KNOWLEDGE TRANSFER FROM UNIVERSITIES TO THE SME SECTOR

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INTRODUCTION

The sustained phase of transition to economies characterised by considerable, and sometimes revolutionary, advances in science, technology and related industries, coupled with subsequent profound changes in economy and society, has increased the importance of the knowledge-intensive phases of production for value-creation. As enterprises, in fact, become more reliant on technology, they will become more dependent on knowledge. Accordingly, policy makers in a growing number of countries have become increasingly concerned with the management of the entire knowledge chain: from creation to the diffusion, conversion and entrepreneurial exploitation of scientific and technological knowledge. The knowledge chain also has profound implications for higher education institutions and business schools, which to be successful, need to help companies create knowledge and become part of knowledge streams.

Knowledge transfer (KT) can be seen as a basic process for speeding up the flow of knowledge among all components of the knowledge chain. To the advocates of KT, this process brings about a self-reinforcing circuit between productivity, economic growth and entrepreneurial activity.[1]

KT can push the economic performance of a country, a region or an industry insofar as it provides a competent guide to the innovation process, which relies on a complex web of relationships. A broad range of competences to identify, capture, industrialise and commercialise free flowing knowledge and technologies intervene to make KT conducive to economic growth. The higher the quality of these competences, the more likely an entire economy is to receive benefits from new venture creations that are superior entrants in the market, as well as from the successful reorganisation of existing firms.

While explicit or institutionalised and codified knowledge (i.e., the official rules codified and written down in books and manuals) certainly contributes to the transmission of information, it is not a substitute for tacit knowledge (i.e., the informal, occupational wisdom and experience generated by people grappling with everyday problems and passed on in café-type communities of practice and online communities[2]) in the transfer of knowledge.

Inventions, products and services, great and small, are created through talking. The best preceptor is a participative engagement in the conversation between knowledge seekers and knowledge users. Conversations are the sense-making conduits through which knowledge flows (Kilpi, 2005). This is where learning dynamics and

Notes

1 According to van Stel, Carree and Thurik (2005).“„...entrepreneurial activity affects economic growth, but...this effect depends upon the level of per capita income. This suggests that entrepreneurship plays a different role in countries in different stages of economic development”.

2 Café-type communities of practice are life forms whose behaviour is organised from the bottom up. Cafés-type face-to-face based communities are suitable for enabling participants to exchange and transfer “skills” or “technical elements of tacit knowledge”. The odd point is that face-to-face interaction induces “conformity effects” and “group thinking”, which gets participants to think inwards. Online knowledge communities generate ideas to be turned into new ventures for the knowledge economy. One feature of these communities is the sense of individualism felt by their participants who “behave as self-contained decision-makers”, instead of going along the “group-type behaviour” path seen in face-to-face based communities. Another feature is that most knowledge community-participants tend to use nicknames. The use of nicknames makes interactions easier, for knowledge exchange happens in an equal footing context that is, irrespective of status considerations. Insofar as these features prevent “conformity effects” from occurring, online knowledge-community participants would settle for being schooled in the art of outward looking. As a result, new companies would be established that look forward rather than backward. In other words, there would be more start-ups whose scope extends well beyond the horizon of the traditional industrial basis to envisage the needs of the knowledge economy (Formica, 2004).

learning value can be optimized. From this perspective, an effective KT process directs its attention to a "conscious conversation" (Yin and Lin, 2002[3]) as the central activity that involves the deployment of a wide range of "soft skills"[4].

Interactions between academic research and industry are a cornerstone of KT. From the perspective of economic performance it is vital that knowledge flows from academia into business and society at large.

If University-Industry (U-I) linkages are to have and to develop excellence, a number of mechanisms need to be in place. Traditionally, mechanisms that lead to advances in U-I relationships include training activities that a university provides to industrial personnel, student placements in companies, university faculty members employed as consultants in industry, industry researchers and business experts as visiting professors, or members of advisory boards to universities, research projects co-funded by industry, licensing of university intellectual property, and university spin-spin offs.

