# HOW DESIGN RESEARCHERS CAN LEAD HIGHER EDUCATION TO A GREATER IMPACT ON SOCIETY

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## ABSTRACT
This paper argues for the lead rôle that the engineering design research community can have in aiding SMEs. The paper details findings based on several rounds of calls and meetings with a total of over 600 SMEs, and interviews with members of large design and manufacturing research group. It was found that SMEs mainly requested support with specific product related problems and tasks, rather than improvements to process or practice. It was also found that university faculty members have little time or incentive to provide such support which may not directly progress a research portfolio. However, with the aid of available government funding, researchers could benefit from undertaking such support work to fill gaps between fixed term research contracts; though administering short term irregular contracts proved a major unresolved barrier. It is recommended that engineering design researchers work as projects managers to provide technology and knowledge transfer, drawing further expertise from researchers within their universities. A trail case was completed showing identifying three key barriers to future progress.

*Keywords: Societal Impact, Knowledge Transfer, Engineering Design Research, Innovation, Strategy*

## 1 INTRODUCTION
*Engineering, probably more than any other scientific or technical discipline, has a long tradition of collaboration between academia and industry"* [1]. As a result engineering research is often expected to secure its funding contributions from industry and the private sector. This approach is positively encouraged and engineering research is promoted as a direct form of support to industry as *"considerable rewards are available to both parties in a successful collaboration, in addition to the benefits generated for the UK economy from technology transfer."* [1]
In order to further enhance such collaborations, a number of Knowledge Transfer Accounts (KTAs) have been set up across the UK to *"stimulate an environment and engender a culture to overcome barriers to better exploit EPSRC-funded research. They will foster the creation of an environment in which impact and knowledge transfer/exchange are valued and encouraged, just as much as is the generation of original research results"* [2]. In addition to supporting university-industry collaboration, the KTAs were set up to help to develop research projects from Technology Readiness Levels (TRLs) [3] of 1-3 on to TRLs of 4-6, which has been acknowledged as a difficulty.
In this paper we report some research conducted during a scoping study funded by a KTA. The purpose of the study was to investigate the potential for a mechanism to assist knowledge transfer between a large engineering design based research group (I*d*MRC, University of Bath) and SMEs (Small/Medium sized Enterprises) based in the same region (South West of England). The study will be reported in light of the Lambert review of business-university collaboration [3] conducted back in 2003 along with the many industrial and academic contributions made to the review. We argue that there still exists a missed opportunity for collaboration between universities and SMEs despite recommendation 2.2 of the review, recommending that *"[g]overnment should seek ways of directing a higher proportion of its support for business R&D towards SMEs"* [2].
Previous literature on K.T. have focused on either 'industry characteristics', 'university characteristics', 'geographical importance' or 'channels for K.T.' [5]. In this paper we will first discuss the nature of university-industry collaboration from engineering design research perspective (section 2). The following sections then go on to discuss the motivations and pitfalls of such collaborations from both the perspectives of the universities (section 3) and industry (section 4) drawing evidence from contact with over 600 SMEs and interviews with 16 members of a large

engineering research group. Based on such information we propose a model for collaboration between universities and SMEs (section 5). We then conclude with several challenges for implementation and some final remarks.

## 2 THE NATURE OF UNIVERSITY-INDUSTRY COLLABORATION

As discussed in the introduction, university – industry collaborations are generally seen as positive and desirable arrangements. In the field of engineering design research, industrial sponsors and collaborators are highly celebrated and engagement with industry is accentuated as much as possible in the reporting of research. There are many instances where these research collaborations yield good results for both sides, but this is not the majority. As one representative from Building Research Establishment (BRE) [6] put it *"Examples of the pinnacle of best practice in business / university collaboration can be readily found. However, in the vast majority of cases, practice is best described as* ***poor*** *or* ***appalling****."*

This section will first highlight some industrial funding considerations for design researchers to reflect on (section 2.1) before addressing university – industry collaborations' failure to meet industrial needs (section 2.2) and the needs of design research (section 2.3).

