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Multiple Perspectives on the Challenges for Knowledge Transfer between Higher Education Institutions and Industry

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Abstract

Knowledge transfer (KT) has been identified as an essential element of innovation, driving competitive advantage in increasingly knowledge-driven economies and as a result recent UK Government reports have sought to increase awareness of the importance of KT within higher education institutions (HEIs). There is therefore a need for relevant empirical research that examines, from multiple perspectives, how KT policy is translated into practice within HEI contexts. This paper responds to this need by presenting an in-depth qualitative case study based on over 50 semi-structured interviews with university-based academic and non-academic participants and representatives of small firms involved in InfoLab21, a high profile 'centre of excellence' for research, development and commercialisation of ICT in Northwest England, UK. The study considers what the key practices of KT are and what promotes and/or hinders their development. Four overarching themes are identified: i) motivation and reward mechanisms; ii) process management and evaluation; iii) clustering and brokerage; and iv) trust and bridge building. Each theme is considered from multiple perspectives and areas for further research are suggested.

Keywords: Knowledge transfer, technology transfer, regional policy, universities

Introduction

> 'The proper understanding of knowledge transfer, its parameters, its dimensions, its scope, its scale and its dependence on knowledge creation is of particular importance to UK competitiveness.' (RCUK 2006b:30)

Knowledge transfer (KT) has been identified as an essential element of innovation, which drives competitive advantage in increasingly knowledge-driven economies. A number of recent UK Government reports have sought to increase awareness of the importance of knowledge transfer - most noticeably the DTI's Innovation Report (DTI, 2003), the Lambert Review (Lambert, 2003), HM Science and Technology Committee reports (House of Commons, 2006), The Race to the Top report (Sainsbury, 2007) and the Government's Science and Innovation Investment Framework 2004-2014 (HM Treasury, 2004). The last named report, for example, states that 'an economic imperative is to make sure that scientific knowledge is used by business to create wealth' and concludes 'That is why knowledge transfer – both the science base 'push' and the business 'pull' – is such an important element of Government's science and innovation strategy' (HM Treasury, 2004:69).

This paper examines KT in this broader context and draws from a case study of one particular facility (InfoLab21) in order to better understand academic, policymaker, practitioner and small firm perspectives. In the context of unprecedented interest in KT by government and HEIs, this empirical study seeks to answer the following research questions: what are the key practices of KT and what issues and processes promote and/or hinder it? The study does this by exploring the experiences and challenges of InfoLab21, a Lancaster University initiative to establish a world-class centre of excellence for research, development and commercialisation of information and communications technologies (ICT) - see www.infolab21.lancs.ac.uk. The initiative was made possible by financial support from the North West Regional Development Agency (NWDA), European Regional Development Fund (ERDF) and Higher Education Innovation Fund (HEIF). InfoLab21 is a well-equipped, high-tech environment shared by academic research staff, research students and small businesses and has three main elements, namely:

- ICT Research: Housing over 260 research staff working in the area of ICT and particularly focussing on networked and multimedia systems.

- Training and Development: Offering an extensive range of education and training courses for ICT professionals ranging from industry-standard vendor qualifications to part-time PhD programmes.
- Knowledge Transfer: Consisting of the Knowledge Business Centre (KBC) where the emphasis is on business and economic development and creating start-ups and spin-out companies emerging from the work of students, research groups and industrial partners.

This study seeks to inform the debate over the issues and practices of KT by considering a wide range of interview data collected from over 50 individuals both directly involved in InfoLab21 and with limited or no association with the project.

The paper is organised as follows: the next section defines KT and reviews the literature and government policy on KT by briefly considering recent key policy documents. Section 3 consists of a summary of the methodology before the key findings are given in section 4. Section 5 contains a discussion of the key findings and their implications for stakeholders, while section 6 (Conclusions), considers the importance of these findings in the context of policy and practice and suggests areas for further research.

Literature review

There is growing interest in knowledge transfer between higher education institutions (HEIs) and industry by policymakers at all levels of government, from regional to international, which has resulted in a range of initiatives. Given the importance of small to medium-sized enterprises (SMEs) for regional and national economies, the academic community has not been slow to focus on researching the relationship between KT, entrepreneurs, small firms, regional policy and HEIs (Salter *et al,*. 2000, Thursby and Thursby, 2004, Wright *et al.*, 2004, Niosi, 2006). More specifically, Thierstein and Willhelm (2001) and Benneworth (2004) and Gittell and Sohlin (2005) have focused on technology centres and HEI-based incubation or co-location facilities. Not all of this recent research is US-based. In the UK Rosa and Dawson (2006) considered the role of female academic entrepreneurs and Macdonald *et al.* (2007) considered the role of European Union funding in facilitating the transfer of expertise from HEIs to industry. Also, in Japan, Fukugawa (2005) and Lynskey (2004) considered interactions between HEIs and small

firms and new technology firms. Importantly the level of engagement with SMEs is cited as a means of measuring KT activities. Meanwhile, government-funded Research Councils in the UK have also responded with various initiatives (RCUK, 2006a, EPSRC, 2006) and external reviews (RCUK, 2006b). Clearly KT activities are seen as important to both HEIs and Research Councils, and form an integral part of regional and national government economic policy for wealth generation. Increasingly in the UK much of the financial decision making for economic development has been delegated to the regional development agencies. Northwest England is no exception to this, with the Northwest Regional Development Agency (NWDA) investing significantly in science in order to improve regional competitiveness. In the last five years the NWDA has chosen to invest over £160 million on a number of flagship research and development (R&D) projects, such as the National Biomanufacturing Centre in Liverpool and InfoLab21 in Lancaster (NWDA, 2003, 2007). Many of these projects are linked to HEIs and include incubator space for SMEs. Whilst large firms are often engaged in KT with HEIs it is acknowledged that SMEs play an important role in any economy and are increasingly being encouraged to engage with the HEI sector (HM Treasury, 2004:63). SMEs are highly heterogeneous and contribute significant proportions of employment and turnover in both European and US economies. For example, in Europe 'SMEs account for a large proportion of economic and professional activity. In practice, 99% of businesses in the European Union are SMEs, and they provide two-thirds of all private sector jobs', (EU, 2007).

