeology ...) supported by powerful research organisms and an academic community of high quality; Global industry leaders including the aeronautics and transportation, energy, services to the environment or food and few clusters of world rank A leadership role in international scientific and infrastructure programs, and the Research for Development; (unclear) Significant public support for R&D, including through the research tax credit.	French system of research and higher education not legible and poorly coordinated in its structures and territorial organisation low coupling between public research organisations, universities and enterprises; Low Private investment in R & D and insufficient presence in emerging sectors; relationships and partnerships with emerging Asia less dynamic than in other countries of similar size; significant rigid management of human resources in a large number of public institutions, with a bad impact on attractiveness of careers, the mobility of researchers, the hosting of foreign researchers.

[source: *National Strategy for Research and Innovation* 2009]

In 2006, a presentation given by Hélène Morvan from Bretagne Innovation, part of the Innovating Regions in Europe (IRE) Knowledge Transfer Working Group, *Regional strategies and policies to support Knowledge Transfer, Brittany*, highlights that government funding should be directed towards creating links between actors (collaborative projects); the provision of external specialist assistance for firms; supporting innovative industrial projects; developing the use of ICT; supporting the creation of innovative firms; supporting competitiveness poles; and funding capital risk and capital development.

Morvan points out that Brittany's strengths are that it is a high-ranking scientific research area; it has strong regional financial support; it has a high level of training and education; and it has high-quality technical and organisational assistance for innovation projects. It terms of weaknesses, she notes that Brittany needs to improve its level of international openness in the business environment; it has weak foreign investment; insufficient partnerships between businesses and the research sector; it has a high number of small and very small enterprises; and that there is a lack of business intelligence and 'watch culture'.

4.3 Build on existing successes

One of the most significant recent changes in Europe is the global economic downturn. This has had a significant affect on the European economy as a whole, and in particular, the UK. As a result, the report, *The Connected University Driving Recovery and Growth in the UK Economy* (Michael Kitson, et al, 2009) was prepared in April last year, and although written for a UK audience, its message is applicable on a European scale.

Lord Sainsbury of Turville wrote the foreword of the report stating that: 'At a time when the UK needs to look for new sources of growth, providing the right conditions for high-tech manufacturing companies and knowledge-intensive business services should be a priority, and there is an exciting opportunity for government and RDAs to build on the success that has already been achieved.

He outlines that the report demonstrates that UK universities are already having a major economic impact on their surrounding areas. ‘This should not come as a surprise. If one looks at the USA one finds that the universities which have had most impact on their local economies, such as MIT, Berkeley, Stanford and Austin, are all world-class research universities.

‘There is, however, enormous scope for business-facing universities to more actively engage with small- and medium-sized businesses in their regions, and government and the RDAs should make certain that they have the incentives and resources to do so.

‘At a time when it is essential to produce the best possible conditions for high-tech manufacturing to grow and be profitable, there is a danger that a great deal of effort will be wasted in introducing totally new incentives or policies. Instead of doing so, the most valuable action that government and the RDAs could take, as this report makes clear, is to build on what has been achieved in the last 15 years and to encourage universities to travel further along the exciting road on which they have already embarked’ (Lord Sainsbury of Turville 2009).

Part five: Monitoring systems and mechanisms for evaluating knowledge transfer

One of the PACEC (2008) report's key findings was that although some form of monitoring system is in place in most HEIs, many have no or limited mechanisms in place to evaluate engagements in knowledge exchange. Where HEIs had effective monitoring systems in place, they typically sought systematic feedback from users, commissioned external assessments of their economic/social impact on a regular (e.g. five-year) basis, and conducted case studies to understand outcomes (both positive and negative).

The issue of measurement has recently been addressed by Martin Holi, et al, (2008) in the Library House report *Metrics for the Evaluation of Knowledge Transfer Activities at Universities*, commissioned by a leading Technology Transfer association, UNICO.

Holi says that: 'It has been difficult to measure how successfully universities engage in such transfer activities, mainly because there was no agreed set of measurement tools. To improve this situation, the stakeholders involved in the process of knowledge transfer need to find and agree on a common way to define, quantify and qualify the performance of knowledge transfer activities of universities'.