Closer co-operation between academia and business underpins growth in a knowledge economy. First and foremost in the United States as an OECD report submits Òstronger interactions between science and industry have characterised the innovation-led economic growth of the past decade and are currently helping the country to secure a lead in science-based industries ranging from IT and biotechnology to the new field of nanotechnologies" (OECD, 2002). Other large advanced economies, such as Japan, Germany and France, are responding the same report highlights with reforms "aimed at removing regulatory barriers to closer industry-science relations, while creating incentives for public research to join forces with business" (OECD, 2002).

When aiming to learn the lessons of U-I interactions from the last two decades, policy makers should enact a KT strategy that embraces:

A symbiotic relationship between research and commercialization. U-I interactions are not mere adaptations of technology in tandem with the university, but they involve significant development activities undertaken by the industrial partner (Motohashi, 2004). Which means to work in a collaborative way among knowledge creators and knowledge users at the intersections of different fields of academic disciplines and industrial activities.

An increasing interdependence with a large number of smaller firms. Traditional and family-run, mid-size and smaller enterprises, have relatively low levels of employment, technical specialists and research expertise, and therefore encounter more difficulties in establishing communication with external sources of knowledge and scientific and technological expertise. This results in higher opportunity costs and transactions costs relative to large companies (Harvie and Lee, 2003). However, when compared to larger business organisations, innovative small enterprises are closer linked to scientific research (US Council of Competitiveness, 2004). In addition, service firms show

3 Yin and Lin define conscious conversation as "a transformational change technique that incorporates deep dialogue skills of reflecting, deep listening, interacting and connecting. It intends to foster common sense, build trust and understanding, and create positive and harmonious relationships among community members. It is familiar to communities of practice in Asia" .

4 Soft skills are behavioural and social components of "emotional intelligence" as opposed to "technical intelligence" (Leonard, 1997). They encompass values, motivations, attitudes, and emotions. Namely:

- Skill in self-awareness (recognising your own strengths and weaknesses)
- Skill in self-regulation (keeping emotions under control)
- Skill in motivation (having optimism and personal drive)
- Skill in reading emotions and motivation of other people (empathy)
- Ability to build and manage relationships (negotiation skills)

lower levels of R&D activity and a higher demand for education and training (OECD, 2004). Overall, smaller manufacturing companies and service firms are more dependent on the acquisition of knowledge from external sources. In this respect, closer links between academia and small businesses are justified and must be addressed in order to lower the costs of access to complementary, external sources of cognition for traditional small companies. This strategy would also deal with the need for research expressed by the innovation-driven, small-scale enterprises, and deliver the education and training required by service firms.

The acquisition and improvement of soft skills. It is argued that from "the importance of not only knowing a great deal but also [of appreciating] the value of being able to effectively use that knowledge", it follows that higher education institutions should attempt "to improve the tacit knowledge related to soft skills" (Volkova and Schmit, 2005).

There are a variety of definitions of KT and differing viewpoints as to the extent to which it is possible to establish a difference between KT and technology transfer (TT). By tapping into the positions taken by parties to the KT debate, in this paper we examine the main characteristics of these two different, albeit related, concepts.

2. Defining knowledge and technology transfer

KT is the process that puts knowledge in action. It relies upon the action and flow by which largely tacit knowledge, not technology per se, is transmitted among people: from one unit (the source: a single person, group or organisation) to another (the recipient), with all kinds of feedback loops. The process is in fact complex and non-linear with a large number of interactions, not simply a matter of knowledge that passes down a production line linking academic researchers upstream and their business counterparts downstream.

KT is concerned with the subsequent absorption through which the recipient is affected by the experience of the source. How to transfer knowledge that exists in a given unit into another is more than a communication problem that information technology (IT) tools can fully accomplish.

First and foremost, KT is an evolutionary process of communicative interaction. It involves human action to construct and transform a mental content, and then human interaction ("action of social relating") for an effective sharing of knowledge, ideas and experiences whereby mental tools akin to knowledge resource maps that "show who has what knowledge and what sources are used" (Stanford, 2005) should be designed[5].

Moreover, since human interaction happens in a community and needs behavioural rules that allow relationships to take place without the rigidity of formal contracts, critical to a viable KT process is the amount of social capital available in a given community. A vibrant

5 See the seminal works on knowledge mapping by Xenia Stanford (2005), Editor-in-Chief, KnowMap: The Knowledge Management, Auditing and Mapping Magazine (http://www.knowmap.com)

As Stanford puts it, "A knowledge map differs from an information or data map by its function or purpose. Generally the purpose of an information map is to show us what we have and where to find it. A knowledge map is intended to help us learn, build, elicit, share, create and regenerate knowledge. It is one of the tools used to make implicit knowledge explicit so it can be made implicit again.