There are concerns in the UK that the Research Assessment Exercise (RAE) has acted as barrier to KT between HEIs and industry (Decter *et al*. 2007, Millar and Senker, 2000). Decter *et al*. (2007) explored this and other barriers through interviews with academics, intermediaries, policymakers and managers in both large and small companies. The research usefully highlighted the differences in motivations between UK and US experiences, most noticeably the effects of the 1980 Bayyh-Dole act in the US on patenting behaviour and concludes that gap-funding to bring technologies closer to market; cultural differences between the university and the company and identifying suitable companies and technologies are the main barriers or problems.

For this study the 'interim definition' of KT proposed for RCUK (2006b), which is graphically represented by Lockett (2006) in Figure 1, is used:

'Knowledge Transfer means the two-way transfer of ideas, research results, expertise or skills between one party and another that enables the creation of new knowledge and its use in: → The development of innovative new products, processes and/or services

→ The development and implementation of public policy

Knowledge transfer will encourage the dissemination and assimilation of knowledge and stimulate engagement between wider society (including business, government and public) and the research community' (RCUK, 2006b:35).
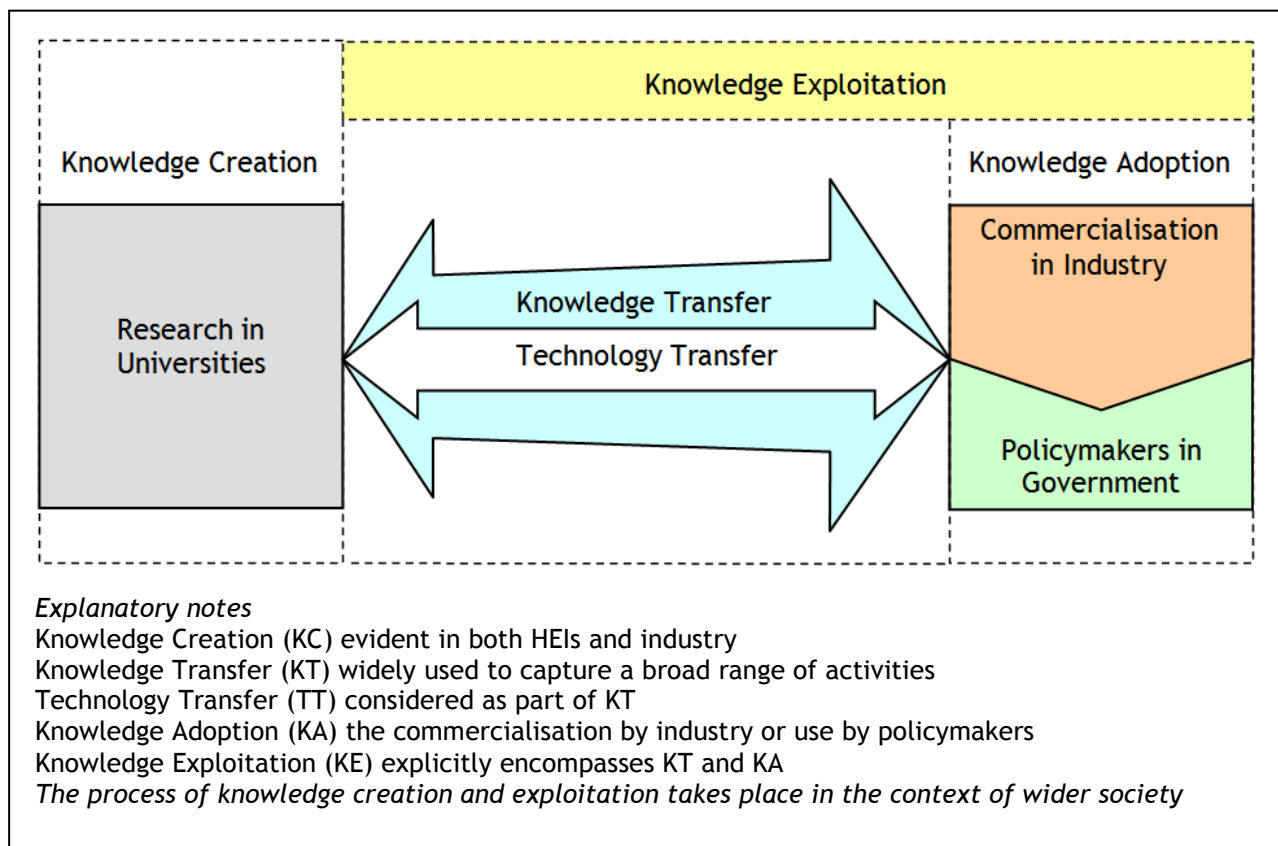
Figure 1. Definition of knowledge transfer and related terms (Lockett, 2006)