Mechanism of Knowledge Transfer	Measures of Quantity	Measures of Quality
Networks	# of people met at events which led to other Knowledge Transfer Activities	% of events held which led to other Knowledge Transfer Activities
Continuing Professional Development (CPD)	Income from courses, # of courses held, # people and companies that attend	% of repeat business, customer feedback
Consultancy	# and value/income of contracts, % income relative to total research income, market share, # of client companies, length of client relationship	% of repeat business, customer feedback, quality of client company, importance of client relative to their company
Collaborative Research	# and value/income of contracts, market share, % income relative to total research income, length of client relationship	% of repeat Business, customer feedback, # of products successfully created from the research
Contract Research	# and value/income of contracts, market share, % income relative to total research income, length of client relationship	% of repeat Business, customer feedback, # of products successfully created from the research
Licensing	# of licenses, income generated from licenses, # of products that arose from licenses	Customer feedback, quality of licensee company, % of licenses generating income
Spin-Outs	# of spin-outs formed, revenues generated, external investment raised*, market value at exit (IPO or trade sale)	Survival rate, quality of investors, investor/ customer satisfaction, growth rate
Teaching	Graduation rate of students, rate at which students get hired (in industry)	Student satisfaction (after subsequent employment), employer satisfaction of student
Other Measures	Physical Migration of Students to Industry, Publications as a Measure of Research Output	

* this measure was analysed in the report using an internal Library House data set

Table 3: Knowledge Transfer Framework (measures that are not currently collected are highlighted in blue) [source: Library House report, Metrics for the Evaluation of Knowledge Transfer Activities at Universities, Holi, et al, 2008]

According to the report, in a five-step process, a new set of robust metrics for the evaluation of knowledge transfer activities at UK universities has been developed. It states: 'First, we identified the major stakeholders of knowledge transfer: the research funders, who fund the research that creates the knowledge to be transferred, the senior university management who represent the academics who perform the research, and the business community who are the recipients of the knowledge. We then invited them to focus groups to discuss their currently used definitions of knowledge transfer, their views on the objectives and mechanisms of the process, and how to measure the success and impact of these knowledge transfer activities.

'Following these discussions, the participating stakeholders defined in step three a framework of the key mechanisms of knowledge transfer and associated measures of their quantity and quality. Importantly, this framework reflected the views of all three stakeholder groups and was not biased towards any particular one of them.

'Fourth, we populated this new framework with publicly available data from UK universities and with commercial data to perform an initial benchmark analysis, focusing on a subset of 20 universities. Finally, we carried out an international comparison with the US and Canada to determine how UK universities perform at knowledge transfer relative to these countries. The most important result of this report is a new tool to measure knowledge transfer. It offers specific metrics to assess both the quantity and the quality of nine different facets of knowledge transfer from UK universities'.

Holi, et al, (2008) says that the development of this new framework, together with the initial benchmark analysis, has led to four conclusions about the UK knowledge transfer process:

1) Universities should focus on directly measuring the knowledge transfer activities that they undertake. More specifically, universities should concentrate on measuring the outputs (direct products of the knowledge transfer), outcomes and gross economic impact of their knowledge transfer activities (both are changes resulting from the knowledge transfer), rather than the net economic impact. This is because outputs, outcomes and gross economic impact can be directly measured, unlike net economic impact, which includes an estimate of what would have happened had there been no knowledge transfer, and as such would be difficult to measure.

2) The UK is on the right track with regards to measuring knowledge transfer and ahead of the US and Canada. There is good agreement between UK stakeholders on what should be measured and several organisations already collect relevant data. These include governmental organisations such as the Higher Education Funding Council for England (HEFCE) and the Higher Education Statistics Agency (HESA), the Scottish Funding Council (SFC) for its Knowledge Transfer Grant scheme, and other organisations such as UNICO. In contrast, in the US, no such governmental equivalents exist, with only one organisation, the Association for University Technology Managers (AUTM), actively collecting knowledge transfer data on US universities through its annual licensing survey.

3) Measures of the quantity of knowledge transfer are already good, but data for measures of quality needs to be improved. Some of this data could be collected in future surveys, whilst in other cases, further work should be done in collaboration with all stakeholders to determine the best ways of measuring and collecting indicators of knowledge transfer quality.