### 2.1. Industrial funding considerations for design research

The engineering design research community is at an interesting juncture. On one hand, it is still proud of its real life application and its societal and industrial benefit. However, on the other hand there is a movement to establish a design science, where more fundamental research with little direct application needs to be conducted. It is believed that this approach will eventually pay off in the form of better application as a result of a deep understanding of the field. It is not the purpose of this paper to address which is the correct approach, but it is important to highlight these differences have an effect on knowledge transfer and industrial relations. As a representative of BAE [7] systems put it in BAEs response to the Lambert review:

*"[r]esearch funded in the academic sector can be divided into the three categories:*

- *Not relevant to industry*
- *Relevant to industry*
- *Claimed to be relevant to industry.*

*We would prefer to get an appropriate balance between the first two categories and minimise the third."* A failure to address this balance could alienate our community from any form of industrial collaboration. However, in reality this is not so black or white, as there is also the important consideration of timescales within which industrial relevance may emerge or be established from research. In BRE's [6] response to the Lambert review, they write *"One concern we have and which we hear from other business partners is the attitude universities have towards funding. They seek funding not to help industry solve its problems or to access a new opportunity, but primarily to be able to do more academic research."* They continue to write, *"Despite their recent wailings about funding shortages, universities and their staff are relatively well-protected from economic realities. There is no current impetus for radical change."* Well if there wasn't back then in 2003 there certainly is now!

### 2.2. Research collaborations' failure to support industry

Even in instances where academic research is directly applicable to industry, university – industry collaborations still fall short of optimal in many instances. Unfortunately, this is often seen as the fault of the universities to support industry *"Industry tries to access universities but is put off by bad experiences. The attitudes and approach of the universities appears to be the problem, rather than that of business."* [6]. These faults include the universities':

- lack of responsiveness to industrial requirements

*"Although there are many examples where individual academic groups are as responsive as their capabilities will allow them to be, the overall system does not respond sufficiently quickly to changes in industrial needs."* [7],

- constrained IP agreements

*"The operation of relationships today (in all engineering and technology sectors) is primarily constrained by IP agreement"* [8]

- lack of communication of expertise and competences

*"The difficulty of finding out "who does what" within universities was also a recurring theme in responses."* [3]

- poor contact management

*"over time they had built up relationships with individual academics – but they commented on the difficulties of maintaining those links if those individuals moved on"* [3]

"*The CBI's survey of 200 of its largest companies suggested that 50% of those who responded saw deficiencies in customer service as the biggest problem that they had encountered in dealing with universities.*" [3]

- lack of long term research plans

*"a general lack of clear, long-term development strategies in university departments."* [8]

### 2.3. Research collaborations' failure to support academia

While universities must take their fair share of the blame for the "appalling" nature of much industrial collaboration, this must be somewhat expected when their own performance indicators are often conflicting and irreconcilable with the requirements of industry. Engineering design researchers often spend much of time and effort to please industrial collaborators and are often forced to sacrifice their intended research goals, studies and methods in order to keep industry onboard. This expanded workload is also placed on top of the huge levels of bureaucracy which is recognised by industry to be *"burdensome to university academics"* [8].

Dealing with the levels of bureaucracy within large companies can be equally as tedious and time consuming for engineering design researchers. Initiating any form of change within companies can take large proportions of time of often short-term research projects as there is often little urgency of industry to react to university requirements unless they see a direct benefit. Although this is a characteristic of large companies, we still pursue these inefficient collaborations in order to secure reasonable sized investments for research funding. *"Few HEIs (Higher Education Institutions) see the value of engaging with SMEs, their focus tends to be on larger Companies"* [9]. Although, it may be fair to say that larger companies are generally more cutting edge and can have some very interesting and new research issues.

In addition, "*SMEs are very often short term - concerned about survival above all else and this provides little time to seek external solutions from HEIs, or others. SMEs may not be able to afford the full economic price charged for advice by an HEI and HEIs cannot afford to subsidise such activity unless it can be justified in investment terms or it can be contained within the wider mission of support to its community.*" [10]

The engineering research community has been backed into a corner and forced to surrender many of its foundational academic principles in order to collaborate with industry with little compromise. A framework to which academia should adhere was suggested [11] drawing experiences from Yale, Harvard and others:

- the university not accepting restriction, inhibition or infringement on academics' free inquiry or capacity orally to communicate results of research;
- no restriction on written publication save the most minor delay to allow for patenting;
- the university only agreeing to arrangements for sponsored research from a sector of society which is compatible with its norms and mission;
- the university not agreeing to any arrangement which will impair the environment of openness and free communication of ideas;
- all authors of publications acknowledge all funding sources and any direct business associations e.g. employment by a corporation that has financial interests in the work being reported;
- academic staff report to their university all commitments to organisations with which they are involved in professional work.