Methodology

The case study method of conducting and reporting research is widely used in the area of social sciences and in particular the fields of management research. Many studies cite the seminal work of Yin (1984, 1989; 1994, 2003), resulting from 20 years of research in the field of social science, to justify their methodological approach. Yin (2003:120) notes that, when explaining a phenomenon, finding causal links 'may be complex and difficult to measure in any precise

manner'. However, all the data collected for this study (and described below) serve to build up a picture of a 'complex situation' (Yin, 1994:13). Case studies are therefore particularly useful tools for practitioners as they build 'a picture to help inform our practice or to see unexplored details of a case' (Creswell, 1998:95). Case study is used in this study precisely because of the emphasis that it places on explanation-building in complex situations.

Data collection

The data comprise a series of 53 interviews, conducted between 2005 and 2006, in which the interviewees have been categorised by primary role as: 14 academics - Group A (G/A), 18 small business owner-managers - Group B (G/B) and 21 non-academics - Group N (G/N), including intermediaries, brokers situated within and outside university structures, and large companies (Appendix A). The interviewees were selected as being representative of the role within their respective organisations. More specifically, interviewees from the academic and commercial communities at Lancaster University encompassed representatives from all levels of the organisation. Potential interviewees were approached, by email, by the authors requesting they participate in the study. All the individuals approached agreed to be interviewed. Interviews were conducted face-to-face or by telephone, using interview guidelines (Appendix B). To provide continuity the independent interviewer conducted all the interviews. All interviews were digitally recorded and transcribed.

Data analysis

The first stage of the analysis consisted of collective, rather than individual, analysis of the transcripts using Wmatrix (www.comp.lancs.ac.uk/ucrel/wmatrix), a computer-mediated linguistics corpus analysis application. Subsequently, the individual interview transcripts were concatenated together in plain text format and then submitted for analysis using the Wmatrix software tool (Rayson, 2007). Wmatrix automatically tokenised and then classified every word in the running text into its part-of-speech (POS) and semantic field categories (domains). Frequency profiles of word, POS and semantic fields were prepared automatically, and key words and key domains emerged by a comparison of the frequency profiles against standard profiles from representative corpora of spoken English, in this case almost a million words from the British National Corpus (BNC) spoken sampler corpus. The log-likelihood statistic was used to indicate

significant deviations from the expected frequencies. This allowed for comparison of words and themes between the data and the spoken English part of the BNC and also between the groups of interviewees. This kind of comparison allows the identification of thematic preoccupations.

The methodology implemented in Wmatrix allowed the authors to review the individual interviews pre-sensitised to the language used across all the interviews. The automatic annotation methods within the tool are robust and accurate (>92% for word meanings and >97% for grammar), however the authors could use the online search tool to confirm frequency of words and engage with the full context and extract appropriate quotations. Wmatrix was used in the first stage of the analysis as an automated assistant to the research team rather than replacing manual analysis completely. The second phase of the analysis resulted in the identification of the key findings, which were subsequently reviewed by the authors who had access to the data and to audio files and transcriptions for each interview. Whilst use of Wmatrix to pre-sensitise the authors to the language used by the interviewees was novel it was however used in support of the identification of key findings rather than to produce them.

Key findings

The findings relating to knowledge transfer from the study are grouped in five main areas, namely: practices of KT, barriers to KT, benefits of KT, and the measuring and monitoring of, KT. Each is considered separately below and relevant interviewee quotations given.

Practices of knowledge transfer

From the 'interim definition' proposed for RCUK (2006b) and the government documents reviewed previously, key concepts in KT include clustering, proximity and the university as regional hub. Historically, universities have been seen as centres of teaching and research with the formal inclusion of KT being fairly recent. Generally training and teaching have also been included in KT, however some respondents in this study exclude undergraduate teaching and training as being not subsumed under KT, in that 'training is too limited because training tends to mean you push this button and then this button and that is not what we are doing', (G/A).

For some respondents, KT practices are more about supporting businesses in a number of different ways at different stages in their businesses' development, with, for instance, financial, premises, technical, management and marketing support. Strategic partnerships are recommended for universities working with large corporate sector companies, but, as one respondent points out, there are benefits to working with local and regionally-based companies, in that 'being local doesn't necessarily mean you are just local', (G/A)

Some of the KT activities of InfoLab21 are summarised by one respondent: 'here in InfoLab we are mainly thinking about knowledge transfer in terms of spin-out companies from the university or researchers in the university working with … companies but other things that the department gets involved in as well is linking with the local community…like the Headstart scheme for year 12 pupils at schools, bringing them into the university and getting them aware of the research that we do and so I suppose they are kind of third mission activities of the university is what I think of as KT', (G/A). In addition, then there are the creation of new patents, licensing, placing students in companies (student projects), the formation of partnerships, and one-way transfer to the university (in terms of course development): 'The knowledge transfer so far has been one-way pretty much in terms of me to the university saying this is a good idea, this is what other people are doing, and they are also working in this', (G/B).

