



# Nine drivers of knowledge transfer between universities and industry R&D partners in South Africa

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This article presents part of the findings of the Research Marketing and Technology Commercialization Survey conducted in South Africa during 2005 and 2006. Part IV (Q4) of this survey was designed to examine nine drivers of knowledge transfer between South African universities in their research and development (R&D) collaborations with industry firms. Respondents from a judgemental sample ranked the knowledge transfer for R&D collaboration between university departments and industry as: (a) the need to extract appropriate knowledge at the right time to make critical decisions; (b) the perception that knowledge is a valuable resource; (c) the emphasis on getting a return on investment in research; (d) the need to protect knowledge for competitive advantage; (e) the need to close the knowledge gap; (f) international trade; (g) the need to protect intellectual property such as patents and trademarks; (h) geographic proximity between the knowledge source and recipient; and (i) war, terrorism and natural disasters.

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**Key words:** Knowledge transfer, university/industry collaboration, systems of innovation

Received 10 November 2006; accepted January 2007

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## 1 Introduction

Schwartz (2004:63–64) indicates that if firms and universities are observant and are able to leverage research and development (R&D) and convert more meaningful arbitrary occurrences into opportunities, they may change an economy and the world. Firms and universities need to apply thinking strategies to their surroundings, to increase collaborations and knowledge transfer while ensuring that sufficient mutual benefits can be derived. If knowledge management is a collection of processes that govern the creation, dissemination, and utilization of knowledge in an organization (Newman 1991), then firms have to provide an enabling environment for the development, nurturing, utilization and sharing of employees' tacit knowledge (Ajiferuke 2003:1). Only firms that are able to protect, re-deploy, build, buy, combine or recombine their knowledge assets, and then deploy them according to rapidly changing circumstances and client needs, stand to survive.

Globalization demands that our society needs to move faster, work smarter and take more risks than at any time in our history. For both firms and universities it is learning and not knowledge that is the primary source of value, because the ability to change knowledge – to learn – is a source of power (Jacques in Prichard *et al.* 2000:208). One has no option but to partake in this wrenching process. South Africa is a society faced with huge, lingering effects of apartheid, but the changing world of work calls for adaptability. This spells out a need to 'foster intellectual curiosity about alternatives together with robust intellectual debate' (O'Connell 2006:8) between stakeholders in industry and their collaborating universities. If, according to the World Summit on Sustainable Development (cited by Yeld 2006:11), sustainable development rests on the three pillars of (a) economic development; (b) social development; and (c) environmental protection, then South African firms and universities are mandated to develop the scientific labour force (DST 2005:4). This implies greater levels of collaborations between all sectors of business, government, industry and higher education institutions.

The manner in which knowledge flows between universities and industry firms is a complex and diverse process. It is fair to say that the relationship between university and industry

(Kenny 1986:73) seems to be blossoming in many forms all over the world – South Africa is no exception. However, a wide gap seems to exist in the expectations and perceptions of both industry partners and universities, probably as a result of a poor understanding of the knowledge transfer mechanisms in their R&D collaborations. Therefore the main research question centres on gaining an understanding of the drivers of knowledge transfer between industry firms and universities in South Africa. These drivers should provide some reasons why industry partners approach universities for R&D engagements and what issues industry considers to be of importance in these collaborations. Having this knowledge could better equip and enable universities and industry to make pro-active and appropriate decisions in their future collaborations.

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## 2 Research design

Concurrent to a literature review that laid the essential foundation, the design of a measuring instrument that offers validity and reliability was initiated (Mouton 2001:100). Members of the Department of Engineering and Technology Management within the Faculty of Engineering, Built Environment and Information Technology (University of Pretoria) designed the proposed survey: The South African Research Marketing and Technology Commercialization Survey.

The Likert Scale (2002:40) was considered, which asks respondents to 'express agreement or disagreement with a set of attitude statements using a five-point scale'. This method seemed the most viable option to capture the responses of industry partners and to gauge the perception they have of their R&D relationships with universities in South Africa. The Likert Scale carries the support of Jamieson (2004), Blaikie (2003), Hansen (2003), Cohen, Manion and Morrison (2000) and Pett (1997). In this survey, industry respondents were asked to rate the drivers of knowledge transfer using a 'rating of significance' from 1 to 5, with 1 being *not significant*, 2 being *vaguely significant*, 3 being *significant*, 4 being *very significant* and 5 being *extremely significant*.

It is important to note that this sample is a convenience or judgmental, non-random sample of companies in South Africa, that is, the research area is defined as South African science and technology industries that have in the past, or are currently, engaged in collaborative R&D projects with higher education institutions.

The survey addresses the following four issues: (a) the gap between university delivery of R&D and industry's perception, as well as the expectations of industry partners in R&D collaborations with research institutes; (b) the extent of linkages between industry stakeholders and decision-makers and researchers within the South African National System of Innovation; (c) the behavioural preferences required for effective engineering and technology management in the South African knowledge economy; and (d) the drivers, barriers, success factors and challenges that affect the transfer of knowledge between the entities mentioned above. In the survey, Question 4 of Section IV addresses the drivers of knowledge transfer, where the focus of this article lies.

In Figure 1 there is an extract from the survey pertaining to the drivers of knowledge transfer.

**Figure 1a** Extract from the survey pertaining to the drivers of knowledge transfer

**QIV-D.** The following may be regarded as drivers of knowledge transfer between the research and the commercialisation stages of the innovation process. Which of these rank highest in your experience?