It is felt buy the authors that first four of the above points are simply not enforceable by engineering researchers in the UK in the current climate.

## 3 CONSIDERATIONS OF THE UNIVERISTY ABOUT K.T WITH SMEs

In this section we will address the responses given during a number of interviews conducted from within a University research group in the context of the KTA programme. The purpose of these

interviews was to elicit the offerings the group had for SMEs, the opportunities that may arise from involvement with SMEs and what were the foreseeable drawbacks of such involvement.

### 3.1. Method

The Innovative Design and Manufacturing Research Centre (IdMRC) was divided into 7 distinct themes. One interview was conducted for each of the research themes. Present during each interview were theme leaders, theme representatives and in some cases other senior researchers, totalling 16 interviewees. The interviews were semi-structured with the aim of promoting discussions regarding knowledge transfer, research and consultancy with SMEs.

The interviews comprised of three parts. First we discussed and listed all of the possible topics that the researchers from within the theme could provide support to industry. For example, "3, 4, 5 Axis Machining", "Life cycle costing", "Reverse engineering" etc. In the second part we discussed the possible mechanisms for knowledge transfer that could be provided for each topic, such as "In house demonstration", "Workshop", "Troubleshooting", "Set-up and configuration" etc. The list, comprised of the interview responses from parts 1 and 2, were used to discuss possible knowledge transfer opportunities when contacting the SMEs (section 4). The third part of the interviews was to discuss the opportunities (section 3.2) and concerns (section 3.3) in partaking in knowledge transfer projects with SMEs, which are listed below.

### 3.2. The opportunities identified

The following opportunities were identified during the interviews undertaken with academics of the research group regarding possible knowledge transfer and consultancy activities with SMEs:

- A number of researchers were eager for contact with industry and exposure to real industrial problems.
- Some knowledge transfer projects may neatly align with research needs or questions of particular research projects, providing the opportunity to gain a good research case study.
- A number of researchers see the K.T. arrangements as a means to secure follow-on research.
- There were a number of researchers who are good engineers and are apt at dealing with industry.
- Research contracts are often short term and there may be periods in-between research contracts in which researchers are out of work. Paid K.T. with SMEs could be one mechanism to build up funding which could be used to fund research between research contracts and grants.

### 3.3. The concerns unveiled

The following concerns were identified during the interviews undertaken with academics of the research group regarding potential problems of knowledge transfer and consultancy work with SMEs:

- Faculty members have little time to conduct K.T. work.
- There is a high turnover or research staff and the expertise is short lived. Researchers do not transfer the knowledge such that it is retained by the research group so that K.T. in their area of expertise cannot be carried out once they have left.

*"Unfortunately, we tend to lose our staff just as they become most valuable to us, because we cannot give them the assurances they need about their future position."* [3]

- Researchers are on research contracts where their time is allocated to particular research projects.
- Academics express concern that it is not the job of researchers or academics to be rolling out research work or engaging in such practices. They should be treading new ground not covering old ground.

*"A major disincentive for academics to undertake business-university collaboration has, thus far, been the lack of recognition given to such activities in grant applications and the Research Assessment Exercise (RAE)."* [1]

- Academics are sceptical that doing such consultancy with the university would be less beneficial than doing it independently.

## 4 CONSIDERATIONS OF SMEs ABOUT K.T. WITH UNIVERSITIES

This section details an extensive study gauging SMEs' interest in knowledge transfer collaborations with the university research group described in section 3.

### 4.1. Method

A mailing list company was contacted and requirements given for 600 local companies who operated in sectors considered suitable for contact by the research group. These sectors included (at random), Warehousing and storage, Engineering design activities for industrial process and production, Manufacture of pumps, Machining etc.

A third-party Telesales Company was then provided with this listing, including both email address and telephone numbers of the Senior Decision Maker within each organisation. A script for the initial call was agreed with the telesales contractor. This was steered by discussions with an expert in survey and questionnaire design, who recommended that details be avoided and that an outline understanding of the work at the university was sufficient to gauge potential interest.

From this, a total of approximately 90 interested companies were identified. Depending upon level of interest shown, either a physical copy or an electronic version of the research group's 'Impact report' was sent out to each interested party. The report details the showcase research projects undertaken at the centre, qualifying the economic and societal impact of the research. After this, researchers followed up the contacts to enquire in more detail how expertise might be exploited in the form of K.T.

### 4.2. Findings

- The impact report was if anything off putting to the majority of the SMEs. This was mainly because it pushed the biggest, best and most leading edge research, making it irrelevant to the seemingly small scale issues faced by SMEs.
- Companies seemed very receptive to some form of involvement "in principle". However, several meetings were cancelled and a number of SMEs just seemed too busy to entertain the idea of working together.
- None of the companies seemed willing to pay for the service other than to cover researchers' costs.

*Industry is generally unwilling to pay the full economic costs of research, on the inappropriate assumption that quality related funding is available to fund these costs."* [3]

- Only a few of the larger SMEs wanted involvement at a process and practice level, however many said they wouldn't rule it out.

*"The low research intensity of businesses located in the UK means that overall demand from businesses for the knowledge generated within universities is weak. It is estimated that only around 16% of UK businesses use information from the higher education sector to help with innovation."* LAMBERT - UK Community Innovation Survey, Department for Trade and Industry, 2001

- The vast majority wanted specific expertise to help with specific problems and many wanted to keep the research group's contact details on file for when such a problem arises.

### 4.3. Conclusions

Based on the contact with the SMEs, the authors of this paper were left with a lot of confidence that more work and possibilities would stem from initial knowledge transfer between the research group and the SMEs. Many could not see where working with us would benefit but in most cases potential areas for collaboration were found. Unfortunately, these often were associated with either the facilities the university had to offer such as wind tunnels, rapid prototyping, CAD systems and reverse engineering capabilities or problem solving capabilities and 'job of work' style consultancy. Thus, it may be necessary for the research group to treat many of the initial collaborations as loss leaders (in terms of time investment), with the intention of more interesting follow on work.

*"Many large-scale collaborative ventures have evolved from an initial small-scale joint project through which trust and confidence have been developed."* [1]

It was decided that there was enough interest to progress the scoping study further and to develop potential mechanisms for performing K.T work between the university and SMEs (see section 7).

## 5 K.T. WITH SMEs - RELATED ORGANISATIONS

In order to further appreciate the problems and benefits of K.T. with SMEs the authors interviewed personnel from 3 related organisations, namely Exeter RKT, Cambridge IfM and the South West Manufacturing Advisory Service (SWMAS) who have extensive experience in paid K.T. and consultancy with SMEs. From these interviews the following points of guidance were collected:

- High-level engagement is the most practical.
  - It is best to tailor offerings to meet the specific industrial need, not 'shoe-horn' restricted expertise into inappropriate contexts.
  - It is good to use high-level engagement to assimilate or to identify which is priority for organisation.
  - Although individuals in a given department may act as useful 'champions' once work is initiated, focus upon engagement at a broader level to ensure that the full extent of possible collaboration is considered. Early 'bottom-up' efforts were of relatively little success.
- Centrally manage the 'brand' for knowledge transfer.
  - Provide a central point-of-contact to ensure that all interest is rigorously pursued.
  - A clear message of the strengths of the University, including a portfolio of success stories.
  - Showcase events to attract industry and to maintain University engagement.
- Manage industrial linkages professionally.
  - Speak the language of industry.
  - Programme managed to meet industrial timescales and imperatives.
  - Separate academic work (the generation of Intellectual Property) from knowledge transfer (the exploitation of such IP).
- Clear link/understanding between industrially-facing functions and academics.
  - Manage contractual agreements between industry, consultants and the academics.
  - Exeter RKT have standard K.T. Partnership contracts which are acknowledged by the university, enabling researchers to spend dedicated contractual periods working for the industrial collaborator.
  - SWMAS recruit consultants with skills matched to specific projects or areas of work.
- Incentivisation of academics is important.
  - Knowledge Transfer Partnerships (K.T.Ps) income counts towards funding assessments.
  - Direct contractual link between consultants and academics.
- Who conducts the Transfer?
  - There were conflicting views, either relying on a set of consultants or it should be academically-led.
  - There was also conflicting views on the diversity of offering and length of the engagement which have different funding, contractual, commercial and academic ramifications.
  - It is a possibility to provide K.T. through a separate Limited Liability Company.

# 6 IMPLEMENTATION PLANS

The background research as conducted in the previous sections supported the development of a number of implementation plans, each of which will be briefly discussed in the following sub sections.

## 6.1. Researcher led consultancy

This idea involved assembling a task force of suitably skilled researchers and research students from across the University. This pool of researchers could then drive proposals for K.T., both in terms of identifying and exploiting opportunities and in drawing in suitable skills from within the assembled team.

A workshop was run on 12th August 2010 by University central research administrators for a selection of postdoctoral researchers. From this meeting it became apparent that the researchers perceived little clear incentive for themselves, especially given the significant amounts of initial effort needed to develop proposals to the point of execution.

## 6.2. Own brand consultancy

This proposal was put together as the result of following up on a couple of the more positive phone calls outlined in section 4. This takes a standard consultancy approach using the university's skills and expertise to solve problems for industry.

There are significant barriers to such an approach. Although many SMEs respect the calibre of graduates from higher education they might not recognise the quality of research which would be applicable toothier business. Thus, this implementation plan would require long-term investment with significant delay before return on such investment was realised. Significant resource would have to be expended in identifying and developing a relationship with interested companies, and much early

collaboration would be focused predominantly upon immediate problem solving work at low cost and with marginal benefit to the researcher. It is anticipated that the subsequent establishment of trust and reputation would ultimately support more advanced collaboration and allow more intellectually and financially rewarding work to be undertaken.

### 6.3. Student project utilisation

This proposal was put together with a Regional Development Officer for Higher Skills and a Teaching Fellow/Enterprise officer in Mechanical Engineering. There was interest in developing a regional setup to match students to companies and real industrial projects, either in substitution for final year and group projects or for summer placement and part time 'extra' work for the students. There may be some joint funding possibilities with regards to this between the KTA and The Development office for Higher Education and Skills. There were several key areas in which, particularly engineering students could be of assistance to SMEs:

1. CAD work: A number of the SMEs were unable to do their own CAD work and could usefully employ students to create CAD models for them. There may be some issues with Licensing.
2. Web design: Some of the students are more than capable at designing websites and modernising the websites for SMEs.
3. Manual task: Simple manual tasks such as data entry
4. Scoping studies: Students could undertake new scoping projects to gather information about competitors, patents, and general market feasibility.
5. Marketing/user studies: There were some requests from SMEs for user studies and market analysis which could be conducted with the marketing students.
6. Conceptual work: The development and modelling of conceptual work which the SMEs do not have time to undertake.
7. Basic empirical testing of designs.

Points 4, 6 and 7 have been performed before through a number of MSc projects and BEng projects. One example can be taken from the work previously undertaken with a local pump manufacturer where an MSc student did some conceptual work to propose new methods/materials to reduce the time of the pump coating process. The MSc student proposed an alternative coating. This was taken up by a BSc student who performed very rudimentary testing to prove a performance increase moving from the previous coating to the new coating.

For this implementation expectation management would be essential. A small portfolio must be created showing successful examples and of cases which have not met their objectives but which illustrate issues which might negatively impact success This is a minimal risk implementation, being of immediate utility to industry whilst retaining the scope to be of direct educational and vocational benefit to students and of interest to academics. The student(s), company and supervisor should co-create a brief at the start of a project to decide on deliverables, ensuring that all parties receive some benefit from the engagement. SMEs should also agree to 1-2 progress meetings, most critically a stage-gate meeting to select the most favoured concept with which to progress. They must also provide a point of contact for the student to be able to ask questions regarding design preferences and clarification of design tasks. Such meetings are vital to ensure the continued collaboration between all parties is maintained and developed over the course of the work, and that the established relationship does not leave with their student. The company should provide a budget for expenses such as travel and prototype generation and testing, both ensuring buy-in from the company and ensuring that programme retains an ability to deliver successful outcomes unencumbered by financial constraint. ..

The extended interaction at this working level allows for design practice to be assessed. From this, further beneficial areas of investigation may be identified, and practical and feasible programmes of work to undertake this investigation may thus be collaboratively and iteratively developed.

### 6.4. K.T. merger

There remains a possibility of merging the K.T. activities of the research group with other institutions (mentioned in section 5) already providing such K.T. consultancy work. Aside from the direct commercial benefits, this provides advantage to the consulting organisation in terms of added expertise and resource, and benefit to the university group in terms of managed and informed access to a hitherto closed or poorly understood market for their ideas. In this case it was suggested that the research group becomes a regional branch of the larger K.T. consultancy group, providing an

additional set of offerings which could be presented to industry and which could be delivered in conjunction with relevant university employees. This also takes advantage of centralised marketing and relationship management across industry and presents a more cohesive set of offerings to industry (important when developing a stream of work which might straddle many different areas of expertise).

## 6.5. Partnership with Manufacturing Advisory Service (MAS)

This plan was evolved after consultation with the head of the South West branch of the Manufacturing Advisory Service (SWMAS). The plan was investigated though the following 5 questions:

### *6.5.1. How is the advisory service rated?*

Four key metrics were suggested:

- Business assists.
- Impact/Gross value added.
- Knowledge based collaborations.
- Environmental goods and services.

Of these four it was suggested that collaboration with the University would improve the knowledge based collaborations which they get awarded for any work with universities. The research group would also hope to add to the Impact and Gross Value Added.

### *6.5.2. What can the advisory service gain from collaboration?*

- "If every project that the university undertook counted towards Knowledge based collaborations then we could increase our offering to the RDA (Regional Development Agency, a UK-based government funding body who part-subsidise the advisory service to drive improvements to local manufacturing)". If this is the case we may have to avoid double counting.
- Added expertise gained from referral to university.
- The research group may be able to assist the advisory service in moving from business improvement to business development.
- The advisory service would benefit from the prestige of the university and research group.

### *6.5.3. Which cases are suitable for referral to the research group?*

- If the task or problem is outside of the expertise of advisory service.
- MAS are limited in the duration of projects they may undertake. An agreement with the university would allow the research group to assume responsibility for longer-term projects.
- When it's more valuable for the client to work with the research group then the advisory service.
- Following on from a lean exercise performed by advisory service to free up some time for the SME, a strategy for the SME's development would probably be performed by 'heavy weight' consultancies. Following this, the implementation phase could be assisted by the University and research group for activities such as detailed design and project management.

### *6.5.4. What are the conditions for the collaboration?*

- All work with SMEs must be logged on the advisory service's client management system. This benefits the advisory service as their working practices are validated by the university. As is the case with much of academia, this also addresses the problem of weak accountability and customer relationship management within the university which has resulted in many successful relationships being lost after completion of a contract.
- Conditions for associate delivery (needs to go through 3rd party procurement system) – The 3rd party (expert in the University) is matched to the expertise needed.
- The research group needs a list of experts to update the advisory service client management system.

### *6.5.5. What would the research group get out of it?*

- First interface with the customer.
- The use of the advisory service name.
- The use of the advisory service pricing structure for clients.
- A workflow model, negotiation mechanism and client management system already in place.

## 7 RECOMENDATION

After evaluating the various implementation plans outlined in the previous section it was decided that the best option would be to work in collaboration with a manufacturing advisory service (outline in section 6.5), exploiting their ready market for expertise.

*"In reality, many academics and industrialists, particularly those working in SMEs, do not have the contacts or the time to identify potential partners for collaboration and it could be useful to consider whether there is a role for Regional Development Agencies (RDAs) or other bodies to assist in this process."* [1]

This recommendation would also be supported by the utilisation of student projects and expertise which could be used for some of the projects requiring more basic engineering support, building on previous proposals [5]. It was thought that this implementation plan would also allow the research group to build as a brand whilst providing effective support to SMEs.

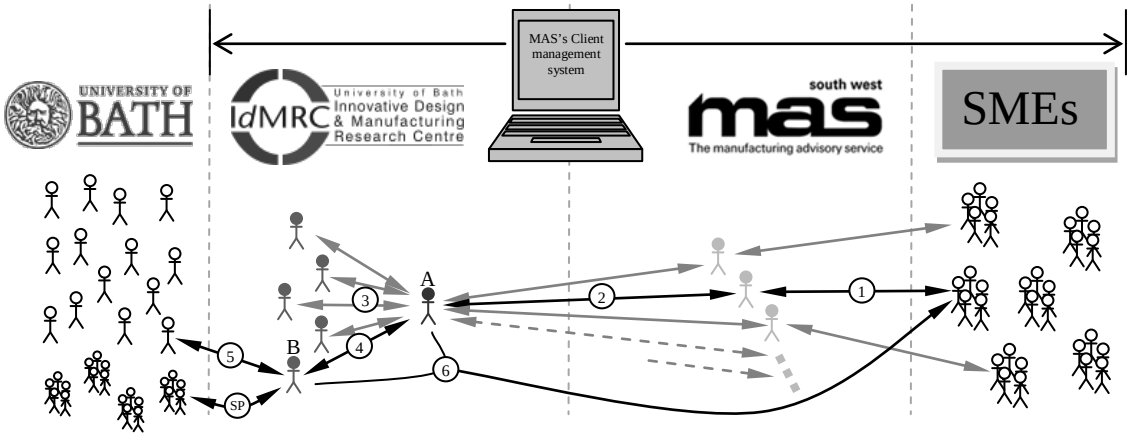


*Figure 1. Implementation plan model*

The SP (student Project) arrow in figure 1 represents the possible involvement of student projects. The circled numbers correspond to the numbered activities listed below:

1. SMEs register into the advisory service's client management system.
2. Suitable projects are referred to a group leader at the research group ('A' figure 2).
3. 'A' puts project work up for bid, to a team of researchers ('B').
4. 'A' will then decide alongside the interested researchers, which of them is most suitable.
5. The project manager will then seek any required expertise from within the university.
6. Agree on a work packages with the SME using the advisory service's pricing.

*"RECCOMENDATION 6.3: RDAs would match fund the contribution by business to collaborative research projects on a sliding scale. For basic and strategic research, RDAs would match the business contribution: for near-market research, the support would be lower."* [3]

These funds contributed by RDAs and the KTA could be used to part fund research projects with the collaborating companies, paid directly to the researchers' accounts or used to reduce the cost of the work for the SME. However, it is highly recommended that the financial support should be used to fund the initial pre-contract scoping work.

## 8 CONCLUSION

This paper describes the needs of SMEs' which could be fulfilled by university research units. It is the recommendation of this research, supported by the Lambert [3] review, that engineering design researchers should play to their strengths and lead this type of K.T. activity, interfacing between the university and the manufacturing, technology and product development industries. Financial support can and should be provided by RDAs and KTAs. The implementation plan proposed is both feasible and beneficial to all parties concerned and would dramatically increase design research's impact on society at a regional level. However, the following three major barriers are yet to be overcome:

### 8.1. Selling Concepts not Solutions

A trial of the recommendation was undertaken where a physics researcher was paid by an SME to work on a lens design problem with a member of the IdMRC. A concept was proposed to the SME

expecting substantial benefits. However, on implementation, undiagnosed problems were experienced. The SME became dissatisfied and reluctant to pay for the skilled efforts despite the agreement that we explicitly offered promising concepts and not solutions. We envisage this to be a difficult model to sell K.T. work to SMEs and must be fully understood before work begins, disclaimers are not enough!

### 8.2. Funding administration

The major barrier facing engineering design research groups from conducting such knowledge transfer proved to be funding and university administration. *"The higher education system in the UK is in general bureaucratic, slow and producer focused… There is a strong case for dragging the governance framework into the 21st century – especially if we are to develop a commercial customer facing culture in our academic institutions."* [3]. It is also in the authors' experiences that this is the case for many institutions particularly across Europe. *"Management and organizational issues can significantly impact on business university collaboration and may actually constitute the major barriers to technology transfer."* [1]

The work conducted during this study added weight to the statements above. Creating short-term contracts for researchers proved as challenging as delivering the K.T. itself. This was partly due to the way in which researchers are funded, often requiring a specific programme of research work to be undertaken. The question left to be answered is: How can research funding/contracts be administered to make use of the flexibility of our researchers, enabling them to react to the needs of industry?

### 8.3. Alignment of goals and motivation

If K.T. and support to SMEs is a desirable activity from design and engineering research groups then research assessment must reflect this. *"Pressure to publish regularly may inhibit academics from entering into collaborations with industry, for example if the collaborative research is unlikely to yield significant publishable data."* [1] *"RAE has encouraged academics to focus on areas where they can publish and has encouraged universities to recruit academics who can publish"* [7]

While this is still the case, the following important question remains for many researchers engaging in K.T. with SMEs: How can we better align our research activities with knowledge transfer projects to get the most value from knowledge transfer work for all parties concerned?

## 9 FINAL NOTE

As design researchers, one thing we must have conviction in is our ability to understand and partake in engineering, technology and product development activities. Our researchers should take a leading role within our universities, guiding academics from all departments into industry to transfer knowledge and deliver guidance to companies who may be our funders of the future. Not only will academia benefit from the real-world testing and validation of their research, it will also become more understanding of the state of this world and of how and where their research could usefully serve it.


## ACKNOWLEDGEMENT

This work was undertaken as part of an EPSRC Knowledge Transfer Account (KTA) grant.


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