Some respondents discuss the potential role of an intermediary or broker in the KT process: that is, the role of intermediaries in identifying suitable partners. Brokers are described as people who know the universities, can 'get embedded' in the university world, but who also understand the world of business. This is sometimes expressed as 'speaking the same language', as for example: 'intermediaries are people who need to find out what the academic world is like and get embedded in it so that when they are talking to companies they can understand what they are taking from the academic world but they also have got to have a knowledge... of companies,' (G/N). One intermediary describes the role as one of working to promote strategic partnerships and identifying and defining a particular problem to work on: 'The way we prefer to work in terms of strategic partnerships is that …we would rather you came to us and said "I have these issues/problems". We would work with you to define that problem and then we would issue a call for researchers to apply – so the idea is it is then open to the entire research community.' (G/N).

Within the university, a well-informed and networked individual is needed to act as an intermediary but for one respondent (G/N), the model of 'academic-broker-industry is not a good model'. For this respondent, the interaction or dialogue between academia and industry needs to be closer and unmediated in order to promote effective mutual understanding. This respondent prefers a dialogical model, employing in the interview the following concepts to recommend that academics become entrepreneurial coaches, and that academics and business speak the same language, 'go on that journey together', engaging in continuous discussion.

Barriers to knowledge transfer

The interviewees were asked to comment on what they saw as barriers to successful KT. Some of these barriers are internal to universities while others are outside the universities, in the perceptions of individuals for example. The main perceived barriers to the success of KT are:

- lack of time and different perceptions of time-scales (both of these work both ways)
- the bias of incentives within universities towards publishing research and teaching (attributable to the UK RAE), the perceived lack of recognition of 'third mission' activities, and IPR issues
- the perception by academics of 'problems' in the SME sector as not generating 'cutting edge' research and the perception by industry (particularly SMEs) of the university as an 'ivory tower', of academics being detached from 'the real world'

Lack of time

A number of academic respondents state that their time is budgeted fully, often for more than two years ahead, thus making it difficult to respond to requests for attention to immediate problems from companies: 'I tend to think of barriers as things like not enough time and not enough reward…for doing that or enough tangible rewards,' (G/A).

As with the academics, potential KT participants in companies are also short of time: 'You have got the issues of time. You have got the issues of how to excite these people to work with a small company and really help the small company change its direction which means you have to spend some time to understand the whole thing', (G/B).

Time-scales

Different perceptions of time-scales of research were also seen as being problematic, with university researchers perhaps looking to projects that will continue over a period of years, while companies may want immediate results: 'if people are doing good work - how useful is that likely to be and what is the time scale? … If you are doing something that is going to be…a new generation of something in ten years time, you might find there are companies who are not terribly interested in that. So timescale is something that we have to think about quite carefully', (G/A).

Again reference was made to 'a disconnect' between the urgency of action and the response time, as seen by one respondent: 'And the other side to that are the timescales. I imagine it is no different from any other small company…there needs to be a sense of urgency…We need it now. We need to solve these issues now and otherwise we don't eat next month. Whereas I get the impression and it might be a wrong impression, but in the academic world the timescales are… a lot longer and are tied to an academic year and such like', (G/B).

Lack of incentives

The way that academic advancement is structured around the RAE with its bias towards the publication of research in refereed journals can mean that there is less benefit to individuals and departments and even potential risk in participating in KT. The following extract explains the problem: 'I think there is a strong barrier in this country [UK], which is institutionalised in the RAE system. If you are an academic and you publish lots of papers which are peer reviewed you get a high score in the RAE system', (G/N).

There is also some evidence from the Group B interviews that some respondents believe that KT in the form of different kinds of collaboration and support is needed at different stages of business development, or even that, by the time a business is able to work with the university, that the business has already moved on from the position where it needed to collaborate: 'I mean I can see an MD thinking right we have got this start up - Infolab looks good although too expensive and then two years down the line when you can afford it the MD is thinking we have moved on from there now', (G/B).

Another respondent indicates that while on the one hand promoting KT, on the other hand the government also promotes the RAE and thus sends mixed messages about what is valued and 'speaks with two voices' regarding multi-disciplinary collaboration: 'It could be, and that is the other problem that academia has got, that you haven't got a structure at the moment that allows you to effectively gain the metrics that you live by, namely RAE… So the government speaks with two voices. On the one hand it says we have got to be multi-disciplinary to compete in the modern world. On the other hand you structure your metrics with academia in the way that you cannot get any benefit whatsoever with a multi-disciplinary function', (G/A).

Status of KT as 'third mission'

Related to the centrality of the RAE, some respondents claimed that calling KT the 'third mission' gives the impression that it is the least valued of the universities' activities (i.e., after research and teaching): 'we have talked "third mission", "third leg" …things like that get bandied around and that is confusing. People seem to think that is a sort of grade three or…a third rate sort of thing', (G/N).

Intellectual property rights (IPR)

The issue of who owns the IPR to any innovation produced by KT is a significant disincentive to academics' involvement: 'I keep hearing about intellectual property at universities…people not wishing to do work in universities because the university will grab the intellectual property rights. We have had people come here and sometimes say they have been scared away from going into universities to do some work for those reasons', (G/N).

IPR is also an issue for some of Group B. That is, the fear that the university might take the IPR from the business: 'so I am a little bit worried IPR is an issue in terms of protection of the IPR belonging to the company and maybe I am just being paranoid or careful?' (G/B).