4) The UK is actively involved in knowledge transfer activities and competitive with US and Canadian universities. Most universities in the UK appear to be particularly active in one or two areas of knowledge transfer, whilst still pursuing others to some extent. A smaller number are active in many areas of knowledge transfer.

Other concluding findings from Holi, et al, (2008) include the fact that the UK appears to be competitive for its size. 'Although the absolute licensing values for US universities are generally higher, in other measures where the absolute value is less important, such as licensing income market share, and the importance of licensing income to the total research income, the UK performs competitively compared with the US and Canada. This also applies to the number of spin-outs formed (Holi, et al, 2008).

Holi, et al, says that: 'In summary, both the amount of knowledge transfer and the ability to measure it are well developed in the UK. With a few minor additions to the data already collected by HEFCE, HESA, SFC and UNICO, and an explicit agreement on using a common measurement framework, the UK should have a world class set of knowledge transfer measures that will accurately assess the impact and success of knowledge transfer, and that other countries will aim to follow'.

A recent report from the European Commission's Expert Group on knowledge transfer metrics, *Metrics for Knowledge Transfer from Public Research Organisations in Europe* (2009), also considers the issue of measuring knowledge transfer activities and outlines a system that, it says, would unify the format of knowledge transfer surveys across Europe.

The Expert Group recommends that the European Commission work with the relevant parties to improve adherence to the following guidelines:

- That current KTO survey operators and others collecting similar data by other means on knowledge transfer from PROs
  • include the following recommended core indicators:
    1. research agreements
    2. invention disclosures
    3. patent applications
    4. patent grants
    5. licenses executed
    6. license income
    7. spin-outs

  • apply recommended definitions (detailed in the report) for core and any supplementary indicators used
  • make their data available for constructing aggregate indicators, using procedures outlined in the report.

- That institutions initiating new surveys of knowledge transfer offices or public research organisations on questions of knowledge transfer in geographical or sectoral areas not yet (or poorly) covered, or even the monitoring of knowledge transfer in individual organisations, do the same.

- That anyone using data and analyses from these surveys acknowledges that the transfer of intellectual property is not the only important channel of knowledge transfer, that monitoring of transfer in other channels should be given more attention in the future, and that there may be better sources for data about other channels than knowledge transfer offices.

- That relevant parties (such as the European Commission, national administrations, professional knowledge transfer organisations, researchers and others) continue the development of insight into other channels and processes of knowledge transfer, through research and development of new indicators.

- That the professional organisations of KTOs and other knowledge transfer agents, stakeholders in the development of the universities' 'third mission', policy makers engaged in monitoring of knowledge transfer, and others, routinely discuss experiences with the implementation of the monitoring systems and over time take initiatives to amend (if necessary) and expand the range of shared indicators.

A unified system would, no doubt, be extremely helpful, and even though most surveys collect similar data for the seven core indicators, comparability is hampered by minor differences in definitions, plus differences in survey methodologies and methods for presenting results (Arundel and Bordoy, 2008, as cited in the *Metrics for Knowledge Transfer from Public Research Organisations in Europe* report).

However, to measure the amount of knowledge transferred from a PRO is virtually impossible (*Metrics for Knowledge Transfer from Public Research Organisations in Europe* 2009).

The report states that there are two commonly used alternatives:

'One is to estimate the value of the knowledge transferred in its different forms. The assessment of cultural, social, and personal value of knowledge is in its infancy, but quite some effort is put into estimating its economic value. Here, the dominant approach is to equate this value with its price – what someone is willing to pay for it. For knowledge in the making, the most common price is the cost of attempting to produce it through research. For knowledge already in codified, personal, or embedded form, the pricing depends partly on the IP strategy of the PRO. One strategy is to put codified knowledge in the public domain, only requiring academic credit when it is later used. In these cases, the value may not be related to the transfer price at all. Another is to negotiate a price for a license to use it, depending on the future value that a prospective customer expects it to have, possibly also payable as future options (e.g. through equity shares in new firms, which actually postpones the valuation process to some extent).

'The other common approach is to measure not the knowledge but the transfer: to count the number of manifestations of knowledge transfer as activities in various transfer channels. The number of spin-off firms and the number of lectures given in network seminars are examples using this approach. These measures are diverse (so they cannot be added across channels) but at least they give a picture of the transfer activities that the PROs are involved in. In some channels a sequence of identifiable and measurable events has been defined. In the licensing channel, such a sequence includes the numbers of invention disclosures, patents applied for, patents granted, and licenses issued (often on the basis of granted patents). Events early in the chain can then serve as leading indicators for those further down. The UNICO study proposes for each channel a set of measures of quantity measuring the immediate transfer activities and a set of measures of quality indicating longer run effects of those activities, for example the number of research contracts and the number of repeated contracts between the same partners (Holi, et al, 2008, as cited in *Metrics for Knowledge Transfer from Public Research Organisations in Europe* 2009).

Part six: Conclusions

Recent years have seen significant developments in the effectiveness of knowledge transfer in both France and the UK.

Like, Schartinger, et al, (2000), this desk-based assessment of best practice in knowledge transfer finds that there is a complex series of knowledge interactions between industry and university. However, they are often difficult to quantify and indicators of university performance, in terms of technology transfer to industry, often concentrate on only a few types of interactions such as research contracts and patent applications.

This assessment concludes that a unified system for quantifying knowledge transfer across a range of channels would be extremely helpful. Even though most surveys collect similar data for the seven core indicators, comparability is hampered by minor differences in definitions, plus differences in survey methodologies and methods for presenting results (Arundel and Bordoy, 2008, as cited in the *Metrics for Knowledge Transfer from Public Research Organisations in Europe* report). This view is also supported by Holi, et al, (2008).

Although funding is almost always suggested as an issue that affects success, and albeit true in many examples, the assessment finds that numerous factors affect the success of knowledge transfer activities. For best practice, an awareness of the most influential of these should be central to any knowledge transfer activity programme.

The research concludes that the ease of knowledge transfer is dependent on the type of knowledge being transferred. In line with Ray Reagans' and Bill McEvily's (2003) findings, it is more difficult to transfer tacit knowledge than codified knowledge, which suggests that tacit knowledge requires more motivation, effort, and ability to transfer than codified knowledge.

Tacit knowledge transfer is also more dependent on having the 'right person with the right connection at the right place, ultimately limiting the number of people who can contribute to the process' (Reagans and McEvily 2003).

Supporting this, and in line with the findings of authors such as Argote and Ingram (2000) and the Lambert Review (2003), the assessment agrees that people play the most critical role in the success of technology transfer and that the best forms of knowledge transfer involve human interaction.

A major determinant of success is how universities interact with relevant business contacts and individuals who understand the 'market' (Stevens and Bagby 2001). Also organisational and managerial behaviours and skills are critical factors in facilitating the university-industry technology transfer process (Siegel, et al, 2003).

This finding is supported by Dominique P Martin and Lionel Pujol (2008). Their work suggests that it is the skill and the actions of individual project leaders that are the keys to the successful exploitation of public research (Martin 2008).

Martin's main conclusions were that the competency profile of the project leader appears to be a central element in the effective capacity to transfer a patent along with the profile of the project team and the type of knowledge being transferred. Also, the competitive market position of company interested in the information was a significant factor in the successful transfer of knowledge.

Other important factors include trust. It is a central element in alliances and joint ventures (Dhanaraj, et al, 2004). Trust allows access to resources and a willingness to work things out through mutual problem-solving (Uzzi, 1997).

The assessment finds that knowledge is also more likely to transfer from a rotating member of staff to a recipient group when both shared a superior social identity (Argote, et al, (2003). It also notes that, while the sharing of best practice was not important for increasing staff engagement in many HEIs, it was a very important mechanism for improving knowledge exchange performance (PACEC report 2008).

For a more efficient and competitive approach, it is important to identify clear guidelines that will encourage simplified co-ordination of research stakeholders (*National Strategy for Research and Innovation* 2009). Also a multi-disciplined approach to knowledge transfer is necessary, and the assessment agrees with the French *National Strategy for Research and Innovation* (2009) that basic research must be promoted in all its dimensions, particularly in the context of a large research infrastructure.

Numerous factors are at play during successful knowledge transfer activities and the assessment suggests that some are more important than others.

Barriers to success also exist. Horng and Hsueh (2005) identify three barriers to university/industry technology transfer: including inflexible bureaucracy, poorly designed reward systems, and ineffective management of technology transfer offices. They found that these factors resulted in a failure to maximise opportunities to transfer technologies, which has a negative impact on companies and ultimately consumers.

In line with the assessment's findings, it concludes that to overcome these barriers to success and to improve university/industry knowledge transfer, it is necessary to:

- design flexible university policies on technology transfer (Horng and Hsueh 2005)
- improve staffing practices in the technology transfer office (Horng and Hsueh 2005)
- devote additional resources to university/industry technology transfer (Horng and Hsueh 2005)
- enhance the reward for engaging in university/industry technology transfer (Horng and Hsueh 2005)
- universities should improve their understanding of the needs of their true 'customers' i.e., firms that can potentially commercialise their technologies (Siegel, et al, 2003)
- streamline university-industry technology transfer policies and procedures (Siegel, et al, 2003)
- hire licensing officers and technology transfer office managers with more business experience and devote additional resources to the technology transfer office and patenting (Siegel, et al, 2003)
- switch to incentive compensation in the technology transfer office (Siegel, et al, 2003)
- hire managers/research administrators with a strategic vision, who can serve as effective boundary spanners (tie to boundary spanning literature) (Siegel, et al, 2003)
- recognise the value of personal relationships and social networks, involving scientists, graduate students, and alumni (Siegel, et al, 2003)
- when establishing collaborative research partnerships determine at the outset the ownership and exploitation rights for any intellectual property (IP) that may be generated (Lambert Review 2003)

- improve job-specific experience (Riege and Zulpo 2007) and hire technology managers with university experience (Siegel, et al, 2003)
- industry should be proactive in their efforts to bridge the cultural gap with academia (Siegel, et al, 2003)
- explore alternative means for tapping into university-industry technology transfer social networks (Siegel, et al, 2003)
- make time available for academics to undertake knowledge transfer activities (PACEC report 2008)
- more knowledge transfer with small and medium-sized enterprises (Sainsbury Review 2007)
- increase the number of Knowledge Transfer Partnerships in the UK (Sainsbury Review 2007)

The assessment also finds that although knowledge transfer activities in the UK are often targeted at large companies and institutions, they have an impact on SMEs through the supply chains of these corporations (PACEC report 2008).

[ends]

References

Argote, L. & Ingram, P. (2000). Knowledge Transfer: A Basis for Competitive Advantage in Firms, Organizational Behaviour and Human Decision Processes, Vol. 82, No. 1, pp 150 - 169

Argote, L., McEvily, B. & Reagans, R. (2003). Introduction to the Special Issue on Managing Knowledge in Organizations: Creating, Retaining, and Transferring Knowledge, Management Science, Vol. 49, No. 4, Special Issue on Managing Knowledge in Organizations: Creating, Retaining, and Transferring Knowledge, pp v-viii

Argote, L., McEvily, B. & Reagans, R. (2003). Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes, Management Science, Vol. 49, No. 4, Special Issue on Managing Knowledge in Organizations: Creating, Retaining, and Transferring Knowledge, pp 571-582

Demeritt, D. & Lees, L. (2005). Research relevance, 'knowledge transfer' and the geographies of CASE studentship collaboration, 2005, Royal Geographical Society (with The Institute of British Geographers) Area, 37.2, pp 127–137

D'Este, P. & Patel, P. (2007). University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry?, Research Policy 36, pp 1295 - 1313

Dhanaraj, C., Lyles, M., Steensma H.K. & Tihanyi, L. (2004). Managing tacit and explicit knowledge transfer in IJVs: the role of relational embeddedness and the impact on performance, 2004, Journal of International Business Studies 35, pp 428 - 442

Horng, D-J. & Hsueh, C-C. (2005). How to Improve Efficiency in Transfer of Scientific Knowledge from University to Firms: The Case of Universities in Taiwan, The Journal of American Academy of Business, Cambridge Vol. 7 No. 2, pp 187-190

Kane, A. A., Argote, L., & Levine, J. (2005). Knowledge transfer between groups via personnel rotation: Effects of social identity and knowledge quality. Organizational Behavior and Human Decision Processes, 96(1), 56-71 (available online 5 November, 2004)

Koskinen, K. & Vanharanta, H. (2002). The role of tacit knowledge in innovation processes of small technology companies, International Journal of Production Economics 80, pp 57–64

Martin, D., Pujol, L. (2008). Valoriser la recherche publique, Le rôle du facteur humain dans la vente ou la cession de licences de brevets par les universités (The Technology Transfer In The Public Domain, the role of human factors in licensing patents from universities), Gérer & Comprendre, n°92, pp 66-77

Matthews, J. B. & Norgaard, R. & National Centre for Higher Education Management Systems & National Institute of Education (US) (1984). *Managing the partnership between higher education and industry [microform] / Jana B. Matthews and Rolf Norgaard* National Centre for Higher Education Management Systems, Boulder, Co.