"A knowledge map includes a text connected to symbols, directions, routes and other key map elements. The text should be concepts, questions or ideas not paragraphs of information or simply objects.

"A knowledge map shows relationships between or among the concepts.

"The value of the true knowledge map can be broken as follows:

What you have that you need - so you can leverage it.

What you have that you do not need - so you can eliminate the "fat" and concentrate on more important elements (the 80/20 rule).

What you do not have that you need - so you can obtain it" (Stanford, 2005).

social capital infrastructure founded on the intelligence and interactions of people with shared visions and common purpose invigorates the KT performance[6].

Knowledge in action that secures availability of pertinent knowledge at the point-of-action, and just in time, has the power to produce innovation as its desired result (Wiig, 2005). KT gives attention to innovation not only in the sense of significant identifiable technological advances, but also from the perspective of the discovery process and its imaginative exploitation (Kirzner, 1985). Hence, KT is about the effectiveness of the knowledge value chain, which allows for unrecognised means and ends to be discovered.

Technology transfer (TT) is a related but different subject. TT places importance on information and efficiency rather than on knowledge and effectiveness. A TT programme is a search/respondence mechanism that uses technical concepts to transfer technical information and data from the results of scientific research. If implemented with efficiency and speed, an information- and data-oriented approach helps develop practical applications that solve practical problems in products and processes of an individuated industry.

In the academic context, KT covers the processes of transferring knowledge, research, skills, experience, and ideas within the universities, and from universities to the greater community of users (the business sector and the wider community), for the purpose of increasing economic returns from this investment and achieving cultural, educational and social benefits for society (see Exhibit 1) (HMSO, 2003: page 39). This definition embraces both the form of KT and that of TT. These two forms sit side by side under the organisational umbrella of a multidisciplinary entity (known as "Office of Technology Transfer", which often includes scientists, engineers, economists, and marketers) dedicated to identifying research results of potential commercial interests, and to

Exhibit 1 KT activities from an academic perspective

- Creation of new knowledge through research, often collaborative in nature. From the standpoint of knowledge produced by the scientific community, this includes knowledge presented in scientific papers, pieces of scientific knowledge not yet formalised in a scientific paper and that type of tacit knowledge concerned with the methodology used in scientific processes and experiments.
- Exchange of knowledge through teaching, training, research or industrial partnerships involving faculty members and students.
- Application of knowledge to social and political issues of the day through participation in advisory boards, government consultations, advice to interest groups, public commentary and other forms of community service.
- Codification of knowledge through written articles, conference presentations or patent applications.
- Commercialization of knowledge through the development, exploitation and marketing of products for the domestic and international marketplace.

Source: Trends in Higher Education: page 78, 2002; Natural Environment Research Council (NERC), UK http://www.nerc.ac.uk/using/ktcall.shtml

6 The OECD definition of social capital "includes such structural and psychological elements as the networks of personal relationships and sense of mutual understanding that enable people to live and work together effectively. Social capital is associated with greater trust, co-operation, reciprocal engagement and social cohesion. Furthermore, social capital can enhance the rapid diffusion of knowledge between individuals, communities as well as within and between firms" (OECD/ONS, 2002; OECD/Government of Canada, 2003). The PRISM REPORT 2003 by the European Commission Information Society Technologies Programme defines social capital "as the set of collective (in the sense of shared) intangible assets available in a territory (a city, a region, a country, a set of countries). Collective intangible assets allow communication and exchange to take place without rigid, formal contracts because they provide behavioural rules (formal or informal) that avoid free-rider problems or other abuses of loose contractual relationships (Eustace, 2003).

developing strategies for how to exploit them.

Collected experience shows that transfer processes are, in general, affected to a considerable degree by a number of impediments. Factors that hinder the desired course of those processes include:

- Inability to bring together the right competencies
- Inability to detect those competencies that are highly intuitive rather than consciously perceived
- Internal conflicts stemming from "professional territoriality" in a given area of expertise
- Generational gaps
- Inappropriate identification of the key holders a specific knowledge or content
- Problems with sharing beliefs, assumptions, heuristics and cultural norms
- Lack of or not well defined motivations and incentives aiming for significantly greater interaction among the parties involved in the transfer process, and
- Inadequate mentoring or guided experience

Much research effort has to go into examining the impeding factors that stand in the way.