Perceptions of universities/academics

There are some indications that negative (although outdated) perceptions of academics as e.g., 'long haired weirdoes' (G/N), discourage participation in KT: 'particularly by SMEs…they view

universities as being full of long haired weirdoes…who don't understand the real world and all of that and they don't actually appreciate that universities now have got business targets as well as academic targets', (G/N). This links with the view of the university as an ivory tower, and academics as detached from the 'real world': 'I suppose some people in universities don't want to interact with companies at all. There is a need for bridging the gap between academia and industry and I think actually we have been making good progress on this', (G/N).

One reported reason for this is that the size or 'name' of a business is important for academics in agreeing to collaborate (although conversely no one from Group A mentioned this as a barrier): 'So there are people in the university who do know [the business] but it seems that we - no one wants to work with us for some reason. They just say well we don't know about you or you don't have a big name or whatever', (G/B).

Technology transferred is not 'cutting edge'
There is also a perception that some of the 'problems' that KT deals with are not 'cutting edge', particularly in relation to SMEs, as the following extract indicates: 'And there will be companies that want solutions to questions now, very often using not very current technology or even outdated technology or science and then companies with a slightly longer horizon. You probably have to get to larger ones to get the much larger horizons.' (G/A).

But these barriers are counterbalanced in the data by a number of facilitating factors that promote the success of KT initiatives. The next section considers the benefits of KT.

Benefits of knowledge transfer
The benefits that accrue from successful KT can occur at several different levels: the individual, the universities, local communities and regions and the national economy. The benefit to an individual working in a company might be the solution to a particular problem, or a greater understanding of what knowledge might be applicable in their context (a kind of coaching), while for an academic, in addition to the financial benefits, an individual's (or team's) research can become more relevant through greater insight into context: 'the other thing that we have and

encourage here is not only people working with industry but spin-off companies and we have three of our colleagues that are company directors themselves', (G/A).

Co-location (of academics and business) is mentioned as a definite facilitating factor: 'co-location with the research community…That has been extremely beneficial and we are leveraging that', (G/B). However, in some cases of co-location, the way that the particular building is designed does not facilitate communication and perpetuates an 'us' and 'them' attitude: 'whilst there is an intention for knowledge sharing between the computing and the business world they are actually on separate wings. The geography doesn't actually support the prepared strategy and I think that is an issue,' (G/B).

At the level of the universities, the benefit of KT is bridging the 'ivory tower' and the 'real world'. By reducing the ivory tower element, KT helps to reconnect institutions with their environments: 'I think the interaction back to the academics is proving very valuable because they could have been accused of being somewhat insular and in this day and age it is important they do recognise…the needs of the market and not just their research aspirations…so I think that interaction, that feedback, they will appreciate it', (G/N).

In addition, for the universities and companies, if the flow of knowledge is two-way, then there is mutual benefit: 'It helps the university in two ways. One is that the university and academics are in contact with industry and therefore they have knowledge and understanding of what is needed out there. It is very important ... in planning their research activities and the second thing of course has to do with exploitation and with income', (G/A).

For the local communities and the region a strong KT hub centred on a university will help in the local and regional retention of graduates. The formation of new spin-off companies will also benefit the local economy by providing new opportunities that will replace the old manufacturing base: 'I think [Britain's] manufacturing base is…almost gone and it is our knowledge base which is our strength and I think we have got to view universities - in addition to their strengths and I am not saying they shouldn't do their research, they need to do that to attract the money and the

status and so on - but they have also got to do knowledge transfer because the economy needs it. The regions need it', (G/N).

But KT also benefits the companies and therefore the economy as a whole: 'if you look at the actual data and the evidence is those countries which do knowledge transfer perform better than we do and there is a pretty straight link, correlation… about rates of knowledge transfer and rates of economic growth. So basically it says if you are a company that works with a university you have on average a better chance of success than a company who doesn't work with a university', (G/N).

Measuring and evaluation of knowledge transfer

The interviewees are concerned about methods for measuring the success of KT activities. Some even doubt the possibility of doing this and/or the value of what can be done. Clearly the simplest thing to measure is what is delivered (the example given by the following respondent is 'a masters' project'): 'the way we measure it at our end is that obviously… if we do work on something and we deliver it', (G/A).

Other respondents mention collecting figures on the survival and success of businesses that have been involved in KT: 'we did a thorough analysis of 133 of the SME's. We started with 150, 17 fell by the wayside, not really for any other reason than they didn't have the time…. Of the 133 we got a gross value added improvement of 24% in a nine-month period, which we were quite pleased about,' (G/N).

Another respondent suggests looking at the revenue generated by the university (although with the caveat 'I do not think that is going to capture it all'): 'At the end of the day if you wanted a very crude measure you could look at something like revenue that is directly attributable to the university as opposed to any other institution or employment within the university or engagement of existing staff at the university but I do think that is going to capture it all', (G/A).

A further criterion that was suggested is the number of jobs created locally or regionally that can be attributed to businesses involved in KT, although this is a long-term process: 'InfoLab has

been open for a couple of years now and there are a lot of companies coming in but in terms of success you can only measure that long term. I think we have a ten-year plan or something for reporting back to the regional development agency …and over that time we are supposed to have shown some success in how many jobs[1]', (G/A).

What the university adds to the process is, for one respondent (G/B), in some ways intangible: 'the only way I can measure is in an intangible way in that we now have the confidence to go into the market place because we do have a completed…product. Now, prior to meeting Lancaster we hadn't a clue. We just didn't know where to start. And we instinctively thought that Lancaster would be the right place to start, given the discussions we had had and the literature that we had had and that proved to be the case. Now what financial value you put on it I couldn't really say, I couldn't measure it at all. It is intangible', (G/B).