**Please use the code:**

<b>1</b>	=	<b>Extremely significant</b>	<b>(E)</b>
<b>2</b>	=	<b>Very significant</b>	<b>(Ve)</b>
<b>3</b>	=	<b>Significant</b>	<b>(S)</b>
<b>4</b>	=	<b>Vaguely significant</b>	<b>(Va)</b>
<b>5</b>	=	<b>Not significant</b>	<b>(N)</b>

<b>Drivers</b>	<b>E</b>	<b>Ve</b>	<b>S</b>	<b>Va</b>	<b>N</b>
Perception that knowledge is a valuable resource	5	4	3	2	1
Emphasis on getting a return for investment in research	5	4	3	2	1
The need to close a knowledge gap	5	4	3	2	1
The need to extract appropriate knowledge at the right time to make critical decisions	5	4	3	2	1
International trade	5	4	3	2	1
To protect patents or trademarks	5	4	3	2	1
War, terrorism and natural disasters	5	4	3	2	1
Geographic proximity between the knowledge source and recipient (e.g., Innovation Hub)	5	4	3	2	1
The need to protect knowledge for competitive advantage	5	4	3	2	1

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### 3 Research methodology

Firms in the industry sectors (Table 1) that have current R&D collaborations with universities, or have had in the past, were selected to participate in the survey:

**Table 1** Industry sectors approached to participate

(a) Agriculture	(b) Forestry and fishing
(c) Mining and minerals processing	(d) Finance
(e) Insurance and real estate	(f) Retail trade

(g) Construction	(h) Resources
(i) Manufacturing	(j) Transport and public utilities
(k) Public administration	(l) Wholesale trade
(m) Services	

In firms, contact was made with their R&D manager, CEO/MD or their technical director. The study team, comprising the author and co-authors, then selected pilot organizations in order to test the survey instrument. The pilot study participants were requested to critically evaluate and complete the survey in its totality and comment on issues such as wording, ambiguity, layout, logic and coherency. This exercise was considered necessary to establish and enhance the face validity of the questions in the survey and to validate each question. These recommendations were incorporated in the survey. A final draft of the survey was then submitted to the Research Ethics Committee of the Faculty of Engineering, Built Environment and Information Technology at the University of Pretoria, for approval.

### 3.1 Distribution of the survey

It was decided to distribute the survey via an e-mail together with a covering letter. The survey was attached as a PDF file. Assurance was given that responses would be treated with the highest confidentiality. Completed surveys could be returned either via e-mail, fax or by post. Care was taken with the design, pilot testing and distribution of the survey to ensure reasonable results.

### 3.2 Progressive work plan

It was necessary to adapt the work plan during the research process to accommodate the poor response rate. Data collection needed to be completed by December 2005, but due to the poor response of industry firms, another concerted effort was launched. Reminder e-mails were sent to all the firms that had not yet responded. The names of additional firms were obtained via referrals, intelligence gathering and prospecting among South Africa's top 100 companies, as well as from the Internet business information provider, Kompas (2006:1) in order to complement the sample frame. A few firms that had received Technology and Human Resources for Industry Programme (THRIP) grants from the National Research Foundation (NRF) (2006:1) in 2004 and 2005 were also approached to participate. In total 211 industry firms received the survey and were requested to participate. Despite the considerable effort, the response rate for this second round was even poorer – a mere four surveys were returned. Following a slight modification for data capturing purposes, the new version of the survey was sent out again in February 2006 to all the firms that had not yet responded. The final due date for responses was set for 31 March 2006. Some of the reasons supplied by firms that declined to participate are given in Table 2.

**Table 2** Reasons for non-participation in survey

No of firms	Reasons for non-participation
17	Declined participation, because they did not engage in any R&D efforts.
9	Deferred because participation interfered with their <i>core business</i> activities.
18	Declined due to time constraints.

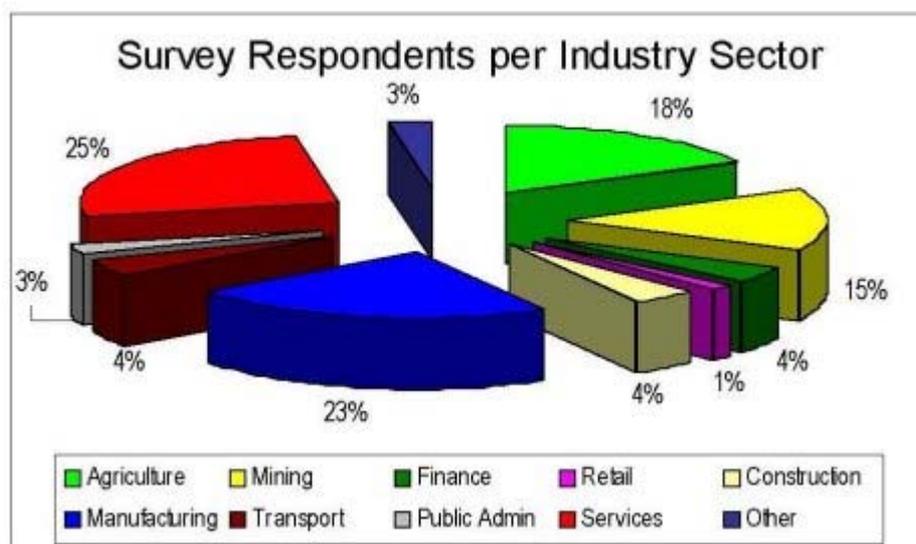
3	Their firm's confidentiality policy disallows them to participate.
5	Were afraid that confidential information was required and had just thrown the surveys away.
4	Indicated that their offices did not handle the R&D function any longer.
81	Did not participate and did not give reasons for non-participation

Of the 211 firms targeted, 74 firms responded and these responses were set aside for analysis. Of these 74 respondents, 13 were from the agricultural sector, 11 from mining industries, 3 from finance, 1 in retail, 3 in construction, 17 in manufacturing, 3 in transport, 2 in public administration, 19 in the service industry sector and 2 in none of the above sectors.

### 3.3 Respondent profile

The respondent profile is given in Figure 2.

**Figure 2** Survey respondents per industry sector



### 3.4 Evaluation of results

The 74 surveys received were evaluated visually to ascertain that all the pages of the survey were intact and legible and were completed by the respondents. The surveys were then handed in at the Department of Statistics, at the University of Pretoria where the data were captured. The SAS Version 8.2 program that was used does an automated checking and cleaning process, whereby programmed discrepancy checks are run. A formal printout was received and the evaluation and analysis of the results commenced.

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## 4 Findings based on respondent feedback

In this section, the findings based on the data gathered from 74 respondents to the Research

Marketing and Technology Commercialization Survey are presented for all nine drivers of knowledge transfer. The viewpoint is that of industry, as buyers of university R&D services.

#### 4.1 Perception of knowledge as a valuable resource

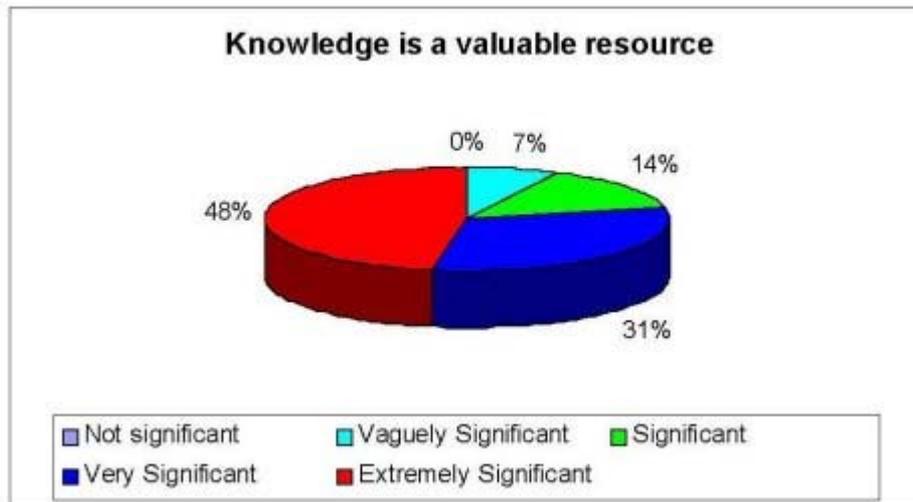
When discussing the issue of knowledge as a valuable resource in terms of its functionality in particular, 'formalized, theoretical knowledge represents one pole whereas cultural, interpersonal, somatic and other forms of tacit knowledge, together with creative skills and talents, represent the other' (Alvesson 1993:1001, 1011). Knowledge-intensive organizations should therefore draw upon cultural values, creativity, originality and interactive capacities. Knowledge also plays other beneficial roles in firms, such as the following:

- Knowledge is a means for creating community and social identity through offering organizational members a shared language and promoting their self-esteem.
- Knowledge is a resource for persuasion.
- Knowledge provides a company with its profile (i.e. an intended image targeted at the market).
- Knowledge creates legitimacy and good faith regarding actions and outcomes.
- Knowledge obscures uncertainty and counteracts reflection.

Knowledge cannot be produced in an unplanned fashion – it needs to be managed well. To Cadas (2006:64), knowledge management is an important tool that enables a company to 'react in a more positive way to different business pressures' and knowledge management enables people to be aware of who the experts are and where they can be located. Although perceived as a valuable resource, knowledge so easily can become *everything* and *nothing*, warns Wikström, Normann, Anell, Ekvall, Forslin and Skärvad (1994). Furthermore, because knowledge-intensive firms are not applying knowledge in a social vacuum, they are involved in communication, interpersonal relations, project management and convincing others (and themselves) about their expertise (Alvesson 1999:1012). Universities can make significant contributions in all these areas to the benefit of all stakeholders. An overwhelming number of respondents to the Research Marketing and Technology Commercialization Survey showed that they rate this driver of knowledge transfer to be extremely significant. Of the industry partners, 48% rated this driver as *extremely significant*, while a further 31% rated it as a *very significant* and valuable resource.

As illustrated in Figure 3, 79% of South African survey respondents have indicated that knowledge is perceived as a very valuable resource. This finding is in line with statements made by Blumentritt and Johnston (1999:287) who acknowledge that 'knowledge is a key intangible asset, but that an isolated piece of knowledge, statement, or theory, is quite literally useless, indeed has no meaning, unless it is embedded in a supporting context of well-developed theory, evidence, and argument'. Therefore, establishing the necessary interpretive context of theory, concepts, data and tacit experience is vital.

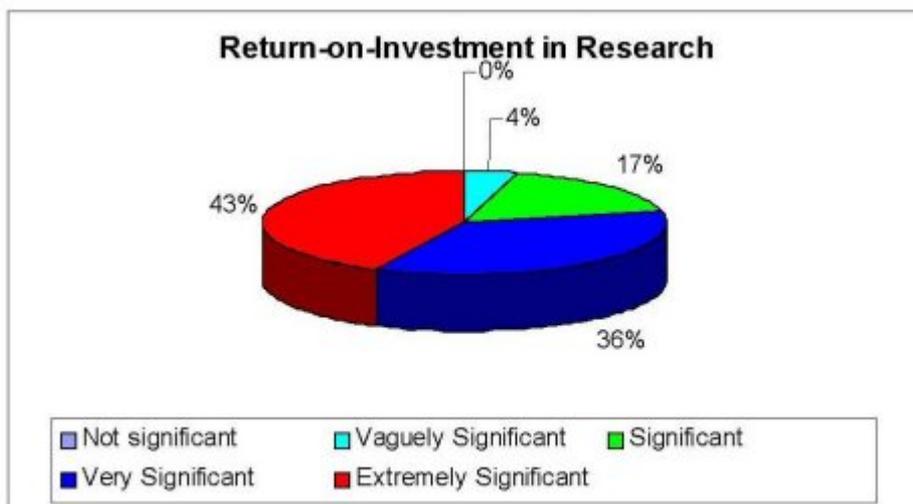
**Figure 3** Respondent votes on the perception that knowledge is a valuable resource



#### 4.2 Emphasis on getting a return on investment in research

Rosenberg (1990) argues that 'industry has no compulsion to advance the frontiers of science; they are merely lured by the possibility of a high payoff and/or royalties'. Siegal, Waldman and Link (1999) agree that industry only funds research if the firm can validate the potential for commercialization. It is therefore no surprise to note in Figure 4 below that over 79% of respondents to the survey also regarded getting a return on investment to be an important driver of knowledge transfer in their R&D collaborations.

**Figure 4** Respondent votes on emphasis on getting a return on investment in research



Of the 74 respondents, 17% said that return on investment is *significant* in their firm, 36% said it was *very significant* and 43% rated it as *extremely significant*. This finding raises the stakes substantially in terms of determining which projects are most likely to receive industry funding. Therefore universities will have to ensure that their R&D proposals articulate the likely benefits that industry will derive from such collaborations. In practical terms this implies that research projects must culminate in tangible technological advances and there must be a strong commitment to ensuring that knowledge does not become isolated from national human resource and science, engineering and technology objectives.

Overall, this driver of knowledge transfer was rated second most significant (of the nine tested in the survey) by industry respondents. This finding confirms a Human Sciences Research Council (HSRC) report (2003:16, 17) which emphasizes the need to ensure that research outputs and project outputs can be commercialized for the purposes of achieving the overarching goals of industry firms. There are also many unintended consequences residing within cooperative research, of which return on investment is one. Feller (1990:335 and 337) confirms that 'commercialization and academic contributions to scientific and technological knowledge may be joint products of research,' but these endeavours must have 'industry creating potential' and a high rate of knowledge diffusion. Rightly one might ask to what extent there is evidence of mutual benefits in knowledge generation, transfer, diffusion and/or application that will ultimately contribute to innovation? In other words, is there proof in South Africa that firms are getting a return on investment in R&D. A HSRC report (2003:ix, 42, 50, 61, 63, 126, 127) confirms that in 2003:

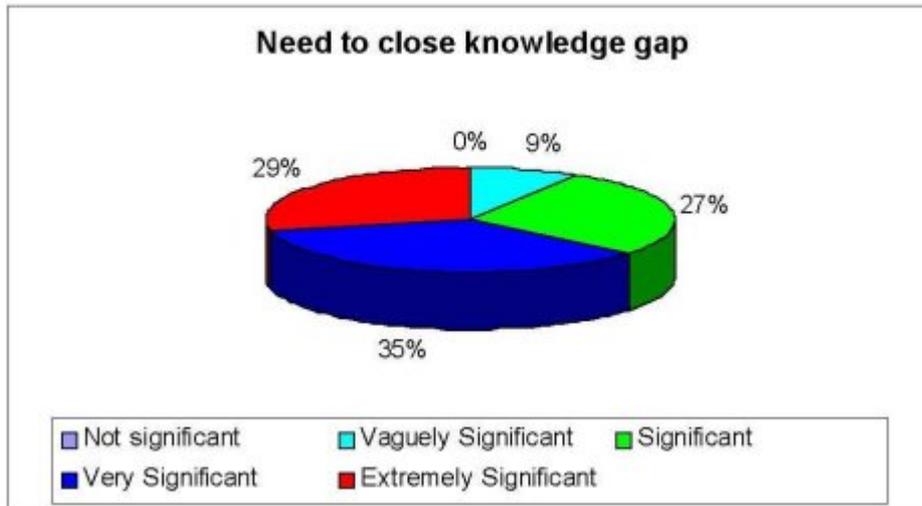
- A total of 423 projects were incentivized through THRIP and the Innovation Fund involving 1293 students.
- These projects involved 573 industry partners: 44% were large enterprises, 28% were small enterprises, 25% were medium enterprises and 3% were micro enterprises.
- A total of R869,1 million was spent by THRIP and the Innovation Fund on Higher Education Institutions, Science, Engineering and Technology Institutions/Industry linkages during 2002/3. Of this amount, 64% was THRIP expenditure and 36% was Innovation Fund expenditure.
- A total of 885 publications were produced.
- A further 35 patents and 296 artefacts were produced.

These figures suggest that the partnerships between South African universities and industry have resulted in tangible benefits with advantages being gained on both sides.

#### **4.3 Need to close the knowledge gap**

In South Africa, closing the knowledge gap between universities and industry firms has to incorporate the challenge of bridging the gap between those who have critical R&D information and the ability to interpret and use it, and those who do not but need access to such information. The rating given by 29% of industry partners, that closing the knowledge gap between themselves and universities is extremely significant, and another 35% of firms saying that this driver is very significant, may reveal the apprehensiveness about the ever-widening gap between what is known and how it is applied or exploited (Figure 5). Etzkowitz (2000) suggests cross-internships between university and industry as one way to reduce the knowledge gap. Another is to provide opportunities for firms and university representatives to hold regular workshops and discussion forums as is done regularly at The Innovation Hub (2006:1).

**Figure 5** Respondent votes on the need to close the knowledge gap



#### 4.4 Need to extract appropriate knowledge to make good decisions

It is true that firms are inescapably bound up with the conditions of their environment and this goes hand-in-hand with location-related resources and advantages (Pfeffer and Salancik 1978:1). Industry respondents to this survey have all acknowledged that they need to protect their knowledge for competitive advantage. Within firms there are various knowledge assets, which need protection. Literature reveals that a firm's resources determine whether or not, and to what extent, they can engage in R&D collaborations with universities. The resources, which determine the nature and level of collaborations, is summarized in Table 3.

**Table 3** Firm resource categories (Powers 2000:33)

Resource category	Description
Financial resources	Monetary related resources such as capital investments from entrepreneurs, venture capitalists, equity holders, or banks as well as other types of financial capital such as retained earnings.
Physical resources	A firm's plant and equipment, technology utilized, geographical location, and access to raw materials.
Human capital resources	Aspects of the firm's workforce including training, experience, judgement, intelligence, relationship, and insight.
Organizational resources	The firm's organizational structure, planning, controlling, and coordinating systems, culture, and informal relationships between groups within and outside the firm.

Competitive advantage is inextricably linked to these assets and/or resources and, should R&D done by universities provide indications of systems or procedures that can better utilize and protect these resources, industry will value the proposition. Industry partners engage universities in R&D if the following four fundamental objectives are met (Siegal *et al.* 1999:20–21). An R&D sponsoring company wants to be able to:

- validate the commercialization (in terms of business potential);
- realistically assess the utility of the technology (i.e. its key applications, variations, modifications, etc. that would directly address known and specific problems and

- needs);
- accurately target commercialization markets, industries or industrial sectors, which could potentially utilize the technology in a cost-effective manner; and
  - initiate commercial actions, which will help them determine technical and economic feasibility.

In Figure 6, 41% of the respondents indicate that being able to extract appropriate information is an *extremely significant* driver of knowledge transfer. If another 41% rate it as *very significant*, it is obvious that the greatest number of industry respondents consider this issue to be important. These observations are no surprise, because all decision-making depends on appropriate instructive and descriptive information, which is unambiguous, contextualized and received in time. This finding is borne out by Yu (2002), who stresses the need for 'speed of information provision,' and by Shrivastava (in Kazanjian *et al.* 2000) who indicates that 'knowledge systematization and grouping, complexity, relevance and timeliness' are critical issues in decision making.

**Figure 6** Respondent votes on the need to extract appropriate knowledge to make good decisions



#### 4.5 Impact of international trade

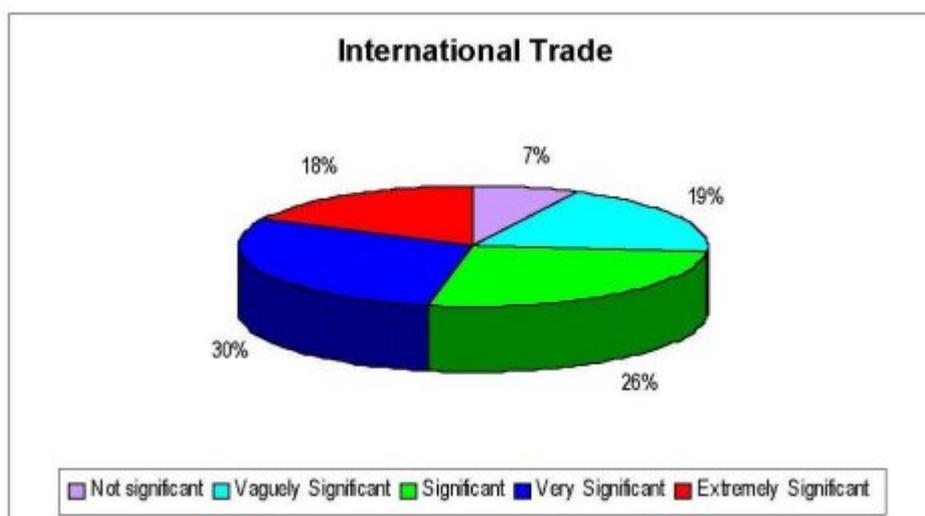
The role of international trade ranks on the lower end of the scale in terms of significance as indicated by South Africa industry respondents but, despite this, the mandate from the South African government is greater national and international collaborations between industry firms and universities. The entrepreneurial university is a term used to refer to universities that possess a wide range of new infrastructural support mechanisms for fostering entrepreneurship within the organization as well as packaging entrepreneurship as a product of trade. This entrepreneurial university is one that views itself as a bridgehead of innovation in modern societies (Jacob *et al.* 2003:1556). The increasing complexity of research and innovative activities militates in favour of using 'formal organizations (universities, R&D laboratories in firms, government laboratories, etc.) as opposed to individual innovators' as the most conducive environment to produce innovations (Dozi in Dozi *et al.* 1988:223). The evidence of a growth in links between industry and universities suggests that firms tend to use universities to contribute to their R&D programmes, because this is a more 'flexible way to do research especially if that means having to fund and maintain their own laboratories and infrastructure' (Godin and Gingras 2000b:277). Firms of all sizes in all countries on most continents find it more expedient to collaborate with universities because, by doing so, they

are able to indirectly transfer part of their costs.

University research is stable and increasing and, despite a real diversification of the loci of production, universities are still at the heart of the knowledge system. Other industry actors as well as international trade stakeholders rely heavily on their expertise. 'The presence of universities in the production of scientific research does not diminish in time, because universities have been able to stay at the centre of the knowledge production system by using collaboration mechanisms. By implication, this points towards stronger interactions between components of the knowledge production system' (Godin and Gingras 2000a:274, 277).

It is therefore interesting to note in Figure 7 below that only 12 of the 74 industry respondents indicated international trade as an extremely significant driver of knowledge transfer between universities and industry, with 20 rating it as very significant and 18 as significant. Frankly, there was an expectation that more respondents would rate this driver of knowledge transfer higher than they did, especially if one recognizes that worldwide the 'form, legitimacy, sovereignty and power of the state are increasingly threatened, because of changes in the complex international links that tend to ignore social and political borders' (Bornman and Schoonraad 2001).

**Figure 7** Respondent votes on the impact of international trade



Thus the grouping of votes on this driver of knowledge transfer seems to indicate an even spread of 18% rating international trade as extremely significant, 30% as very significant in their firms and another 26% as significant.

#### **4.6 Intellectual property protection**

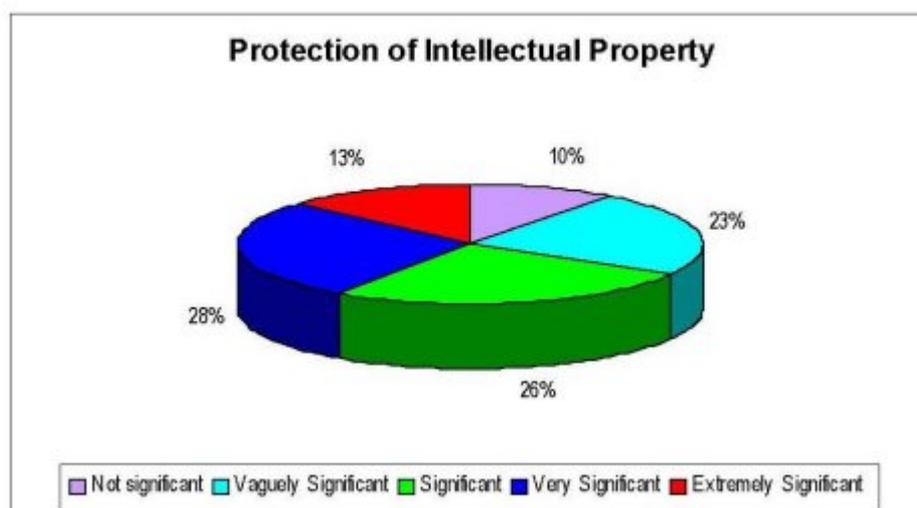
Intellectual assets represent one of the strongest forms of intangible value impacting on the knowledge and learning economy (DST 2002). The relatively low rating of this driver is surprising in view of the fact that Powell and Owen-Smith (1998) consider the ownership of intellectual property rights as a critical indicator of the extent to which projects are mutually collaborative and mutually beneficial. It is evident from the findings of this research that intellectual property protection and ownership, together with the economic, financial and technology risks involved in knowledge transfer, feature prominently as serious concerns and real potential barriers in the eyes of industry partners who consider engaging universities in R&D. Understandably industry partners want the assurance that confidentiality will be paramount. This explains why industry organizations rate protective attitude as a significant

barrier. In reaction more and more universities are starting to implement pro-active 'portfolio management to generate revenue from their intellectual property' (Haase 2004:16–17).

While it is important that patents held by academics should be regarded as evidence of quality research, it does seem as though there are some academics who are unwilling, or unable, to protect and commercialize their discoveries (Etzkowitz 2000). Firms indicate that 'patents are less effective when they are unlikely to be held valid if challenged, if firms cannot enforce them, if competition can legally invent around patents, if the technology is moving so fast that patents are irrelevant, if patent documents require disclosure of too much proprietary information, if licensing is required by court decisions, or if firms participate in cross-licensing agreements with competitors' (Levin *et al.* in Shane 2002:125). Based on the above, the HSRC (2003) notes that 'in South Africa 50% of the Higher Education Institutions and industry partners share the Intellectual Property Rights, while 30% of the projects allocate the Intellectual Property Rights to industry alone and 4% to the Higher Education Institution alone. THRIP does not prescribe how Intellectual Property Rights are distributed, but THRIP does require that the parties agree upon the distribution of these rights before commencement of any project. The Innovation Fund, however, requires that intellectual property be vested with the consortium of partners and reserves the right to claim ownership of intellectual property if, after five years, the funder is able to determine that no attempt has been made to exploit the results of the project' (HSRC 2003:32, 33).

The survey findings, in terms of the significance of the driver of intellectual property protection, provide the following results in Figure 8: Only 13% of industry respondents viewed intellectual property protection as an *extremely significant* driver of knowledge transfer between themselves and universities. Of the respondents, 28% indicated that intellectual property protection is *very significant* and a further 26% indicated that this driver is merely *significant*. These low figures do not, therefore, provide a strong argument to suggest that intellectual property protection may be a highly relevant driver of knowledge transfer in the interface between industry and universities in South Africa.

**Figure 8** Respondent votes on the protection of intellectual property

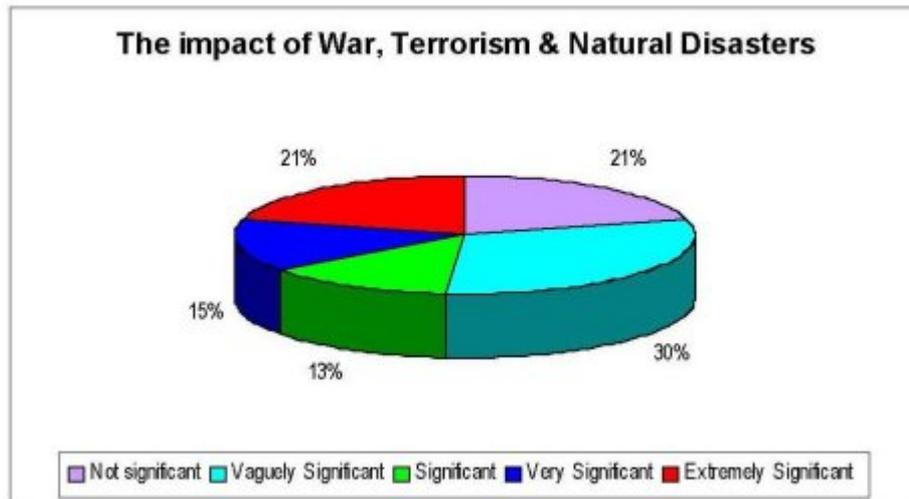


#### 4.7 Impact of war, terrorism and natural disasters

Wars, natural disasters and acts of terrorism are powerful events that should act as drivers of knowledge transfer between industry and universities on R&D collaboration. However, only 21% of respondents considered this driver to be *extremely significant*, with a further 15%

indicating that the impact of war, terrorism and natural disasters is *very significant* (Figure 9). The interesting finding in South Africa is that overall the rating of this driver of knowledge transfer lies mostly in the lower percentile of significance. It is surprising to note that 21% of the respondents consider these issues to be of no significance at all. Should 'crime' have been included in this driver of knowledge transfer, it is suspected that this figure would differ dramatically as a driver of knowledge transfer.

**Figure 9** Respondent votes on the impact of war, terrorism and natural disasters



Gerner and Schrodtt (2002:221–224) write that society expects knowledge workers to serve their communities with knowledge, explanation, insights and policy alternatives. The new challenge is filtering out information and by this these authors mean that firms and universities must detect rumours and fill in missing details; they must sort out conflicting interpretations of events and anticipate future economic and political decisions, and they must counteract inaccurate public perceptions. Whether we like it or not, the elite print media are the filter through which academic ideas reach into the policy community (Gerner and Schrodtt 2002:228), so the role universities can play in advising firms and governments must not be underestimated.

#### 4.8 Geographic proximity between knowledge source and recipient

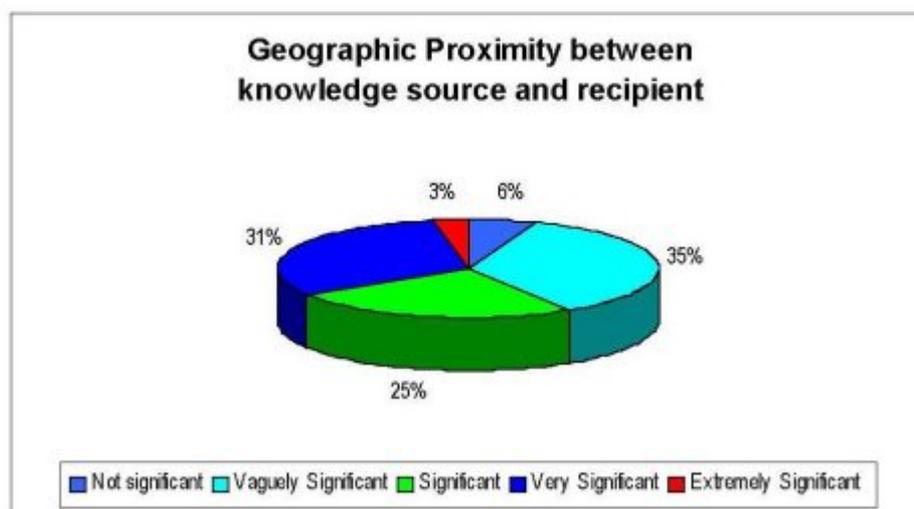
Proximity between industry firms and universities promotes the natural exchange of ideas through formal (i.e. cooperative alliances) and informal networks, that is, the mobility of scientists in research institutions and engineers in industry (Löfsten and Lindelöf 2005). This in turn increases localized knowledge spill overs (Almeida and Kogut 1999; Almeida *et al.* 2003; Zucker and Darby 1996). Industry respondents in South Africa indicated that geographic proximity does not rate highly in terms of significance as a driver of knowledge transfer.

One reason for the finding in Figure 10 may be traced to Hanson *et al.* (1999) who found that knowledge transfer is most effective if 'networks of people from universities and industry share knowledge face-to-face, over the telephone, by e-mail, and via video conferences', because by doing so they are able to collectively arrive at deeper insights on problems they need to solve. Advanced ICT technologies facilitate remote exchange between knowledge sources located in universities and the recipients in industry. Thus it is not surprising that data obtained shows that only 32% rate this driver as very significant, 24% as significant and 35% of industry partners rate geographic proximity between themselves and their

collaborators within universities as vaguely significant.

Bower (in Löfsten and Lindelöf 2005) observes that greater flexibility is needed if universities want to encourage links with industry to advance new technologies. Some factors affected by geographic proximity according to Hislop (2003) are: (a) the type of knowledge involved; (b) the characteristics of the knowledge; (c) the location of the knowledge; and (d) how dispersed the required knowledge is.

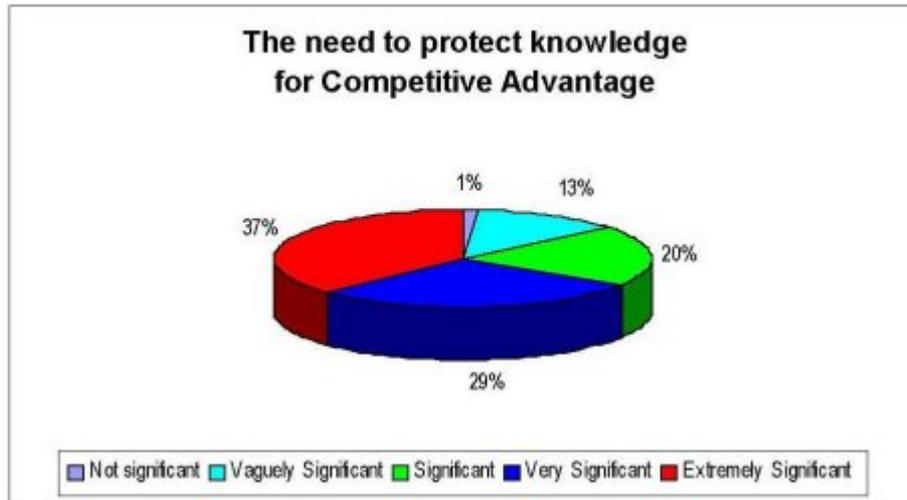
**Figure 10** Respondent votes on geographic proximity between knowledge source and recipient



#### 4.9 Need to protect knowledge for competitive advantage

In the competitive environment, firms must have access to a wellspring of new technologies and actionable knowledge (Werther *et al.* 1994; Santoro and Gopalakrishnan 2001); the reason being that knowledge enables organizational renewal and sustainable competitive advantage (Inkpen 1996). This being the case, the respondents from South Africa concurred with worldwide trends of protecting knowledge assets for competitive advantage: In Figure 11 it can be noted that 37% of the respondents felt that this issue is an *extremely significant* driver of knowledge transfer and another 29% of respondents rated it as *very significant*, while 20% gave this driver a rating of *significant* and a further 13% indicated that this driver is *vaguely significant*. One possible reason for this finding may be that confidentiality clauses in contracts protect the knowledge domain and prevent disclosure of know-how to competitors without prior consent. This gives a firm a relative advantage over competitors. It is, however, evident that alliances with universities do provide firms with a window on their partners' broad capabilities and multiple knowledge reservoirs (Argote and Ingram 2000) and collaboration allows firms to share the risks, to build on shared capabilities and to create synergies for better competitiveness (Santoro and Gopalakrishnan 2001).

**Figure 11** Respondent votes on the need to protect knowledge for competitive advantage



Therefore, what is important in R&D collaborations between firms and universities is that business managers in firms need to know most about a technology when it is new (Robey and Markus 1998:8, 12). Novel findings appeal to practitioners, because they are things that neither they nor anyone else already knows. This is the kind of information that firms want, because it gives them a competitive advantage. Universities must take cognisance of this and be pro-active in terms of communicating new knowledge.

The chart in Figure 12 provides a summary of the respondent voting for all nine drivers of knowledge transfer:

**Figure 12** Respondent votes on the nine drivers of knowledge transfer between industry and universities

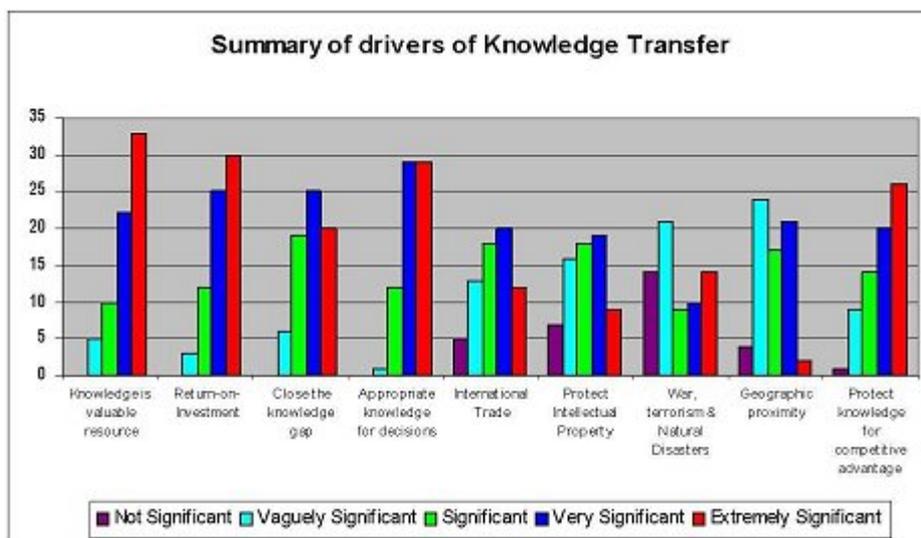


Table 4 indicates the percentage rating by industry respondents to the nine drivers of knowledge transfer.

**Table 4** Summary of how industry respondents rate the drivers of knowledge transfer

Driver	Not Significant	Vaguely Significant	Significant	Very Significant	Extremely Significant
Knowledge is valuable resource	0	5	10	22	33
Return-on-Investment	0	3	12	25	30
Close the knowledge gap	0	6	19	25	20
Appropriate knowledge for decisions	0	1	12	29	29
International Trade	5	13	18	20	12
Protect Intellectual Property	7	16	18	19	8
War, terrorism & Natural Disasters	14	21	9	10	14
Geographic proximity	4	24	17	21	2
Protect knowledge for competitive advantage	1	9	14	20	26

<b>Driver of Knowledge Transfer</b>	<b>Extremely Significant</b>	<b>Very Significant</b>	<b>Significant</b>	<b>Vaguely Significant</b>	<b>Not Significant</b>
Knowledge as a valuable resource	46%	34%	14%	6%	0%
Return-on-investment	41%	37%	17%	5%	0%
Need to close the knowledge gap	28%	36%	28%	8%	0%
Appropriate knowledge to make decisions	40%	41%	16%	3%	0%
International trade	19%	32%	27%	16%	6%
Protect intellectual property	14%	30%	25%	22%	9%
War, terrorism and natural disasters	21%	16%	14%	28%	21%
Geographic proximity	3%	32%	24%	35%	6%
The need to protect knowledge for competitive advantage	40%	29%	20%	11%	0%

From these figures the following is evident: By combining the figures of extremely significant with very significant, the following four drivers have the highest significance rating:

- Perception that knowledge is a valuable resource (46+37=83%)
- The need to extract appropriate knowledge in order to make good decisions (40+41=81%)
- Return on investment (41+37=78%)
- The need to protect knowledge for competitive advantage (40+29=69%).

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## 5 Research limitations

The paucity of the sample size is one limitation. However, it does allow some reasonable, but cautious comments to be made on the drivers of knowledge transfer incorporated in this survey. Another limitation is the poor representation in some of the industry sectors, which limits the research results in generalizable terms, firstly due to the non-probabilistic population sampled and secondly due to the plethora of business and industry types not included in the sample frame.

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## 6 Conclusion

Universities are aware that industry motives for R&D partnerships relate largely to the perception of research expertise and to the human and physical resources available at these institutions (HSRC 2003:88).

In Table 5 the nine drivers of knowledge transfer have been listed according to descending order of significance by the judgemental sample of respondents.

**Table 5** Drivers of knowledge transfer in order of decreasing mean

<b>Drivers of knowledge transfer</b>	<b>Significance rating (mean)</b>	<b>Level of agreement with rating (standard deviation)</b>
Extract appropriate knowledge for decision-making	4,212	0,774
Knowledge is a valuable resource	4,200	0,904
Return-on-investment	4,153	0,870
Protect knowledge for competitive advantage	3,984	1,023
The need to close the knowledge gap	3,846	0,922
International trade	3,412	1,158
Intellectual property protection	3,171	1,202
Geographic proximity	2,904	1,027
War, terrorism and natural disasters	2,873	1,453

Industry respondents are of the opinion that the following three drivers have a high mean:

- Extracting appropriate knowledge for decision making (4,212 mean)
- The perception that knowledge is a valuable resource (4,200 mean)
- The need to get a return on investment in research (4,153 mean).

Furthermore, the spread or dispersion indicated by the standard deviation is very small, which is an indication that the respondents in this survey have a high level of agreement on the significance of these particular drivers.

Competition in the triple helix arena of government, industry and universities means that all three parties should sharpen their entrepreneurial skills to effectuate transformation of the South African science and technology landscape. Academics must find ways to increase the relevance of their research to industry by reconsidering topic selection, as well as the purpose, content and readability of the reports and articles they write. One key strategy is that of responsiveness in the higher education sector. Greater responsiveness implies that universities should take the problems and challenges presented by the societal context in which they operate seriously (HSRC 2003:1). Knowledge transfer appears to work best when it is seen not so much as a relay race, but as a team sport. Then knowledge transfer is not a process in which – during the first few rounds of the race – the knowledge baton is kept inside the university and passed on to the outside world only during the last rounds. Rather, it

is 'a game during which the ball moves continually between the players and in which all players have to collaborate and share resources to win' (Entrepreneurial Higher Education Institution 2002:10–11).

One significant point of this study is that there is a distinct need to explore creative ways of combining and pooling capacity nationally and within the continent (DST 2005:5). Only by deepening research knowledge and sustainable research strengths will South Africa be able to differentiate itself. Universities, as providers of scientific R&D knowledge, realize that one role of science and knowledge is to solve problems vital to society while working for the common good in the most effective way (Brante 1988:122). It is believed that the development, ownership, protection and utilization of all South African knowledge assets are necessary in order to compete in the new global economy. Higher education is therefore tasked with the arduous formation of a critical, creative and compassionate citizenry. Nothing else will suffice.

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## 7 Areas for future research

There are several areas in which research efforts can be focused in future. For example, similar understanding of barriers, challenges and success factors is required. Further research is needed to understand the mechanisms by which universities transfer R&D knowledge in order to increase industry competitiveness and efficiency as well as overall economic and social development. Research on how collaboration with universities influences the decision-making procedures in industry firms may be a relevant topic, as would be research that explores how intellectual property rights are negotiated between universities and industry partners.

It is hoped that this research has contributed to our understanding of knowledge transfer mechanisms in the South African systems of innovation context.

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ISSN 1560-683X

Published by [InterWord Communications](#) for Department of Information and Knowledge Management,  
University of Johannesburg