3. Knowledge transfer modes

KT can occur by various routes. Processes of integration, collaboration, communication, and commercialization of knowledge are associated either with the softer side of the transfer process, such as sponsored students, contract and collaborative research, or with the harder side of it, such as intellectual property, licensing and spin-off companies (HMSO, 2003: 39).

This section provides a description of these processes.

3.1 Knowledge integration process

The rationale that sustains this process is that we are no longer in the age of information. Economies are shifting from information to knowledge integration economies. Hence, the view that the economy is poised to bounce forward has to be built on its knowledge bases. This requires an integrated approach to respond to the new economic and social needs.

The field survey examines the knowledge integration process from two angles:

- One perspective looks at the interdependency between academic institutions and SMEs, taking into account the number of research partnerships between the HEI surveyed with SMEs embedded in its environment (from now on, Local Business Enterprises - LBEs).
- The second perspective reveals two basic types of relationship for KT:

▸ Type A: Transfer of inputs ("supply push")

A type of relationship that concerns contract research, consultancy and other university out-reach initiatives to business, such as transfer of research, skills, management strategies, and knowledge capital in general.

This relationship emphasises the supply of input (of a "knowledge package"), lending relatively little weight to the interaction with the end users. The crucial consequence of a linear approach to KT is that organisational and behavioural characteristics of LBEs, as well as their capacity to absorb the input transferred, are neglected.

▸ Type B: Knowledge transfer designed in a demand-led way ("demand pull") This is a coupling type of relationship that holds two properties. One property makes the relationship dependent on the needs of business and, therefore, its primarily objective is that of fitting the cognitive characteristics of the recipient actors (Garavelli, Gorgoglione and Albino: Part 1). A second property is that the relationship is driven by the interplay between the supplier and the receiver of knowledge. The better the interchange, the higher the value of KT, and the more intense the iterative process, that by trial and error

produces new knowledge at every stage.

It has been found that knowledge transfer, designed in a demand-led way and capable of fostering ties with knowledge providers outside the region, is to a significant degree important in those regions or countries with a low density of knowledge services (which reflects an inadequate knowledge base) and where local firms are learners whose very limited capacity of absorbing new knowledge fields requires a language of communication that reflects the learners preferred ways of being instructed about that new knowledge (Tödtling and Trippl, 2004; Powell, 1987).

In these problematic regions, a critical role could be played by a relationship promoter who would be responsible for gathering subject-specific knowledge that backs local firms thus improving the effectiveness of the knowledge exchange (Gissing, 2005). Relationship management would contribute to raising the meagre demand for the knowledge and skills available at university sites, redirecting a share of university research to be driven by the needs of the LBEs.

3.2 Knowledge collaboration

Collaboration, together with social cohesion and connectivity, is crucial for knowledge sharing and value creation. The value of leveraging knowledge between partners creates a greater wealth and sustainability for us all (see the "Third Law of Knowledge Dynamics" in Amidon, Formica and Laurent-Mercier, 2005: Introduction).

Knowledge collaboration describes an open process of value creation in which contributing members make every effort to capture all the relevant pieces of knowledge across functions, businesses and even across nations.

Different tools are used to create meaningful venues for collaboration. The tools described below are those moulded over many years of collaborative experience between academia and business. They show two facets: one is that of a controlled situation (closer to the concept of a contrived consultation) in which each party involved solicits a demand or a response from the other component(s), and the other is that of an unstructured, unpredictable and spontaneous interaction which promotes cross-fertilization of ideas for prosperous innovation.

3.2.1 Traineeships/Internships

In this organizational form, knowledge transfer occurs by means of interaction between the knowledge provider ("teacher") and the recipient individual ("learner"). The training process enables the learner to use, in a well-defined context, the knowledge transferred by the source. The provider knows a-priori the solution to a specific problem that the recipient has to solve (Garavelli, Gorgoglione and Albino).

Knowledge practice includes both project-based placements of students in a company[7] and company employees in an academic lab for the realization of a specific project, which is the mission of a partnership between the university and that company.

3.2.2 Continuing professional development

The Lambert Review acknowledges that continuing professional development (CPD) is an important form of knowledge transfer, which an increasing number of universities are providing to business employees. The Review comes to the conclusion that through CDP "Businesses can raise the skill levels of their workforce and learn about the latest academic ideas, while universities gain access to the latest developments in professional

7 The Shell Technology Enterprise Programme (STEP) is a nationwide scheme which provides placements for undergraduates, mostly during their summer vacations, to work on a project in an SME that meets a specific business need. All students receive a skills assessment package and three days' training from their local provider (usually a business support agency or university), to enable them to record the transferable skills learnt during their placement. Many businesses receive contributions towards the cost of the placement from local business support agencies, which play an active role in helping them define the project, and in quality-assuring it (HMSO, 2003:120).

practice" (HMSO, 2003:122).

3.2.3 Collaborative research

The collaborative research form of knowledge transfer aims at promoting a context where academic researchers work alongside company employees for the purpose of creating, developing and testing a prototype based on their reciprocal ideas, and which could be the platform for the development of a new product or service possibly leading to a new venture creation that is focused on application fields far from the original application of the knowledge transferred.

Along with staff, the data and equipment necessary for the successful testing and development of the prototype, the company can provide the partnership with funds that secure the sustainability of the project. The academic partner can tilt the university action in the direction of offering access to both in-house expertise and its international network of scientists and researchers.

Collaborative research can be carried out in a 'collaboratory' an appropriate lab type infrastructure that link up teams of people from university and companies with disparate cultures, different cognitive systems and skills. In a collaboratory, research focused on specific company problems and scientific research is carried out through the interactions between academic trained corporate researchers and university researchers willing their scientific results to put to practical use.

By providing access to the use of this infrastructure to groups of talented students or postgraduate students who can benefit from the knowledge exchange among the participants, spending more time working alongside academic researchers and company employees on shared problems and projects, new business formation becomes more likely to happen through spin-offs and start-ups that lead to new knowledge-based enterprises founded by students and graduates, and supported by in-collaboratory companies.

3.3 Knowledge communication

Tacit knowledge is not transferable without communication between individuals. In order to share knowledge, trust and understanding are important factors. Each participant in the transfer process needs to develop autonomous critical capabilities and practices for the purpose of making an effective use of the knowledge transferred.

The extent to which knowledge communication is built on the principle of participation, by being evocative and not only informative, is a sign of how powerful it could be in shifting the current emphasis on information in favour of imaginative ideas to be converted into sound commercial ventures.

At the present time, most universities are still organized to inform faculty and students about the process of commercial development from academic research. Workshops and seminars help to communicate an understanding of this process, but their informative content is too limited in its scope it does not address the recipient's need to acquire that autonomous practice which would allow the recipient to play in the realm of imagination where the information is interpreted and turned into knowledge in action.

The much-vaunted university channel of knowledge communication is at the intersection between disciplines, both technical and business, and capable of melding the worlds of science and industry. Funding interdisciplinary chairs that focus on both technical and business topics is a first step toward that and would give fresh weight to the question of how universities can contribute to effective knowledge communication.

3.4 Knowledge commercialisation

The conversion of knowledge creation into economic

knowledge that can constitute a business opportunity is the aim of an increasing number of academic institutions.

3.4.1 One-stop centres

In this respect, there are universities that have set up one-stop centres to guide faculty inventions and scientific research through the commercialisation process. These centres are focused on:

- How to assess the commercial applications of the results of a research project
- How to effectively formalise them into a business plan
- How to identify the best way (product, service, technology) to employ to the commercialisation of the results of a research project

UK universities, for instance, have established science enterprise centres whose aims are "to foster the commercialisation of research and new ideas; to stimulate scientific entrepreneurialism; to incorporate the teaching of enterprise into the science and engineering curricula; to act as centres of excellence for the transfer and exploitation of scientific knowledge and expertise" (European Commission, 2004).

3.4.2 Incubation of research based start-ups

Knowledge transfer involves new business launches or identification of new business opportunities within existing organizations.

Universities and other higher education institutions that put in motion processes of knowledge transfer are often also interested in embarking upon a process of incubation ventures through which knowledge based opportunities flow across conventional intellectual and business borders. By doing so, they support ventures that originate from scientific research.

The incubation process, in general, is embedded in a physical and organizational infrastructure called an "incubator", which measures the success of higher education not only in graduates but also in faculty-student promoted real business start-ups. Scientists, academic researchers and talented students, who perceive practical implications from their findings, often lack the strategic vision and profit-seeking approach that a would-be entrepreneur should have. The incubation process brings together, in a single organisation, these entrepreneurial scientists, researchers and students, and enhances their ability to interface knowledge and innovation. Research findings and novel technologies, which are the result of their curiosity-driven research projects, are re-directed toward business concepts that can be converted into viable commercial products and services.[8]

3.4.3 Spin-in

Developing spin-off firms based on sharing university potential is not the sole role of the incubation process. The same process can also spin in creative ideas from local businesses and help to form partnerships for new venture creation with the pool of knowledge-rich scientific and technical personnel, and talented students, backed by the incubator infrastructure and its support staff (Powell, Harloe and Goldsmith, 2000:11).

3.4.4 Licensing

A good number of university spin-offs that have the status of a joint closed stock partially or fully owned by both an

8 8 The overriding concern is the conflict of interest that develops as research teams give birth to spin-off phenomena. As Strandburg (2005: 64) has observed, "Commercialization of spin-offs of curiosity-driven university research may involve the active participation of the scientist inventor. It is not clear what impact the involvement of scientists in such entrepreneurship is likely to have on the market for curiosity-driven research. One salient concern is that an entrepreneur-scientist might seek to suppress the work of another scientist if that work had the potential to threaten the commercial success of his entrepreneurial project. The usual personal preferences and social norms that mitigate such a scientist's desire to suppress competing work in the basic research community are still operative, of course, but they may be less effective against the entrepreneurial scientist because of the added personal incentives to suppress that the commercial enterprise provides. The basic research community might effectively avoid this potential distortion of the curiosity-driven demand function by using more stringent conflict of interest screening of peer reviewers. Scientists with commercial stakes in enterprises related to particular areas of curiosity-driven research could be precluded from reviewing proposals and publications in those areas".

academic institute, which is committed to the exploitation of its research results, and one or more scientific entrepreneurs (entrepreneurial scientists included) may not prove to be sustainable. Rather, this increases the likelihood that something negative will occur, and therefore the propensity of universities to shift the emphasis from developing commercially viable academic spin-offs to being much more focused on licensing.

MIT, a leading institution in the transfer process, has been a pioneer of policy efforts designed to tackle the issue of licensing. As observed by the *Lambert Review* (HMSO, 2003: 67), "Unlike many UK universities, MIT has no business incubation activities at all. The strategy of the technology licensing office (TLO) is to encourage as many invention disclosures as possible from faculty members by minimising the barriers to disclosure currently MIT discloses about 450 inventions per year. MIT's TLO then licenses these inventions as nonexclusive or exclusive licences to industry and local venture capital firms. Rather than getting involved in the complexities of spinout formation, the TLO provides a shop window for industry to view its IP and agrees as many licence deals as possible".

A licensing policy opens up opportunities for incentives that motivate inventor academics to patent as a means of maintaining control over future research (Strandburg, 2005).

5. Conclusion: What Does the Future Hold?

In this paper we have described KT modes that will be required to initiate and sustain effectively concerted and persistent interactions between the intellectual resources of universities and the SME sector. In particular, because human interaction is the most effective form of knowledge transfer, we have placed importance on university staff skilled in KT and staff transfer between universities and firms as a gateway for businesses wanting to access expertise and facilities available at the university.

To secure a better future for knowledge flow between universities and firms, knowledge transfer needs trustful and outward looking knowledge brokers with excellent interpersonal skills, commercial awareness and contractual experience. Trust is a critical component of the business formula for those who should build bridges in a field so subtle and ambiguous as that of transferring know how, know what, know why, know whom, know when.

For the foreseeable future, KT advancements would not be imperilled in as much as arrangements for KT are likely to be made within a frame of reference that fits with the enterprising role of knowledge intermediaries organized in trust-promoting groups. These groups could play a greater role in building sustainable relationships between the academic community and the business sector, with an emphasis on SMEs.

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