Economic growth in the region could also be looked at as a measure of success: 'I mean the kind of economic remit would be to stimulate economic growth in the region and that would be partly the responsibility of the universities', (G/N).

Some respondents make the point that tangible outputs need to be measured in order to satisfy funding agencies and their 'bureaucratic regimes': 'It has been an extremely bureaucratic regime ... so we are closely monitored by the funding bodies themselves…It is more finite numbers than any sort of metric but in a very simplistic form. We - basically the large pot of money with outputs related to it and lots of this money either comes from the government or particularly the Commission - the European Commission - so there is a vast chunk of money going to the region that has a great set of outputs against it', (G/N).

But one respondent feels that a focus on 'benchmarking and metric' can detract from the process of engagement and can get in the way of actually doing things: 'Go to any university and they invariably assess you on benchmarking and metric - I hate it because ultimately it is about engagement. It is about getting on with it rather than reporting - we have to report, obviously, but

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[1] Typically ERDF funded projects are measured in terms of the number of jobs and sales created by the beneficiaries.

you know any of that, we find it is time consuming and it is having the appropriate mechanisms in place', (G/N). This kind of measurement is also seen to run the risk of missing the 'softer impacts': 'there are a lot of softer outcomes that can benefit companies that you don't really benchmark because it is not part of the requirement', (G/N).

Another respondent notes that measurement is not straightforward and should concentrate on outcomes rather than outputs: 'benchmarking and measurement and output measurement and stuff isn't always straightforward. But again I think the answer to that isn't necessarily to get hung up on how you make them consistent or how you benchmark, but it is to look at outcomes really more than outputs What you don't want is DTI saying, we don't do that because it doesn't meet this benchmark. You just look at what the outcomes are and you need to really take a bit of a leap of faith and trust', (G/N).

A number of respondents note that any kind of measurement must in any case be long-term: 'one thing I would say is that you have to be prepared to measure these factors over quite a large number of years actually and perhaps to look for trends, progress', (G/A). And measurement must deal with things that are difficult to measure: 'how do you measure how well we are exploiting research? So whilst we have a very broad suite of ways in which we encourage this engagement we need to be able to measure it and to be able to nail it down a bit more to demonstrate that we are measuring up', (G/N).

The theme of benchmarking and measurement of outcomes leads to some suggestions for dealing with questions of evaluation as a formative continuous process, being long-term (strategic), and dealing with complex and multi-level processes: 'It is actually trying to understand each other's context and capabilities and help each other and then finally we get on and try to do it and when we have done it we evaluate it. So it is a continuous process, which UPBEAT [http://www.upbeat.eu.com/] tries to model and monitor', (G/A).

Discussion

In summary the key findings identified as part of this study include: i) KT is a two-way but not equal exchange and that knowledge exploitation, consisting of knowledge transfer and adoption,

is focused primarily on commercialisation in industry rather than influencing policymakers; ii) barriers to KT include: lack of time, time-scales, lack of incentives, status of KT as 'third mission', intellectual property rights, perceptions of universities/academics that technology transferred is not 'cutting edge'; iii) there is a general awareness of the benefits of knowledge transfer; iv) there is considerable uncertainly regarding 'measuring and evaluation' and 'motivation and reward mechanisms'.

Regarding motivation and reward mechanisms, the academic community appears to have been given different messages as to what is valued by the government and policymakers. This confusion tends to result in a continued focus on existing research and teaching activities for which rewards are more clearly understood. This is in spite of a general awareness of the actual and potential benefits of KT to different stakeholders and society.

Evaluation remains a central and unresolved issue. KT evaluation needs to ask questions as to how to deal with the complexity of the process, how to do justice to the long timescales of the process and the way it operates on different societal levels, in addition to the issue of how ideas and concepts impact on wealth creation.

Four additional, largely positive, issues are also worth noting: namely: i) increased evidence of intermediaries working within HEIs successfully facilitating KT; ii) increased recognition and importance of postgraduate students doing projects for industry as a means of achieving KT. This view appears to indicate a subtle change from seeing students as the recipients of KT (through teaching and industrial placements) to being part of the KT process through project activities of benefit to industry; iii) the different needs of SMEs, particularly small firms and those of large firms should be recognised. Larger firms appear to be happier with the long-term nature of academic research, whereas SMEs' needs and expectations are more immediate outputs and clearer evidence of financial returns; iv) intellectual property rights (IPR) appears to still be an area of some confusion and conflict within both academia and industry.

Whilst there is widespread acknowledgement of the importance of the 'push' from research in HEIs and the 'pull' of commercial needs from industry, within the area of KT the evidence from

this study indicates that the scales are still tipped towards 'push' rather than the more commercially orientated 'pull' from industry. Connecting the 'pull' from industry with the 'push' from research remains a challenge. However, all the respondents who were engaged in KT activities held a broadly positive view of the societal benefits of knowledge transfer.