Morvan, M. (2006). Regional strategies and policies to support Knowledge Transfer, The IRE (innovating regions in Europe) Knowledge Transfer Working Group (Brittany), presentation, Madrid, Spain, 19th - 20th February, 2006

Mustar, P. (2006). Innovations in Policies to Foster the Creation of University Spin-Off Firms A European comparison: France and the United Kingdom, presentation to the Technology Transfer Society Conference, Georgia Tech, Atlanta, 27-29 September, 2006

Nonaka, I., & Takeuchi, H. (1995). The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. New York: Oxford University Press

Polanyi, M., (1966). The Tacit Dimension. First published Doubleday & Co, 1966. Reprinted Peter Smith, Gloucester, Mass, 1983. Chapter 1: Tacit Knowing

Rahm, D., Kirkland, J., & Bozeman, B. (2000). University - industry R&D collaboration 12 in the US, the United Kingdom and Japan. Dordrecht: Kluwer Academic Publishers

Riege, A. & Zulpo, M., (2007). Knowledge Transfer Process Cycle: Between Factory Floor and Middle Management, 2007, Australian Journal of Management, Vol. 32, No. 2 pp 293 - 314

Schartinger, D., Rammera, C., Fischer, M. & Fröhlich, J. (2001). Knowledge interactions between universities and industry in Austria: sectoral patterns and determinants, Research Policy 31, pp 303 - 328

Slaugher, S. and Leslie, L. (1997). Academic Capitalism: Politics, Policies, and the Entrepreneurial University (Baltimore: Johns Hopkins Press)

Siegel, D., Waldman, D., Atwater, L. & Link, A. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration, Journal of High Technology Management Research Vol 14, pp 111 - 133

Stevens J & Bagby, J. (2001). Knowledge Transfer from Universities to Business: Returns for All Stakeholders? Organization speaking out Vol 8 No 2, pp 259 - 268

Uzzi, B. (1997). Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness, American Sociological Review, 61: pp 674-698

Government reports

French Rebublic, Ministry of Higher Education and Research (Ministère de L'Enseignement Supérieur et de la Recherche) (accessed January 2010). http://www.competitivite.gouv.fr/spip.php?rubrique39&lang=en

Holi, M.T. et al (2008) Metrics for the Evaluation of Knowledge Transfer Activities at Universities, Library House report commissioned by UNICO

Kitson, M., Howells, J., Braham, R., & Westlake, S. (with foreword by Lord Sainsbury of Turville), (2009). The Connected University Driving Recovery and Growth in the UK Economy

Lambert Review of Business-University Collaboration, December 2003

Langlois-Berthelot, M., Malleray, P-A., Macron, E., Cytermann, J-R., Balme, P., Dupont, J-L, Szymankievicz, C., & Guillaume, H. (2007). The promotion of research (N°2006-M-016-01 &

N°2006-82), French Government publication

Lord Sainsbury of Turville, The Race to the Top, A Review of Government's Science and Innovation Policies, October 2007

Metrics for Knowledge Transfer from Public Research Organisations in Europe, report from the European Commission's Expert Group on Knowledge Transfer Metrics, Directorate-General for Research, 2009

National Strategy for Research and Innovation (Stratégie nationale de recherche et d'innovation), (2009). French Rebublic, Ministry of Higher Education and Research (Ministère de L'Enseignement Supérieur et de la Recherche)

PACEC report, October (2008). Higher Education Innovation Fund round four institutional strategies

Wellings, P. (2008). Intellectual Property And Research Benefits

Science as a Solution: An Innovation Agenda for the Next President. Association of American Universities, (2008). http://www.aau.edu/reports/SAAS_08.pdf

Streamlining University/Business Collaborative Research Negotiations (2007). An Independent Report to the "Funders' Forum" of the Department for Innovation Universities and Skills