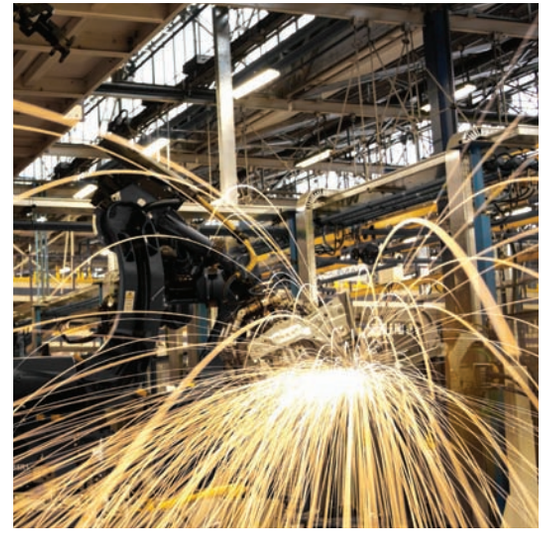
CIHE

LEADERSHIP FOR BUSINESS AND HIGHER EDUCATION

Absorbing Research

The role of university research in business and market innovation



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We would like to acknowledge the support of RCUK in making this research possible.
The views expressed are those of the authors and should not be attributed to RCUK or the companies interviewed.

Introduction

Executive summary:

- University research has a distinctive contribution to make in creating value through supporting company innovation processes, and thus has a role in contributing to economic impact. But there are dangers in positioning university research too close to market and thereby crowding out company innovation and undermining its value.
- There are particular advantages for companies to engage with university researchers. Companies most value the ability of universities to generate novel ideas, to think at 'right angles' to their R&D staff and develop expertise from addressing new problems.
- The absorptive capacity of companies is a crucial variable in determining the value that can be secured from using university research in company innovation processes. Recognising this, it is important for universities to improve their understanding of company absorptive capacity as a function of their relationships with companies about the application of their research.
- Companies and universities need a shared understanding of how research contributes to market innovation in companies. Such a shared understanding will encourage greater university-business research collaboration and add to the absorptive capacity of the system.

The CIHE's work on business, universities and knowledge exchange has explored a broad range of university-business interactions which benefit businesses[1]. As a result we know a lot more about the processes through which university-business collaborations are formed, how these proceed, and how they result in value creation. But we know far less about the distinctive role of university-business collaboration in company innovation processes, and therefore the importance of university research as a contributor to company profits and thus a source of economic impact.

For this study, supported by Research Councils UK (RCUK), we wanted to understand more about the distinctive advantages companies found in collaborating with university researchers. The research investigated the nature, relative scale and contribution of university research to company innovation processes. It also explored the capabilities required of companies to derive value from such collaboration, and the nature of different strategies to achieve market innovation.

The research considered the factors affecting absorptive capacity at the company level and their importance in determining successful university-business collaboration. We also mapped the different uses of university research acquired or created through collaboration and compared these types of use against the portfolio of RCUK knowledge exchange products to determine how these products assist companies in generating profitable market innovations.

The report contains the findings from 22 case study companies[2]. We examined:

- company innovation strategies and processes;
- where in these processes and typically for what purposes they collaborated formally or informally with university researchers;
- what advantages and challenges they perceived in working with university researchers;
- who was involved and what capabilities and resources were used in the process of using these interactions in their innovation strategies.

The findings from these case studies were also discussed with a range of companies[3] at three workshops, both to test and also build on the findings. A total of 18 companies participated in the workshops. The findings and recommendations from the fieldwork and workshops are presented in this summary report[4].

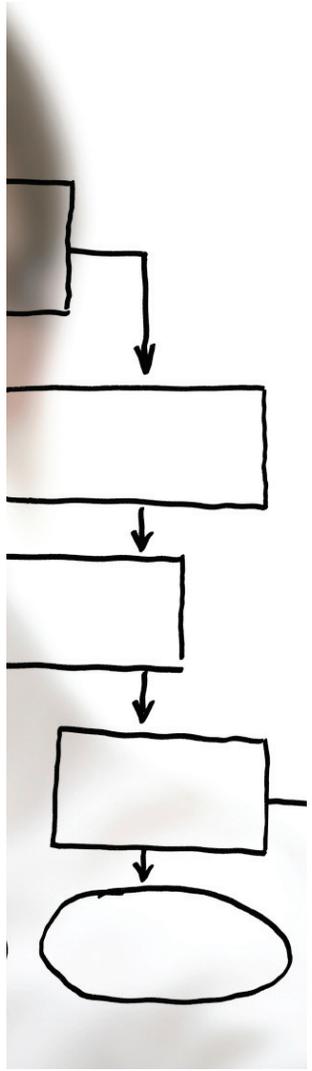
Stages of market innovation and research impact

The contribution of university research depends on the nature of the business and its innovation strategy. From an analysis of the case studies we identified four different ways in which companies used university research. The categories correspond approximately to the relative distance to application from the research interaction. They range from exploratory interactions to near-to-market interactions where the contribution of the rese arch to market innovation (i.e. profit impacting) is highly visible. The categories do not offer a rigid taxonomy, but rather characterise points on a continuum. The stages have various entry and exit points for companies, and reflects the iterative nature of the process. The four-stages are outlined below:

The Exploratory Stage – University research supports the innovation process in companies by being used in identifying potential opportunities and issues for companies as they develop their business, market and product strategies. This may involve companies considering a range of possible anticipated outcomes for research.

The Qualification Stage – Research outcomes, and in particular the ways in which they can be applied on a predictable basis, are considered for incorporation into the formal innovation processes of companies to address an already identified requirement.

The Definition Stage – Research outcomes are used in the formulation of a project designed to achieve a specific outcome in a company. This may involve the application of proven scientific research in a product development process. This stage is characterised by companies identifying pathways to localising research.



The Delivery Stage – Research outcomes, and in particular the expertise of university researchers, are used in the execution of a project, and are intended to make a purposive and direct connection to company business activities and commercial benefit. This stage involves the active localisation of research.

This market-based perspective on research contributions to company innovation, and therefore company profits, is highly context dependent. Companies use research outcomes in different ways and in different parts of their innovation processes. Where companies make major R&D investments in highly structured innovation processes the primary university-business interface takes place at the Exploratory and Qualification stages. The contribution to revenue and profit from this interface is then heavily dependent on downstream investment by the company. By contrast, where research outcomes are used in less R&D intensive contexts, e.g. in manufacturing processes, the interactions may be closer to application and have a clearer connection to revenue and profit. In all the cases we studied, we found that the impact generated from university research depended on company-driven actions in recognising and realising market opportunities to increase profitability through process, product or service innovation, and not on the traditional technology-push model of innovation.

The research found that none of the companies studied were passive recipients of research and technology developed by universities. Rather, companies were active collaborators with universities in using university research in company innovation processes.

How businesses assess the contribution of university research

Since the use of university research needs to be localised within the company's objectives and capabilities, the research found that its exploitation often needed a process of co-formulation with academics. The case studies showed that companies valued both the specific deliverables from research collaborations and a broader set of benefits[5]:

- the expertise developed in individual researchers as a result of a collection of previous research projects;
- access to a broad base of information which includes research journals and conference papers to locate academics and understand their expertise;
- the methods, techniques and data developed in the course of any research.

Over time this broader mix of research outcomes are often re-configured and combined with a company's own insights and technologies as part of the ongoing and iterative nature of university-business interaction across all four phases of the interactions outlined above. Hence a company interacts with a collection of intellectual assets built up over a succession of research projects. There is often no line of sight connection between a company's outcomes and the original research. This makes the impact of individual projects very hard to identify, a problem compounded by the difficulty in separating the university's contribution from that of a company as it seeks to realise commercial value. The process through which research is reconfigured is illustrated in Figure 1 overleaf. Other than when engaged specifically on Research Council funded collaborative projects, companies have little visibility regarding the source of the investment that has produced the research outcomes they use.

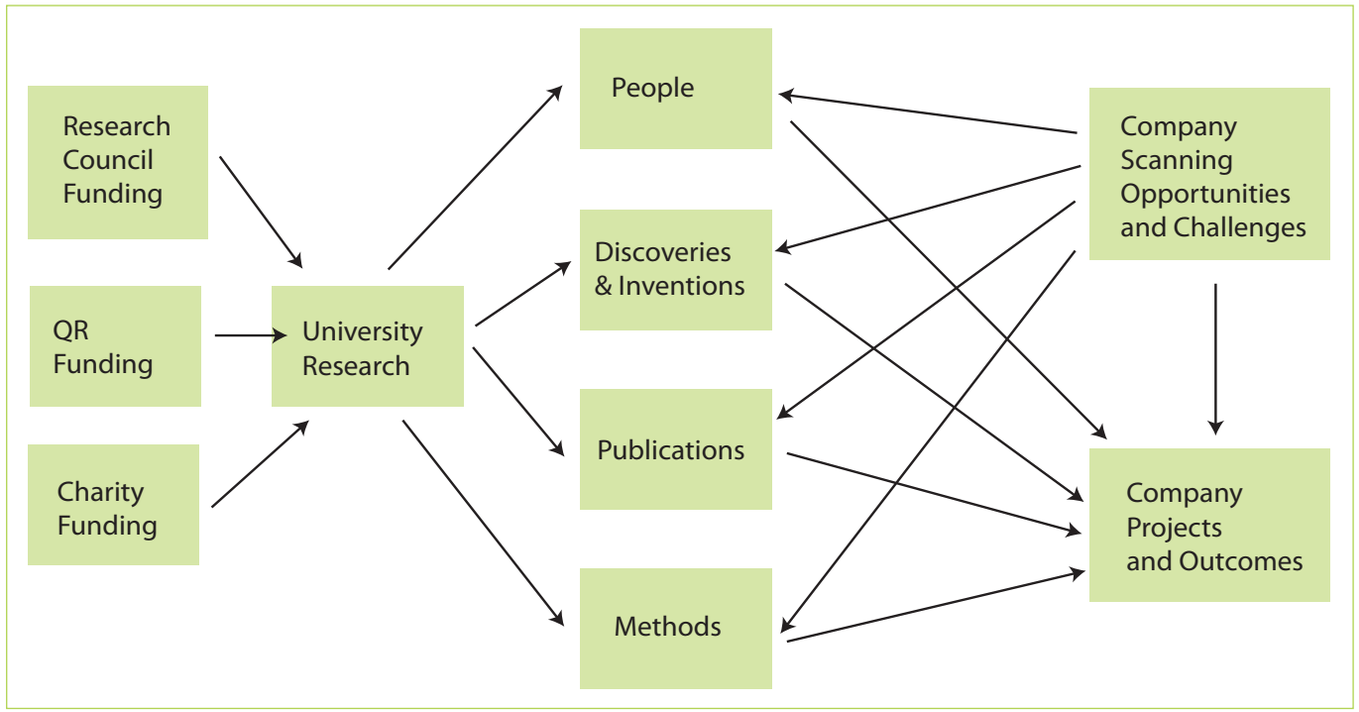
AstraZeneca – upstream collaboration delivers added value

One of the motivations for companies such as AstraZeneca to engage with the university science base is to keep in touch with scientific developments to assess the potential for meeting an unmet medical need. Along with a number of its competitors in the pharmaceutical sector they collaborate with the Protein Phosphorylation Unit at the University of Dundee.

Several of the systems that the unit is studying have the potential for therapeutic intervention in cancer treatments. Initially the possibility that protein kinases and protein phosphatases might contribute to drug development was an unknown quantity.

Now the collaboration (with 5 companies including AstraZeneca) is helping to speed up the development of protein kinase inhibitors with therapeutic potential. Beyond this pre-competitive collaboration, the development of new drugs requires major investment and integration with internal company R&D assets to create value. This has made it difficult to estimate the value of the university's contribution, but the continuing support for the unit by major pharmaceutical companies is a very good indication of the value that the companies derive.

Figure 1: Company engagement with research outcomes



The companies identified a range of competitive advantages to using university research and how they contributed to their innovation processes (see Table 1 on page 8). They also viewed universities as supporters of market innovation in companies, rather than drivers of innovation[6]. In all the cases studied there was evidence of clear downstream investment by the company to introduce an innovation, to leverage economic value from the research.

The research found that companies and universities have different expectations of the role that university research has in company innovation processes. The university may underestimate the work the company needs to undertake to achieve a commercial return or overestimate the contribution made by the research and in either case expect too great a commercial return.

Measuring the impact of university research

This study demonstrated that other than in a very limited number of cases, (e.g. at the delivery stages) numerical metrics are likely to be inappropriate or misleading as an indicator of impact. This impact may extend beyond the application of research in a particular product or service (the output), and include how it has informed the innovation processes in a company, been used in an investment decision or led to the allocation of resources. Hence impact indicators should be appropriate to the stage of research it relates to, e.g. ranging from identifying future academic or industrial partners for application development through to the successful completion of a prototype with an industrial collaborator. Impact is identified as a response in potential user behaviour enabled and encouraged by research outcomes, not as a standard metric (such as licence income or patents licensed).

Working with universities - added value and limiting factors

Companies valued university research contributions to the extent that many mentioned that they continued to invest in their own staff time and in sharing research costs in the work they undertook with universities, even where the immediate outcomes were less tangible. Table 1 highlights some of the factors which have a bearing on the co-creating processes between universities and companies. The enabling and limiting factors outlined in Table 1 highlight some of the characteristics of universities which have an influence on the interactions universities have with companies. Clearly the absorptive capacity of companies to absorb, embed and use university research in their innovation processes is also crucial to these interactions.

Companies mentioned the distinctive value of academic research in searching beyond the current horizon and their motivations for objectivity rather than profit. On the other hand, the bureaucratic processes that some universities have regarding technology transfer can lead to increased transaction costs, especially for smaller companies.

The views listed in Table 1 are expressed from a business perspective. Given that the primary data from this study is based on a survey of businesses, they should not be taken as a value judgement implying that limiting factors are criticisms of academe. The two sectors have explicitly different value systems and the differences between these two value systems are the sources of both these enabling and limiting factors.

The next section explores some of these limiting factors in more detail but also identifies a number of ways in which universities can address these.

Shifting from closed to open innovation strategies

Adopting an open innovation strategy was a key influence in leading companies to identify opportunities for collaboration with universities. Examples identified in the case studies include Zoeftig, Unilever, Heales Medical Technologies and Schlumberger Cambridge Research. In the case of BMT a move to an open innovation model was triggered by the availability of high performance low-cost computing which opened up the possibility of developing simulation models. This required access to a wider range of expertise than the company had at its disposal internally.

University research adding value

The "really difficult problems" are often found in the Qualification and Definition Stages. Examples from WillisRe and Volterra include predicting the occurrence and impact of rare events. The answers to these challenges often rely on the expertise developed out of leading edge research. Such expertise is typically neither commoditised nor widespread; it is typically found in or unique to universities.

Table 1 Factors influencing university-business collaboration

Enabling factors	Limiting factors
University researchers can speculate on curiosity driven research and the development of knowledge for its own sake. This is important for research at the Exploratory and Qualification Stages where blue skies research can help companies think at right angles to their R&D staff.	University researchers have a discipline focus rather than an application focus. Most business problems are inherently multi-disciplinary in nature. University research motivations and interests tend to be located in disciplines and researchers do not engage readily across disciplines.
University researchers may develop specific expertise by a concentration on focused research topics. This depth in knowledge may be unique to the researchers and not available outside their relevant research group.	University researchers focus on the value of achieving results which are both robust and repeatable. This can sometimes be incompatible with commercial objectives, where an "80%" solution may suffice.
The motivations of academic researchers towards robust academic deliverables can support different approaches to a problem – perhaps an iteration of the Definition and Delivery Stages or even a return to the Qualification Stages. This can provide a solution more localised to a specific company problem better than an "off the shelf" consultancy model. Leading edge research and expertise is typically neither commoditised nor widespread; it is typically found in or unique to universities.	The use of university research outcomes support opportunities for market innovation by companies. This is not necessarily a view shared by university researchers who may regard themselves as the sources and drivers of business innovation. Lack of shared expectations of the role of university research leads to "crossed transactions". These can cause problems between the parties in negotiations and the valuation of the university contribution. The importance of co-recognition and co-formulation of opportunities may be lost in a linear expectation of the innovation process particularly if a "Technology Transfer Office" dominates business engagement.
The motivations of academic researchers are for objectivity rather than profit. Companies say this is helpful in receiving an objective response rather than "what they want to hear". Academic motivation for searching beyond the current horizon is the very source of the distinctiveness of university research – its value beyond any immediate commercial value, i.e. the possibility of value in the long-run.	The natural pace of activity tends to be slower for universities. Lack of true commercial experience leads to protracted and bureaucratic processes. These tendencies reinforce each other to increase transaction costs which are a deterrent especially to smaller companies which are unused to such dealings.

Limiting factors

The findings revealed a range of inhibitors in the contribution that university research makes to company innovation. These ranged from high transaction costs, the lack of speed in the responsiveness of universities, to the lack of capability within firms to absorb, embed and use the research – this is discussed later in this report. These issues were emphasised by companies with short innovation cycles, and by SMEs that are often without dedicated R&D capability. For small firms, managing the innovation process competes for time with managing the business. For those less experienced in working with universities, the transactions costs involved could easily be perceived to outweigh the possible benefits. Despite the disadvantages experienced, large companies interviewed and small companies at the workshops indicated that they are well worth overcoming.

In addressing these limiting factors the research emphasised the performance of the "gatekeeping" role by boundary spanning academics in liaising with company "gatekeepers" to work collaboratively to overcome these issues. By "gatekeepers" we mean those individuals who are embedded in academic or business environments and act as 'intermediators of contacts and knowledge'. They understand the university and business 'life-worlds', maintain informal ties with researchers and translate the results from research in ways that has meaning and is disseminated throughout their organisations[7]. This behaviour is not only confined to dealing with problems; it is also important in each of the four types of university-business interaction outlined in this report to help identify opportunities to collaborate to achieve market innovation in companies.

"It (university research) is a small part of innovation, but without it, it doesn't work..."

"The potential (of applying university research in a small company) is enormous, but we have to work out how best to make it accessible."

"T-shaped" academics[8] who can help companies connect with and understand how a wide range of academic research may be relevant to an identified business issue are crucial to resolving what are often multi-disciplinary problems. "T-shaped" academics have depth in their subject knowledge but also have strong links to other fields that enables them to work across bodies of research – and not just be confined to their own field of study. Many of the companies interviewed and those from the workshops mentioned the the value and rarity of such "T-shaped" qualities in researchers. The research found only one example in 22 cases where the companies had identified an academic who displayed "T-shaped" behaviours. The concept of "T-shaped" academics has a much wider application than purely at the academe–company interface, but it certainly is important for accelerating university-business research collaboration.

Given the need for active translation between university researcher and company in any form of knowledge exchange, the same may similarly apply to the interface between fundamental and applied disciplines in universities. On the university side, more effective translation and connectedness between fundamental and applied disciplines through using "T-shaped" academics might potentially move research outcomes into application more effectively and enhance the capacity in the system as a whole.

Absorptive capacity as a key requirement for market innovation

The research findings highlighted the importance of absorptive capacity[9] in companies as a key requirement for working with universities to achieve successful market innovation. Company engagement is clearly affected by their propensity and capability to engage and to absorb, to translate and exploit knowledge. Different types of interaction require different degrees of these capabilities. Significantly, the case studies and the workshops found that the practice of collaboration itself – even informal knowledge exchange – increased the ability and propensity of companies to continue collaborating with universities.

Companies require their own internal capacity (or external help) to understand and value how academic knowledge could benefit them. They need the relevant management processes so that individuals can secure the internal commitment and resources needed to take part in projects. A culture of open innovation will be needed if the company is to get the maximum benefit from academia. Equally it requires people who can visit and operate in the world and language of academe and can see the potential from working on equal terms and not solely in a formal contractual relationship with academics.

Absorptive capacity includes the ability of the partners together to:

- recognise the potential for using university research outcomes in business;
- localise the research outcomes to the company context and address a specific business need;
- commit the necessary resources to embed the localised knowledge as an intellectual asset of the company; and
- develop the systems not only to evaluate and commit resources to a project but also to diffuse and exploit the results throughout the business.

Given that absorptive capacity is a key ingredient in successful business-university collaboration, can we identify the characteristics which represent a company's absorptive capacity? Outlined below are some of those identified by this research:

- the company's innovation strategy, whether it is "open" or "closed", and how this affects their approach to knowledge acquisition (see Figure 2);
- the propensity and ability of employees to behave entrepreneurially, spot opportunities, pursue them and secure resources to bring them to realisation;
- the extent to which knowledge and capability development is valued in the company culture;
- the extent to which the company recognises both the opportunities from university collaboration and how it is also responsible for contributing to a successful collaboration.

The findings from both the case studies and the workshops reveal that the learning derived from university-business collaboration needs active engagement and management on the part of the company in order to ensure a satisfactory outcome. The workshops highlighted this might be challenging, especially for small companies. The research also found that it is not the properties of the company alone that are important but the dynamics of working together.

Investing in the capacity to engage

One of the companies we interviewed recognised that it was losing its organic capacity to relate to universities as their original dowry of scientific staff retired and the company lost access to the personal relationships these staff had developed. This led to the company building strategic relationships with a limited number of university partners. At a practical level they learnt from their experience of developing optical sensors with Heriot Watt University that they needed to hire a scientist with the relevant expertise to help the company's engineers internalise and industrialise the sensors.

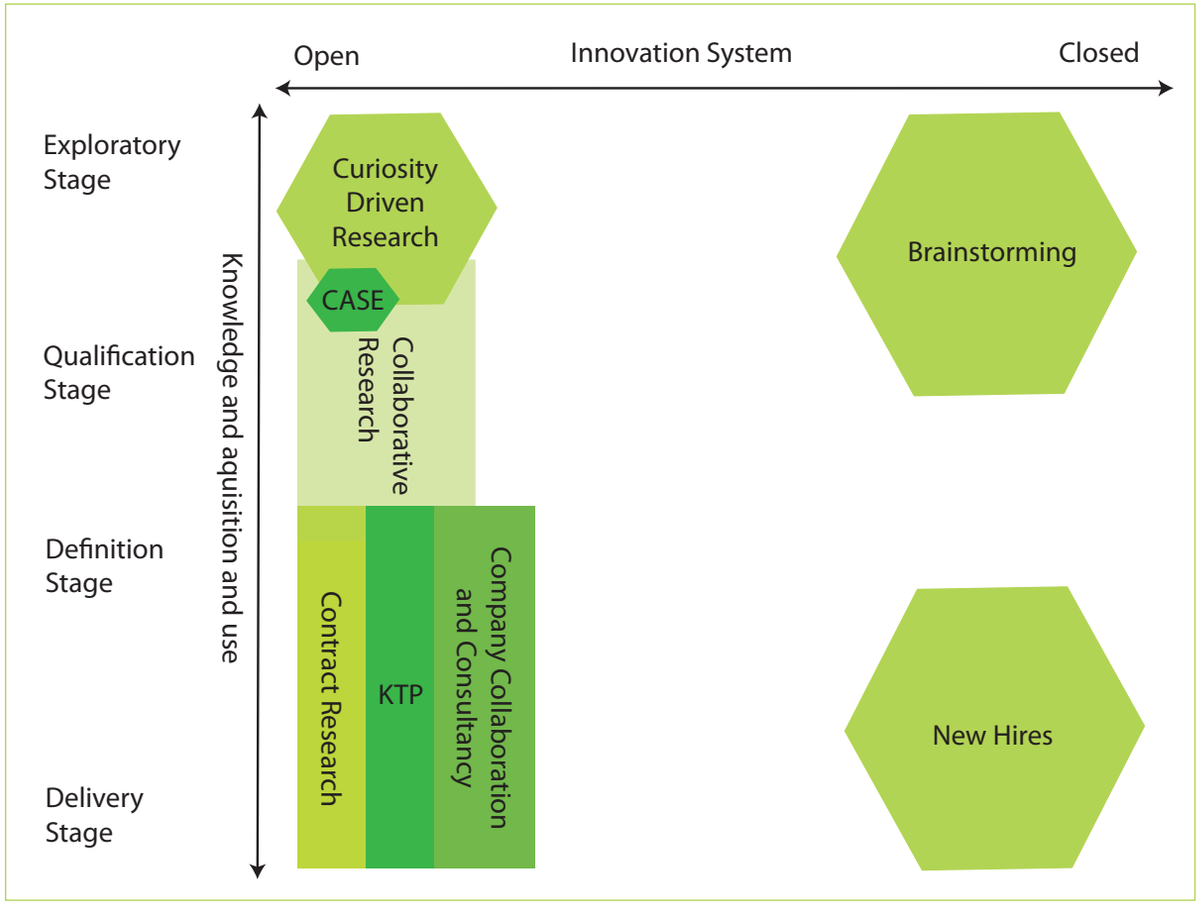
"You need to realise you need to engage actively to ensure that you get the best out of university collaborations."

Mapping company research acquisition processes

Thinking of university-business interaction as part of an innovation eco-system helped us identify the variables that have a bearing on the nature of the interaction, the success (or lack thereof) of the interaction, and the impact achieved. The research mapped the different types of Research Council 'products' against the different stages of use of university research and also took account of the innovation systems used by companies (closed or open). Figure 2 shows this mapping process, and highlights the limited options available to companies that adopted closed innovation strategies. This contrasts with the range of value chain impacts available through adopting more open and collaborative modes of university-business engagement.

The RCUK products ranged in terms of their distance to market, with CASE and curiosity-driven research being used at the Exploratory Stage while KTPs and contract research were not unsurprisingly most useful at the Delivery Stage. Companies that don't recognise the value of open innovation have limited options, and there are difficulties in helping companies move from a closed to an open system of innovation. Some sort of 'bridging mechanism' is required to help companies see how university research can add value in their innovation processes. There is also evidence from the workshops that alongside identifying potential opportunities, companies also need to better manage the barriers to interaction; this is part of their absorptive capacity.

Figure 2 Knowledge Acquisition Strategies



Mapping the use of RCUK products in company innovation processes

The research explored the extent to which the array of Research Council knowledge exchange 'products' or programmes are factors that could influence the way in which university-business collaboration develops. The analysis involved positioning the RCUK products against the absorptive capacity of companies, using different levels of experience of working with a university as a proxy. The resulting "escalator" of products set against different levels of absorptive capacity is outlined in Figure 3.

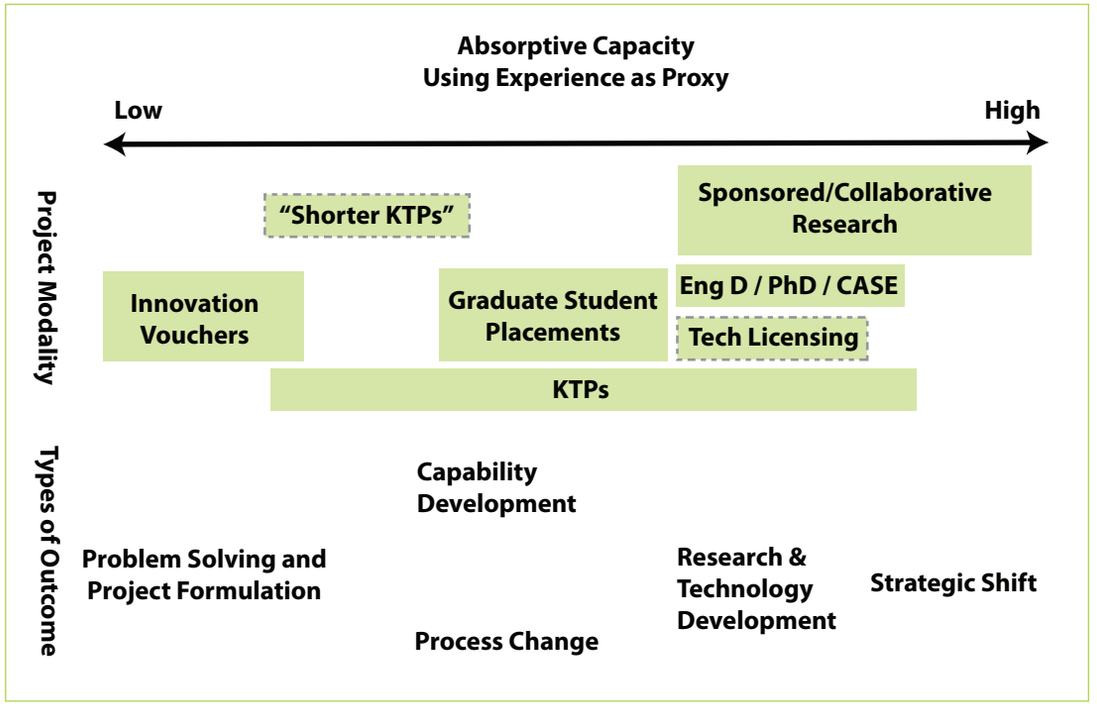
Products requiring a lower absorptive capacity were shown in the case study companies to stimulate an interest in engaging in further collaboration – *"stepping up the escalator"*. This often prompted companies to invest in their capacity in order to engage in wider forms of collaboration with universities. The ensuing interactions with university research also involved stages further away from any direct market application, i.e. companies increasingly saw the value of interacting with universities about curiosity-driven and fundamental research. Those participating in the workshops corroborated these findings.

Innovation Vouchers, for example, are not Research Council products but significant evidence from the workshops showed that they are effective in bridging the barriers companies have in engaging with universities. They also reduce the transaction costs which deter inexperienced companies in the formative stages of building links with universities. They may even lead companies to engage with the 'first' steps' on the escalator – taking on a graduate as a KTP associate, and perhaps even commissioning contract research from a university. Graduate projects were valued as part of a larger innovation cycle, provided that sufficient resources were available in the company to scope them out properly and assign resources to manage and ensure delivery.

It is hoped that developing a better understanding of how these products 'fit' with the innovation processes of companies may trigger some 'product re-positioning' by RCUK and thereby enhance the impact being sought from Research Council interventions.

"We learned project management techniques (from being supported through KTP) that we've applied to the rest of the company's projects."

Figure 3 Escalator of RCUK knowledge exchange products



Recommendations

The analysis from the case studies and the company workshops highlight a number of actions that the Research Councils, along with the Funding Councils and the Technology Strategy Board (TSB) could take to increase the ability of companies and universities to work together to create economic value from research. These recommendations also take account of the need to lower the barriers to company engagement with university research and address the factors which prevent university research generating economic impact.

Create a joined-up strategic communications strategy

The most important and urgent action required is the need for a joined-up, coherent and consistent communications strategy from RCUK, the Funding Councils and TSB about research impact: what it means, who is responsible for achieving it and how to address the key barriers that inhibit university-business collaboration on research. Notwithstanding the guidance issued by RCUK and the Funding Councils to date, this research highlights that there is still some misunderstanding of the role of university research in contributing to company innovation. Hence a proactive communications strategy should focus on:

- developing a better understanding of the role universities have as supporters rather than drivers of innovation;
- highlighting that it is often companies that generate economic impact and that universities make a crucial contribution to this impact;
- supporting the "gatekeeping" function within institutions to enable boundary spanning activity by academics;
- encouraging opportunity recognition for the application of university research;
- facilitating inter-disciplinary research and also developing a better understanding the barriers that prevent it;
- recognising and developing company absorptive capacity.

Use financial levers to incentivise collaborative behaviours

The Research Councils and the Funding Councils can use the available financial levers to incentivise appropriate behaviour by universities, and thus better harness the role universities have in company innovation processes[10]. In many cases (for the Research Councils with the development of impact pathways in bids for funding, for HEFCE with the inclusion of impact in the Research Excellence Framework (REF), and for TSB with programmes such as KTP) these funding levers already exist. A key role of the communications plan reinforced by the actions that follow in these recommendations is to connect the way impact is conceptualised with these existing financial levers to incentivise appropriate actions.

Recommended actions:

- Fund "public space" activities which support universities and companies to work collectively on sharing the research challenges they each face; identifying where they could collaborate to address global issues or respond to strategic public procurement needs through the Small Business Research Initiative (SBRI) programme.
- Fund "T-shaped" fellowships to help academics work across bodies of research beyond their own discipline. This will encourage more effective connectedness between fundamental and applied disciplines and might move research outcomes into application more effectively.
- Fund activities that support universities to better identify pathways to impact. Beyond issuing guidelines about impact, the Research Councils should support the experiential learning of different ways of developing different pathways to impact.

Companies benefiting from university research

Companies such as EADS, BT and Syngenta have started to evaluate the contribution of university research to projects, but they recognise that the benefits cannot be measured directly in financial terms. Furthermore, it was not possible to separate out the contribution made by university research, but there was clear value from collaborating with universities through the range of the interactions outlined in Figure 3.

Unilever has a new potential product constituent; Schlumberger a new service; Zoeftig and Heales Medical new products and services. AstraZeneca may have a new drug faster; GlaxoSmithKline may have a shorter and less expensive means of getting through Phase III trials. First Great Western has an increase of 20% in passenger traffic on rural branch lines and Network Rail has achieved substantial savings in maintenance costs.

The genesis of all of these would owe something to university research.

Frame impact around the contribution research makes to market innovation

The context and nature of research and its possible uses by external stakeholders are determining factors in how it contributes to impact. The Research Councils need to help embed an understanding within the academic community that giving consideration to possible impact is not a prescriptive process. It requires an understanding of how impact might arise within the context of each research question and project. This may lead to 'considerations of use' in projects being identified to test interest at an earlier stage. It is crucial that principal investigators and their teams understand that although generating impact is not their primary role, they can be more active potential collaborators in company innovation processes without undermining their distinctive role in curiosity-driven research.

Recommended actions:

- The CIHE to work with RCUK on developing an experiential (how to's) learning programme grounded in practice to help principal investigators to reflect on the nature of the impact which might arise from a set of possible research outcomes, e.g. a proof of scientific principle would not be expected immediately to give rise to a commercial outcome but could be of value when engaging with researchers in an applied discipline or in a business setting.
- The CIHE to extract how impact has arisen from the cases studied to demonstrate the variety of possible impacts which might result from using university research.

Implement more sophisticated impact plans that focus on pathways to impact

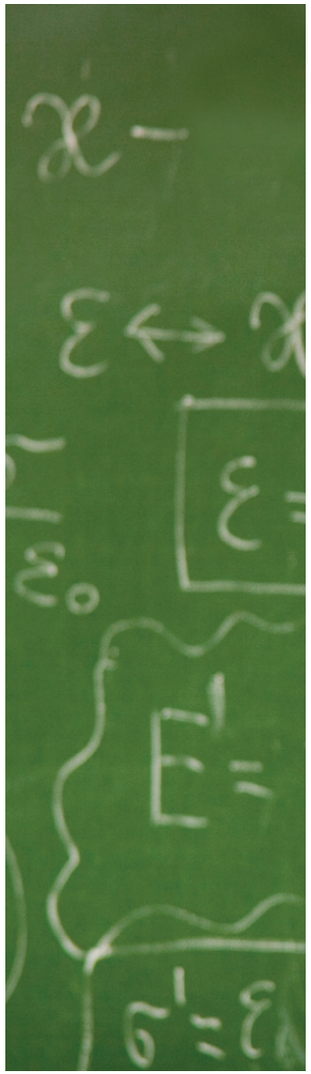
Although impact pathways are required in research proposals to identify potential research users and potential uses (to the extent that this is possible prior to project commencement as the outcomes cannot always be predicted), more emphasis is needed on engagement with potential users to better identify future pathways to impact. These should not distort the research but should encourage appropriate engagement with potential users to realise the potential value the research may have[11].

Recommended action:

- The Research Councils to emphasise the value of the impact pathways to the research itself.
- Principal investigators to consider how to more actively engage with industry and other potential users of the research from the outset of their projects. This will help identify pathways to impact by harnessing the absorptive capacity of the potential users and generate an enthusiasm for the potential uses of research[12].

Reward gatekeepers who work with business and break the 'teach, tell, publish' paradigm

The "gatekeeping" role by boundary spanning academics in liaising with company "gatekeepers" stimulates the opportunity recognition process. These activities may not be valued using the conventional metrics for assessing academic performance and career progression. Universities should change their recognition and reward structures specifically to identify and encourage researchers who might work with companies on the use of their research.



Recommended action:

- The Research Councils and the TSB to support the development of audience-related outputs as proposed in the REF framework[13]. This may encourage active "gatekeeping" behaviour by academics. This would be welcomed by both the corporate R&D Directors surveyed for the CIHE's response on the REF proposals and in the companies studied for this research.

Train young researchers in business-university relationships

Developing an understanding of how university research impacts on innovation in business could also be included in the proposals for training postgraduate researchers[14]. This does not mean that researchers should be expected to predict research outcomes nor specific research impact. It is important that researchers have an understanding of the processes through which investment in university research supports innovation in companies and appreciate the importance of developing the boundary spanning relationships through which pathways to impact are identified.

Recommended action:

- The Research Councils to ensure its programmes on career progression for young researchers[15] develops the commercial, management and transferable skills that will be needed in either a university research setting in exploring the possible uses of research or when working in a commercial setting within a company.

Develop and reward "T-shaped" academics

Large and small companies alike stressed the importance of inter-disciplinary research in addressing business challenges and opportunities, although the workshops suggested that the challenges are likely to be greater in small companies. We need to encourage not just the formation of relationships between business and university "gatekeepers", but also the development of "T-shaped" researchers, people who can recognise the applicability of research outcomes in one (perhaps their own) domain for others and are willing to engage in them[16].

Recommended action:

- HEFCE is engaged with this issue through the development of the REF, but the Research Councils can act to support challenge-based research that relies on inter-disciplinary knowledge, and fund "T-shaped" fellowships as another mechanism of encouraging academics to leverage their collective knowledge across discipline boundaries. The EPSRC are already developing "Dream Fellowships" to provide time and resources for research leaders to engage with industry through placements and exchange programmes to define transformative research challenges[17].

Create and fund "public spaces" to stimulate new challenges aimed at business issues

The Research Councils, TSB and the Funding Councils should support the development of "Public Space" activities such as conferences or workshops. These could identify research relevant to major societal or business challenges and bring potential academic and company "gatekeepers" together in a non-competitive space. These "public space" undertakings could be one way of harnessing and stimulating the absorptive capacity of business; they can offer a space in which universities together with businesses can experiment, act and learn[18]. They also bring the realities and complexities of the challenges facing business to the attention of university researchers.

Educate universities about the absorptive capacity problem

The case studies and workshops demonstrate that a positive experience with universities about the uses of research can have positive outcomes for the company – beyond the narrow outputs of any particular use of university research. There is a need, however, to educate universities about the absorptive capacity problems companies have in engaging with them. The recommended actions outlined below are focused on repositioning the current programmes to help universities with this.

Recommended actions:

- The Research Councils to use the CIHE research to work with universities to be more proactive in recognising the limiting effect of company absorptive capacity. This coupled with a conscious repositioning of the different RCUK knowledge exchange products could provide an "escalator" of different types of engagement.
- The Research Councils and universities to use the schematic of the "experience escalator" outlined in Figure 3 as a possible template for universities and knowledge exchange intermediaries.
- The Research Councils and the Funding Councils to support universities in using Innovation Vouchers as a valid component of the knowledge exchange offer – this was highlighted in two of the three workshops[19].
- The Research Councils to develop the knowledge exchange portfolio suggested in Figure 3 on their online 'Knowledge Transfer Portal' for a relative positioning of the different products against the suitability of projects and participants. Illustrating the connectedness across the product portfolio would help companies better identify the different types of products and expected outcomes. Encouraging universities to adopt a similar portfolio approach may also help shift their behaviour to be more responsive[20].

Conclusion

This report has investigated the contribution of university research to market innovation and examined the nature, relative scale and contribution of university research to company innovation processes. It has found that absorptive capacity at the company level is a determining factor in achieving successful university-business collaboration, and that universities and businesses together can find solutions to improving the knowledge acquisition process in companies.

The research has also tested the portfolio of Research Council products and found that there are opportunities for repositioning them to better fit with the role that universities have in company innovation processes. The report makes a number of wide-ranging recommendations to the Research Councils and other agencies about how they can better support university-business collaboration and the use of university research in market innovation. Clearly companies are motivated by the profitable use of university research, but the research has also shown that there is a need to better inform companies about the role universities can have as co-creators of knowledge that can help address the challenges that companies face.

"We were looking for support in using open source components but consultancies and companies were too rigid in their approach; the university was much more willing to learn and adapt."

Businesses and universities co-creating value

There is a wide range of relationship types ranging from graduate recruitment through to collaborative and contract research:

- *Pure technology licensing represents a small fraction of the interactions.*
- *Collaborative working in both specifying and implementing projects is a key feature of successful projects.*
- *Boundary spanning activities by individuals who build relationships characterised by trust and understanding are a key precedent and component of this collaborative working.*
- *The vital knowledge exchange relationships for companies are with university academics.*
- *The ability of companies to acquire and apply knowledge (their "absorptive capacity") is a critical dependency for effective knowledge exchange and application in the business.*
- *The range of effects on company value chains is much broader than the incorporation of technology in product.*

Annex 1: Assessing the different forms of research impact

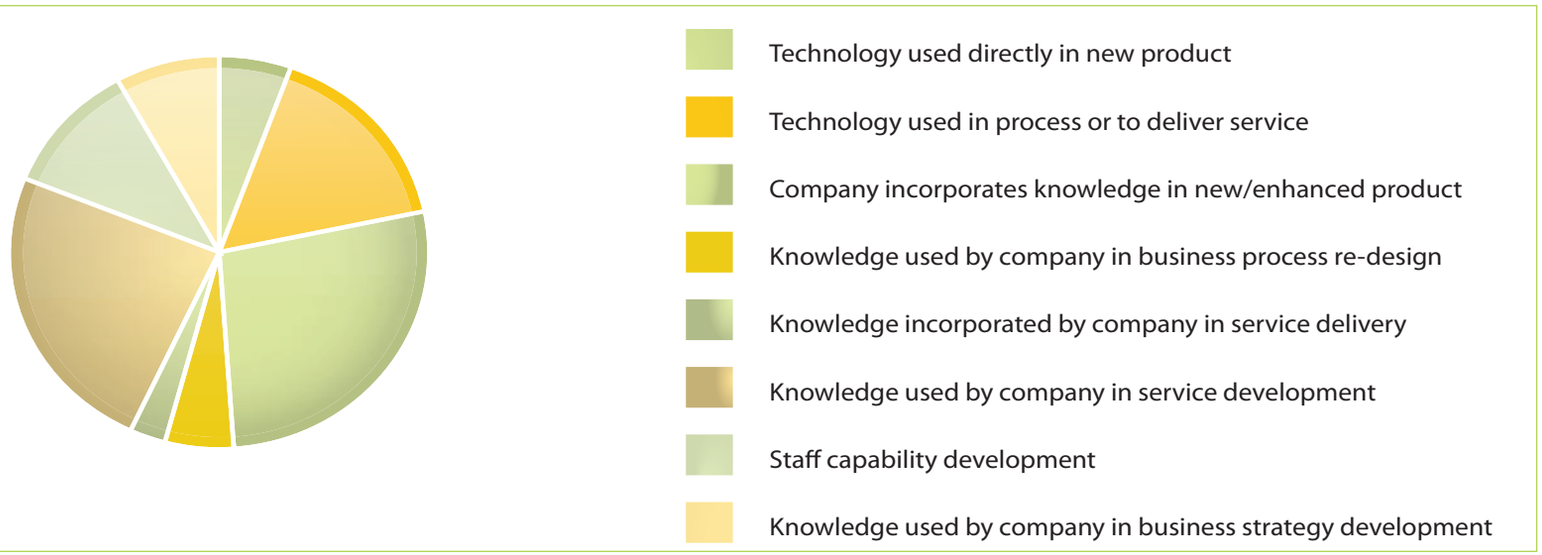
Figure 4 below outlines the wide range of research use by companies. These are highly context sensitive – often dependent on the issues and opportunities facing the company and its need for, and ability to apply, the outcomes from university research[21].

Most notably, we can see from Figure 4 that the contribution of university technology directly into product is low (2 cases out of 37) – this contrasts with the dominant policy imperative of commercialising university research into products and services[22].

Another key finding is a better understanding of how value arises in companies as a result of internally driven and collaborative efforts involving partnerships with universities and others. More specifically, this research has assessed the role of university research in these innovation processes.

Figure 4 also shows that the research outcomes used by companies cover a broad mix - ranging from curiosity-driven research to very near-to-market research applications. The propensity and ability of companies to use research differentially depending on its nearness to market is heavily influenced by its own R&D capability to interpret and absorb the research. R&D intensive companies with long formal innovation processes are much more likely to engage with research at some distance from the market. This makes the impact of individual university research projects very difficult to identify in such cases. Hence different types of knowledge engagement are required of universities in accordance with the needs of the companies they work with. This flexibility in responsiveness is not easily accommodated, both by university systems of engagement and by the funding frameworks – both are built on fairly rigid and prescriptive models.

Figure 4 Research impacts on business



Annex 2: List of companies interviewed

- ARUP
- AstraZeneca plc
- AWE Aldermaston
- British Maritime Technology Group Ltd
- BT plc
- EADS (Innovation Works)
- e2v (Technologies) Ltd
- Eye Gaze Ltd
- First Great Western Ltd
- FlyBe Ltd
- GlaxoSmithKline plc
- Heales Medical Ltd
- Network Rail Ltd
- Orla Protein Technologies Ltd
- Schlumberger Cambridge Research Ltd
- Smart Holograms Ltd
- Syngenta UK Ltd
- Unilever plc
- Volterra Ltd
- Waitrose plc
- Willis Re
- Zoeftig Ltd

References

1 See Abreu, M., Grinevich, V., Hughes, A. Kitson, M., and Ternouth, P (2008); Universities, Business and Knowledge Exchange, Council for Industry and Higher Education, London, UK. & Centre for Business Research, University of Cambridge.
See also Cope, J.; Garner, C.; Kneller, R,; Mongeon, M. and Ternouth, P.(2008) University-Business Interaction: a comparative study of Mechanisms and Incentives in Four Countries, Volume II, Initiatives in Comprehensive Understanding of Civilizational Issues: A New Era of Science and Bioethics, Sasakawa Peace Foundation, Tokyo, Japan and CIHE, London, UK.

2 The findings reported are based on in-depth feedback from a limited number of companies rather than a large sample of businesses. Whilst there was a great deal of coherence and internal consistency in these findings which has resulted in a high degree of confidence in the conclusions reached, there may well be other opinions which contradict them.

3 The workshops localised the findings to three different company types. These canvassed the views of different segments each with their own needs and challenges when attempting to enhance the economic impact arising from research. Companies studied covered the digital media sector and a range of small technology firms (SMEs), both high-tech and low-tech businesses.

4 A full report of the fieldwork, with case studies, along with notes from the three consultation workshops held with SMEs was submitted to RCUK for internal use. This summary report synthesises the key messages from these reports and makes a number of over-arching recommendations based on the analysis of the data.

5 See Abreu et al (2008) for examples of companies that purposefully seek to work with universities to learn from blue skies research, but also to work with curiosity-driven researchers to better understand the challenges the company faces and co-create solutions using varied applications of leading edge knowledge and technologies.

6 For further corroborating evidence of universities as contributors to company innovation, see Connell, D. and Probert, J. (2010) 'Exploding the Myths of UK Innovation Policy: How 'Soft Companies' and R&D Contracts for Customers Drive the Growth of the Hi-Tech Economy', Centre for Business Research, University of Cambridge

7 See Tushman and Katz, 1980; Allen et al, 1979; Edmunds and Morris, 2000; Nikolainen, 2007; Sosa et al, 2002.

8 See 'The ten faces of innovation: IDEO's strategies for beating the devil's advocate & driving creativity throughout your organization', (2005), Kelley, T. and Littman, J., Currency/Doubleday

9 See Cohen and Levinthal, 1989, 1990 and see also Zahra and George, 2002 as cited in Cope et al (2008).

10 This includes the range of benefits which can accrue to companies through working with universities (i.e. not just technology into application) which are much wider and more generally applicable than is commonly perceived by non-collaborating companies This suggestion is based on some of the interviews with non-collaborating companies carried out in the early stages of the fieldwork.

11 This is entirely consistent with the views expressed by CIHE's consultees on the REF - .'Supporting Research Excellence: a business perspective on the REF; A CIHE-sponsored consultation for the Higher Education Funding Council for England', (2009), CIHE, London

12 See 'Causation and Effectuation: Towards a Shift from Economic Inevitability to Entrepreneurial Contingency', The Academy of Management Review, Apr 2001, Vol.26, No.2, ABI/INFORM Global pg. 243. Sarasvathy's approach to entrepreneurship uses effectual reasoning to explain the importance of action for the entrepreneur. Unlike causal reasoning that comes to life through careful planning and subsequent execution, effectual reasoning lives and breathes execution. Plans are made and unmade and revised and recast through action and interaction with others on a daily basis.

13 'Research Excellence Framework: second consultation on the assessment and funding of research', HEFCE, (2009), Bristol

14 See the recommendations made by Wellings – 'Intellectual Property and Research Benefits: a report prepared for the Rt. Hon. John Denham, MP, Secretary of State for Innovation, Universities and Skills, Professor Paul Wellings, (2008) Lancaster University

15 The Research Councils have signed up to a Concordat and Joint Skills Statement – see http://www.researchconcordat.ac.uk/. The EPSRC, BBSRC and NERC support industry fellowships through the Royal Society to ensure young researchers have greater contact with business.

16 These findings are echoed by the CIHE's consultation on the REF.

17 The EPSRC 'Dream Fellowships' may be explored as a possible model for developing "T-shaped" academics.

18 Previous CIHE research on the role of public procurement in stimulating innovation is another instrument through which "public space" could be mobilised. More specifically, embedding the principles of innovation, risk taking and venturing could usefully stimulate greater innovation and breakthroughs in public service delivery. The SBRI programme is currently working with the Departments of Defence and Health to set aside a percentage of their R&D procurement budgets for 'market-making' and stimulating innovation through university-business collaboration.

19 CIHE consultation workshops held with high-tech SME's and medium/low tech SME's

20 The barriers to solution-focused interaction rather than product-focused interaction resulting from multiple sales channels in universities was described in Ternouth, P. (2002) Knowledge Transfer, Towards a Strategic Framework, Council for Industry and Higher Education, London

21 We have reported similar findings previously but these studies were not confined to research centred interactions. Abreu et al (2008) and Cope et al (2009) also included CPD and course development projects whereas this study is purely focused on the use of research outcomes.

22 See the Wellings report (2008).

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