Conclusions

The themes that are discussed in this paper indicate that knowledge transfer (KT), although seen by many of the respondents as vague and difficult to define, is nevertheless recognised as indicating an orientation that universities are increasingly taking to the world outside. Furthermore this helps those involved to understand that people in universities and industry can learn from each other and that different stakeholders have differing views. The study confirms the value and validity of the proposed RCUK (2006b) 'interim definition':

> 'Knowledge Transfer means the two-way transfer of ideas, research results, expertise or skills between one party and another that enables the creation of new knowledge and its use in: → The development of innovative new products, processes and/or services
>
> → The development and implementation of public policy
>
> Knowledge transfer will encourage the dissemination and assimilation of knowledge and stimulate engagement between wider society (including business, government and public) and the research community.' (RCUK, 2006b:35)

However the study highlights two differences: namely, that whilst being a two-way exchange, KT is not equal and that knowledge exploitation, consisting of knowledge transfer and adoption, is focused primarily on commercialisation in industry rather than influencing policymakers (although InfoLab21 may not be typical). Figure 2 highlights the main areas and the actors involved and places these in the context of KT (adapted from Lockett, 2006).
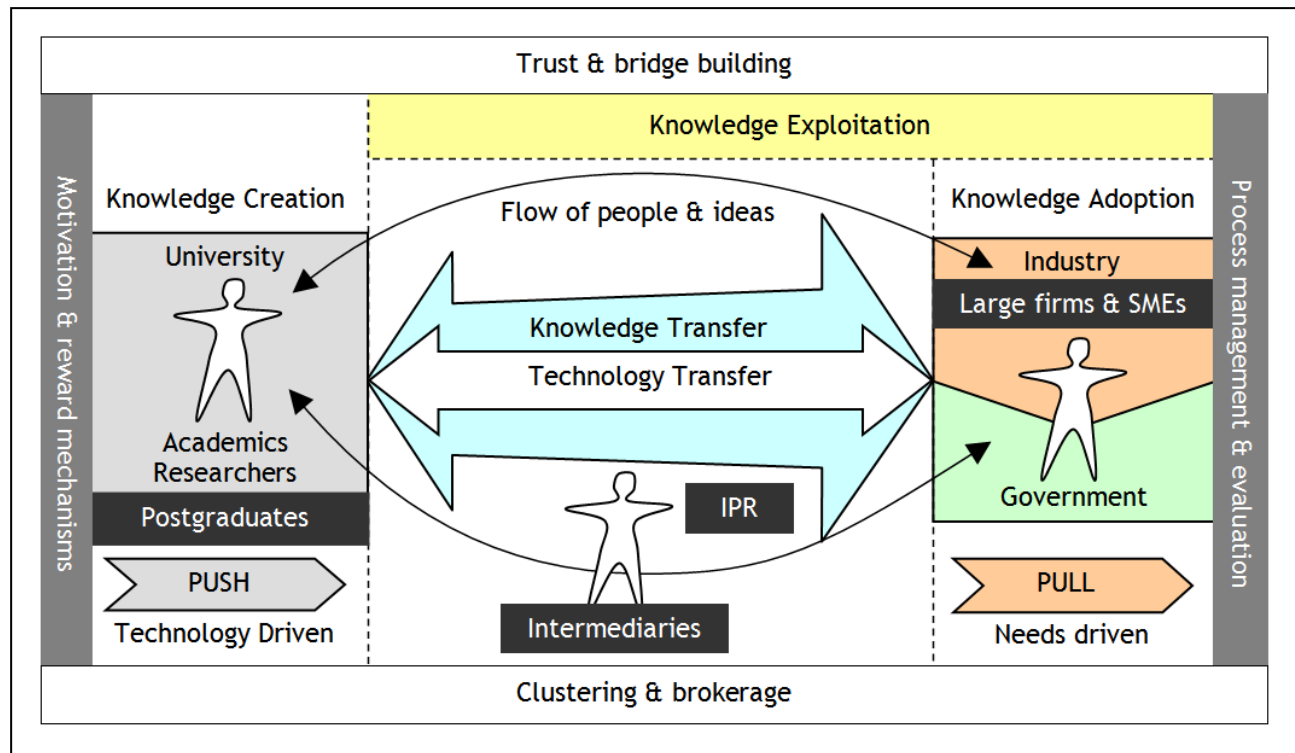
Figure 2. Key issues and actors relating to knowledge transfer (adapted from Lockett 2006)

This study makes a contribution to a better understanding of KT, which could be of use to stakeholder groups, including policymakers, brokers, academics and entrepreneurs. Four overarching issues dominate knowledge creation, transfer and adoption, namely: i) motivation and reward mechanisms; ii) process management and evaluation; iii) clustering and brokerage; and iv) trust and bridge building (Figure 2). The study provides some comfort for policymakers and brokers regarding iii) and iv) in that there is considerable evidence that these two inter-related issues are being addressed. Certainly InfoLab21 appears to be deeply engaged and successful in 'trust and bridge building' and 'clustering and brokerage'. What does appear to be of particular concern for policymakers and brokers now is, firstly, the challenge of developing appropriate motivation and reward mechanisms, particularly for academics, to encourage engagement in KT activities. And secondly, and perhaps more worryingly for all the stakeholders concerned, the apparent lack of evidence of process management and evaluation mechanisms surrounding the area of knowledge transfer generally. Whilst there is some evidence of good practice within InfoLab21, there should be concern that clear policy and practice have yet to emerge more widely. A notable exception is the UPBEAT project (http://www.upbeat.eu.com/)

funded by the Council for Industry and Higher Education (CIHE), HEFCE and EPSRC, (UPBEAT, 2007).

By taking a deliberate multiple perspective (academics, intermediaries, policymakers and managers in both large and small companies) the research, albeit based on a single case study, also contributes to and extends the existing KT and HEI focused literature both from the UK (Salter *et al.*, 2000; Rosa and Dawson, 2006; Macdonald *et al.*, 2007) and more widely (Thierstein and Willhelm, 2001; Benneworth, 2004; Lynskey, 2004; Wright *et al.*, 2004; Fukugawa, 2005; Gittell and Sohlin, 2005; Niosi, 2006). It is worth noting that all the respondents were engaged, to a lesser or greater extent, in KT and, perhaps, not surprisingly held a broadly positive view of the societal benefits of knowledge transfer.

The research highlights a number of challenges worthy of further investigation. Firstly, clearer understanding of reward mechanisms in order to address issues of motivation could enable HEIs to achieve an increase in knowledge transfer activities. Academics remain the key to unlocking the commercial potential of research but need to be rewarded for working with KT practitioners and industry. Many academics appear willing to engage but not at the expense of their careers and fear that being enterprising academics will mean becoming an entrepreneur and abandoning research and teaching activities. Secondly, the increased understanding of appropriate evaluation mechanisms, which include both quantitative and qualitative methods, could contribute to the emerging debate on a metrics-based allocation of funding to HEIs post-RAE 2008. And finally, the need for the identification and investigation of good practice in KT process management is strongly indicated by concerns related to differing time-scales and perceptions between academia, non-academics and small business owner managers. These groups have much to learn from each other but need robust and well-tested mechanisms for achieving agreed project outcomes in a timely and cost-effective manner. Knowledge exploitation (the transfer and adoption of knowledge and technology through commercialisation) is a complex process, which requires simplification through the sharing of best practice and use of specialist and expert facilitation. Thirdly, further research might deliberately challenge the somewhat positivistic view of respondents and explore the underling motivations including the societal and organisational pressures on staff to participate in KT activities. Finally, whilst it was evident from the study that

many relationships existed which facilitated KT it could be worthwhile exploring the social and human capital that is required and accumulated by engaging in these activities.

In short, whilst much progress has been made both this study and other commentators remain concerned about key aspects of KT. The focus of research should therefore move from defining and justifying KT to its exploitation, through understanding the commercialisation process and effective evaluation.

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Appendix A   List of participants

Group	Role	Organisation
A	Programme Manager	Research Council - EPSRC
A	Programme Manager	Research Council - EPSRC
A	Professor of Computing	University of Lancaster
A	Lecturer in Communication Systems	University of Lancaster
A	Business Development Manager	University of Lancaster
A	Professor of Computing	University of Lancaster
A	Professor of Communication Systems	University of Lancaster
A	Professor of Communication Systems	University of Lancaster
A	Professor of Computing	University of Lancaster
A	Senior Lecturer of Computing	University of Lancaster
A	Researcher in Communication Systems	University of Lancaster
A	Dean of Science and Technology	University of Lancaster
A	Professor of Communication Systems	University of Lancaster
A	Pro-Vice-Chancellor	University of Salford
N	Project Manager	Business Link Cumbria
N	Project Manager	Business Link Lancashire
N	Project Director	CMI@Adastral Park, Manchester
N	Programme Manager	Department of Trade and Industry
N	Commercial Director	Head of UCL Ventures
N	Research Manager	Intel
N	Economic Develop Manager	Lancaster City Council
N	Economic Development Officer	Lancaster City Council
N	Business Manager	North West Development Agency
N	Project Manager	North West Development Agency
N	Project Manager	North West Universities Association
N	Project Manager	The Heath Business & Technical Park, Manchester
N	Project Manager	University College London
N	Project Manager	University of Lancaster
N	Project Manager	University of Lancaster
N	Business Development Manager	University of Lancaster
N	Project Manager	University of Lancaster
N	Commercial Director	University of Lancaster
N	Project Manager	University of Lancaster
N	Project Director	University of Lancaster
N	Project Director	University of Manchester Incubation Company
B	Director	University spin-out company
B	Director	University spin-out company
B	Director	Web services company
B	Managing Director	Information services company
B	Director	Web services company
B	Managing Director	Web services company
B	Director	Application service provider
B	Director	Web services company
B	Director	Security services company
B	Managing Director	Information services company
B	Managing Director	University spin-out company

Groups: A = Academic, N = Non-academic, B = Small business

Appendix B   Interview guidelines

About you:
Name; position; organisation, brief description of current roles and responsibilities.

Definition:
What do you think knowledge transfer encompasses?

Activities:
What knowledge transfer activities is your organisation involved in at present?
What knowledge transfer activities are you personally involved in at present
What knowledge transfer activities other than those do you have experience of?
Which were the most successful and why?
Which were the least successful and why?

ICT Sector:
Are there any special factors which influence knowledge transfer in the ICT sector?

Drivers and benefits:
Why is knowledge transfer from Universities to industry important and what are the drivers for it?
What are the potential benefits to Universities of knowledge transfer?
What are the potential benefits to industry of knowledge transfer?
Who else benefits from this form of knowledge transfer?

Barriers and concerns:
What, if any, are the barriers to knowledge transfer that you have come across?
How, if at all, were you able to overcome these barriers?
Do you have any concerns about knowledge transfer and your organisation's involvement in it?

Support:
What does your organisation do to encourage/support/facilitate knowledge transfer?
Which of these activities are successful and how do you know?
What more could you or your organisation do to support knowledge transfer?

Measurement and benchmarking:
Are you aware of any measurement and benchmarking approaches used in knowledge transfer?
What, if any, approaches do you personally used?

Any other comments: