

**Partnering of High Technology Small Firms with Universities
In Order to Commercialise ICT Research**

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Abstract

High Technology Small Firms are knowledge wealthy and also knowledge hungry, their research being focused primarily on the commercialisation of technology. Universities knowledge covers a broad spectrum of research, from commercially focused research, normally associated with new Universities, through to 'blue sky research, normally associated with the traditional Universities. This paper explores the opportunities that exist through research partnerships; Universities realise the commercialisation of research developing a commercial focus in research and teaching; whereas the small firm enhances their technology, to incorporate ideas and concepts from a less commercially driven source. ICT is fairly unique, as not only can it be applied to ICT applications, but can enhance other high technology arenas. Due to its broad range of applications and fast rate of change, special means are required to identify and incorporate its use. This paper addresses the issues related to the commercialisation of ICT research from Universities into high technology small firms.

Introduction

The Authors of this paper have been actively involved in working with commercial organisations in order to facilitate the transfer of knowledge from a University environment in to commercial settings. The one author currently works on a European Regional Development Fund project, which engages with West Midlands SMEs, to develop their use of ICT, having previously held similar and strategic roles in the support of ICT SMEs. The other author has overseen over 70 Knowledge Transfer Partnerships; a UK Department of Trade and Industry scheme to facilitate the transfer of University expertise to industry; these schemes typically being of 2 years duration. The authors draw on their experience to demonstrate how high technology firms can successfully engage with universities.

High technology small firms are on the leading edge of technology in terms of their research; as are Universities, but both groups have a different prime emphasis for their research. Small firms are looking to provide solutions to their customers in order to remain profitable and to give the business the ability to grow through new product enhancements and diversification in to related product offerings. In contrast academics within Universities are looking to develop the body of knowledge within their field of research in order to enhance their reputation in their field, with the rewards to the Universities being to gain an enhance reputation for undertaking research and subsequently increased appeal to students, both undergraduate and post-graduate.

The challenge universities are now facing, in the UK's education sector, is how to engage more pro actively with industry, for a more immediate result of enhancing graduate employability through a more commercial focused curriculum; but longer term for the greater gains that can be achieved through partnering with industry, in order to facilitate the transfer of the university's intellectual capital in to commercial realisation, this leading to additional funding for research, enhanced teaching through real-life scenarios to aid learning and a enhanced commercial acumen for the institution.

Normally the commercial / university partnership is defined by the commercial partner having the infrastructure and market in order to commercialise the product and the university providing the intellectual capital from its research activities; the product concept being devised by either partner, or in collaboration. With high technology firms there is a different challenge, as a significant share of the intellectual capital resides within the firm itself; hence a new focus is needed to identify how the intellectual capital can be integrated and shared

between the two organisations. This paper aims to address how the partnership between the University and the commercial partner can be realised in order to optimise the benefits to both parties.

The paper's discussion of universities partnering with high technology firms, leads to the identification of a roadmap to enable the successful commercialisation of ICT research. The paper includes: developing a foundation for the partnership in terms of responsibility and ownership of the intellectual capital, identification of what each party wants to gain from the joint project, the integration of the parties knowledge in to a structured project, the running of a project that can successfully deliver the objectives and how to ensure the project will exist beyond the initial collaboration to enable a long term relationship. Not only does the paper focus on the operational and positive aspects of a joint relationship, but it also identifies the problems that may occur and how they can be mitigated.

ICT in / as High Technology Small Firms

There are many definitions of what types of companies can be classified as high technology small firms and Cordes et al (1999) undertakes a good review of several versions. In each ICT is scantily addressed in Charles et al (1976) it is not even mentioned, although it could be argued that at this stage ICT was still in its infancy. In subsequent definitions it is still has a narrow classification covering such aspects as 'computer and office equipment'; although it could be included in the other categories of 'communications equipment and electronic components as listed in NSB (1993). What is significant of all of these definitions is that ICT is a rapidly changing technology and could still be considered to be in its infancy. As Nordström & Ridderstråle, (2000) identified it has 'a phenomenal rate of change and shows no sign of slowing'.

Keeble et al (1998) wrote that ICT could be classified as high technology and identified that the number of U.K. computer services and software firms had increased by 16,000 (110%) between 1985 and 1993 and these were overwhelmingly smaller firms, to the point where ICT is playing a significant role in high technology small firms. This trend not ceasing with the advent of internet based technologies and more recently mobile computing technologies, with a significant number of the smaller firms worked with by the authors being in these newer technologies.

This paper is primarily focused on high technology small firms that produce ICT as a product or service, but in the modern era where the use of ICT can have a major impact on any business, it is difficult to differentiate between a high technology small firm that classifies itself as one of the other categories of high technology small firms, but has ICT as a major component of its product delivery. Hence this paper classifies a high technology small firm as one that meets the broad Cordes et al (1999) definition as:

"... whether developing or applying new technological knowledge plays an integral role in the competitive strategy of the firm. Using this approach, a firm would be classified as high tech if one of its primary assets was the possession of advanced technological knowledge used to develop new products or processes."

Here we consider that one of its primary assets would be ICT. For example, an organisation may classify itself as aerospace, but employ and retain a significant intellectual capacity in ICT, for example, the one author worked for an aerospace company that employed 150 staff

on a aerospace software development project and was on the leading edge of research in to fly-by-wire / fly-by-light technologies; All of which clearly aligns itself to ICT. In an earlier paper Cordes et al (1986) did have one if its three classifications as '(i) the extent of technology embodied in products and production processes', so there is some support for this argument.

Preparation for Commercialisation in Small Firms

Research has shown that SMEs have very distinct characteristics. On the positive side they are able to adapt quickly in the way they work, decisions can be acted upon quickly; they have close proximity to their markets and significant customer loyalty (Julien, Carrier, and Hebert 1988). This is believed to be due to SMEs operating within niche markets and having good relationships with their clients. Dupont (1986) sees their involvement in very specific markets as increasing their vulnerability, and implies that SMEs therefore have a limited number of products or services. In addition Bergeron and Raymond (1992) believe SMEs suffer from a lack of resources in terms of finance, information and people to develop a thorough understanding and analysis of their environment.

Bergeron and Raymond (1992) stated that the above characteristics affected the use of IT in SMEs, in particular they identified the lack of resources and the dependency on a few key individuals. In addition the companies studied supported the supposition that the potential to use IT is found throughout the whole of a SMEs operations. Here there has been found a potential contrast; where small firms classify themselves as ICT product / service companies they invest significantly (and wisely) in ICT related technologies, but other high technology firms who do not see themselves as primarily ICT related have been found (but not in all cases) to limit their expenditure on ICT related solutions and potentially be 'blinkered' to the opportunities it may offer.

HEI Characteristics / Drivers

Castellenos et al (2004) identifies that intellectual capital is an important part of a universities endowment of intangibles. It is developed to give both direct and indirect benefits to society, whereas small firm research is more focused towards a more commercial benefit. Universities don't on the whole actively manage their R & D capital in a structured manner in order to enable its transfer to industry. Although some authors have presented cases where this commercial focus has been developed within a university environment with Todorovic et al (2005) demonstrating an entrepreneurial approach in his case study and Garrick et al (2004) who advocate a more vocational focus for partnership with industry.

Robertson and Bond (2001) identified various reasons why academics research; including the linkage between research and its contribution to developing the transmission of advanced knowledge, providing a stimulating environment for academics and a global connection that encompasses the link between teaching and research for a department. In addition Castellanos et al (2004) identified the need to accumulate knowledge and develop multi-disciplinary research groups that can solve actual problems and create the acceptance of the university as the organisation that supports them in their relationship with companies, institutions and other bodies in society.

Todorovic et al (2005) found that entrepreneurship could be used to change the culture in order to create greater flexibility, innovation and adaptability within the academic researchers and

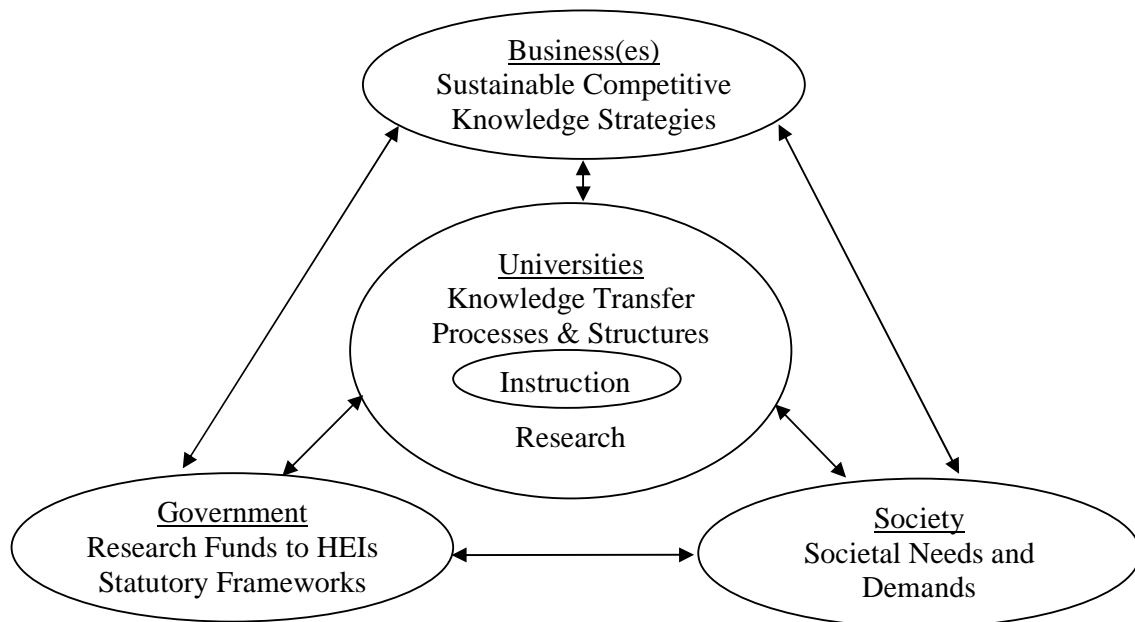
at the organisational level he identified the need to overcome ‘bureaucracy and paucity of interdisciplinary research’.

Jacobson et al (2004) in their research in to the influencers that drove University based researchers to partake in knowledge transfer identified; Funding agencies that emphasised a need to demonstrate the scope for knowledge transfer in the bids from applicants for research grants; The increased pressure on budgets and increased corporation and commodification in society; They also identified the changes in the way Universities operate in order to enable effective knowledge transfer, although this does need a mutual, reciprocal arrangement with the academics. Although they do warn that the focus of Universities doing research for good of society risks being lost in the drive to meet the needs of corporate society.

The Mechanism of Knowledge Transfer

Bower and Christensen (2000) drew attention to the importance of knowledge-based strategies for business regarding the leverage of intellect to achieve competitive advantage. Stevens and Bagby (2001) stated that at the time of writing there were no existing frameworks, theories or empirical evidence that identified the relative payoff to all stakeholders of publicly subsidised university transfer of knowledge to business.

Whilst it is acknowledged that the ‘relative payoff’ can be difficult to assess, once the transfer process has been identified, attributes and deliverables can be assigned emphasising the transitional characteristics acquired by corporate partners.



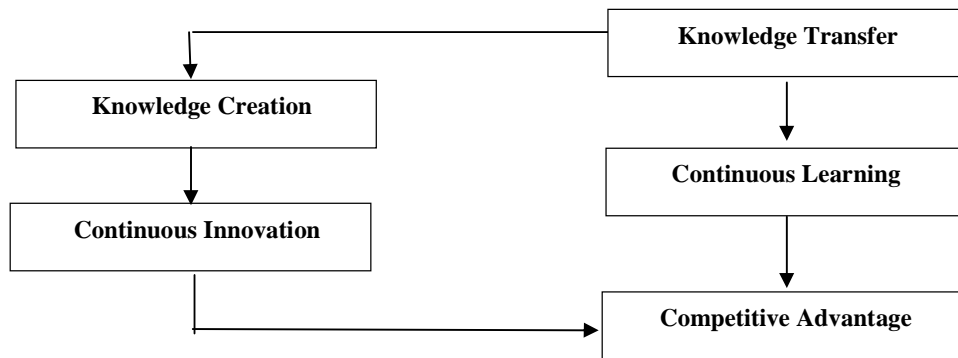
Interdependence between business, government, society, and universities in knowledge transfer processes (Stevens and Bagby 2001)

As indicated in the figure above, the government apportions funding to universities for the generation of knowledge that can then be disseminated back into society via a cascading process. University generated knowledge is traditionally conveyed to business through co-operational platforms such as patents, intellectual property rights (IPR) contracts, spin-outs and joint venture initiatives with the originators.

“...in the role of knowledge transfer to business, universities have become critical upstream suppliers of vital resource” Stevens and Bagby (2001)

Competitive advantage through Intellectual Capital

It can be argued that intellectual capital can only be truly commercialised through the realisation of competitive advantage. Nonaka (1994) argues that for an organisation to develop competitive advantage based on intellectual capital, they need to move through three stages (see figure below): This suggests that there are a number of phases involved in developing an organisation’s intellectual capital: individual learning to develop localised knowledge, tacit knowledge transfer to disseminate knowledge across the organisation and organisational learning to embed the new knowledge into the organisation’s procedures and unconscious actions, thus developing competitive advantage. This would appear to counter the earlier Stevens and Bagby (2001) claim that at the present time there are no existing frameworks, theories or empirical evidence that identifies the relative payoff.



Conceptual Framework (Nonaka, 1994)

“It is not sufficient for a firm to access useful knowledge. It has also to organise methods for the internal diffusion of new knowledge, to ensure that knowledge which is received from external sources is communicated and utilised effectively throughout the organisation.” Jones (2003)

Therefore, it will be necessary to offer further explanation into the three stages as mentioned above. A clarification into their collaborative interaction should illustrate their roles within knowledge transfer activity.

Organisational learning

Knowledge transfer has been demonstrated to be a major determinant in the survival or demise of the small firm. It is therefore clearly important to consider the activities of businesses (SME’s) in relation to learning and skills development facilitated through the collaboration with Universities. If the tacit knowledge held within organisations is to be maximised, businesses (SME’s) need to be persuaded to invest in their people. Academic theory, as previously stated, contends that true competitive advantage can only be achieved by exploiting the intellectual capital, and knowledge, contained within an organisation.

“The main, producers of wealth are information and knowledge” Mullins (2002) clearly adds weight to the argument, yet fails to take into account the importance of an appropriate culture to act as the enabler.

Barriers to Knowledge Transfer

The ability to transfer knowledge quickly and effectively has been identified as one of the key attributes of a learning organisation. Others include the creation of a problem seeking and solving culture. A learning organisation is described as using these attributes, whereby individuals are encouraged to share knowledge in order for the organisation to learn as a whole. It has been proven that, without a culture of collaboration and co-operation being in existence, knowledge transfer cannot be achieved. Goh and Richards (1997). This suggests that organisational culture is of equal, if not more, importance than the actual knowledge to be transferred.

It is often stressed that many businesses, SME's in particular, appear to be failing to fully exploit the information, knowledge, and skills in the knowledge-base embodied in universities Iles and Yolles (2002). The knowledge retained within universities is getting increasingly more difficult to develop in a commercial setting due to its complex legal, financial and administrative nature. Ever expanding management systems are being deployed in order to identify, co-ordinate and administer the process.

It has been found that working with academic holders of knowledge they traditionally impart research findings to other like-minded individuals by delivering a 'paper' through an appropriate forum such as a conference. There is a small core of academics who undertake commercial activity but the imparting of this knowledge in to the traditional academic arena is often less prolific, this is believed to being down to factors such as the amount of time that commercial research takes up and its commercial focus pressure that can impact a chosen research and teaching activities; and intellectual protection aspects of the work, which impedes the release of the knowledge via the traditional academic channels.

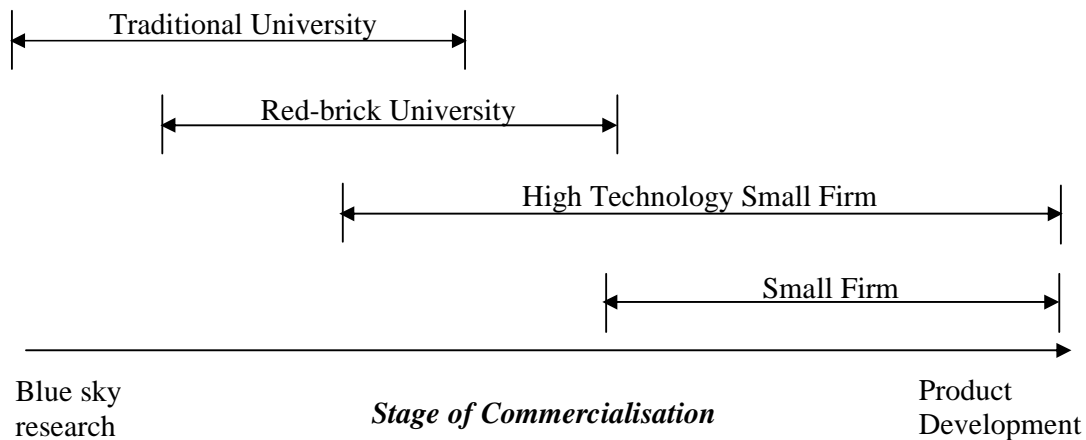
A key aspect Merton (1973) identified inhibiting the relationship between academics specifically and Industry are secrecy agreements that prevented academics from publishing, releasing or discussing their research results thus hampering the ability to enhance their academic reputation and use their research work in teaching. This can also impact the University as a whole in its use of intellectual property and confidentiality agreements, as once there are controls over the use of knowledge for a particular application it then makes it much more difficult to use in a related field. This impacts ICT being used for the subsequent use of a technology or technique, where it has already been used in an alternative high technology sector and constraints have been put on its use.

Normally these controls are for a set time period, but due to the fast moving nature of ICT even a short delay can have an a major impact on the currency of the research. For general high technology partnering Blumenthal et al (1996) identify a limit on publication of no more than two months, although they did find corporate sponsors putting on controls of over six months. With the competitive nature, fast exchange of ideas and quick implementation of alternative solutions even the shortest of these delays are excessive.

This view is supported by the findings of Harman (2002) who cites the dangers of university – industry research partnerships 'compromising academic freedom and impeding the free

flow of research information'. What has not been found in the ICT related partnerships, is issues related to the research being compromised by conflict of interests and commercial pressures as identified by Weissman (2001) and cited in Harman et al (2002), it is believed this is due to the more open network of sharing of knowledge, enabled by factors such as the internet and the faster pace of technology being commercialised, both these leading to less pressure on secrecy and a greater focus on intellectual protection of application rather than technology. Although Harman (2002) in summary on the risks of University-industry research links does state that the benefits clearly outweighs the dangers, as has been found in the vast majority of cases of collaborative ventures in which the authors have engaged.

More specifically related to ICT related partnerships the greatest concern has been the intellectual property issues, as discussed in greater depth later. In terms of the focus on commercial activities the authors' host University is a 'red-brick' University where the focus of research is often considered to be more commercially focused rather than 'blue-sky' research; hence the difference between the commercialisation realisation of the academic research and the needs of the small firm's application is smaller. This differentiation being even smaller if not non-existent between the high technology ICT related small firm and the academic research. Here the focus is on matching the technology knowledge of both parties rather than bridging the gap between the academic and high technology small firm's research.



Organisations and the Types of Research Undertaken

If we consider the diagram above, we can consider that in terms of research we have an overlap between University and high technology small firms research this is where the collaborative set of working is being focused at, but in addition there may be opportunities to extend the research in to more advanced research that can assist the small firm to further enhance its product offerings.

The motivations to acquire research range from peer group acceptance and pure academic achievement, to further exploration within an area that holds a particular interest. Commercial opportunities very rarely play any part in the thought process. Due to the ICT arena being fast moving it has been found that the latest trends in ICT are very quickly commercialised. This means that the academic research is very much at the point of being commercialised; hence the barriers to partnership are reduced, it also gives benefits to academics as it can quickly

give a set of commercial case studies to feed in to teaching; hence commercial application of technology is more significant to the academic approach.

Acceptance of commercialisation and collaborative possibilities can be an insurmountable barrier to the release of knowledge. It is only through the provision of on-going internal development that mind-sets can be broadened to encompass commercial knowledge transfer alliances. Internal constraints found within the knowledge bases (Universities, in this context) still represent by far the greatest challenge to the effective transfer of knowledge via the collaboration with a commercially orientated partner.

Benefits of University–Industry Research Links

The emphasis that has been put on Universities, both internally through commercial pressures and externally through government policy, to develop their links with industry has produced impressive results as Harman and Sherwell (2002) described the benefits including a greater involvement in R & D by academics, greater financial resources for Universities and financial and career opportunities for PhD students and most importantly a significant expansion in technology transfer and a focus on commercialisation of research. In addition it has been found that there are greater career opportunities for undergraduate students, particularly as there is an emphasis on vocational sandwich years. With this increased relationship with industry there is a more relevance to the curriculum being taught and a more real-life emphasis for the material that is taught to students. Specifically Harman and Sherwell (2002) identified that

“Universities have benefited from access to important technical know-how while industries have benefited from accessing the results of basic research and facilities to conduct research.”

Hendry et al (2000) identified the key reasons why SMEs in the High Technology sector should engage with Universities:

“The three key reasons for doing so are informal engagement with experts with relevant scientific and engineering knowledge, recruitment of scientific and engineering personnel, and collaborative research on both product and process improvement.”

Universities being well placed to deliver in each of these areas through academic research, post-graduate researchers and graduating students.

The key to developing the relationship between the University and High Technology Small Firm is to match the societal focus of the HEIs research as identified by Castellenos et al (2004) to the commercial focus of the High Technology Small Firm, where research has to be very focused towards financial returns as financial constraints place a significant burden on the growth of high technology small firms as identified by Westhead and Storey (1997).

Siegel, Waldman and Link (1999) as cited in Hall et al (2001) identified the most significant barrier to industry / University technology transfer as the lack of understanding on both parties to each others norms and environments of working.

An initial trepidation may be found in the development of this relationship as industry has been found through practical experience to identify academics with being boffins and unable

to realise blue-sky thinking in to commercial solutions. In practice after an initial period of settling in, it has been found that both parties can develop a mutually beneficial relationship from which both parties drivers can meet. An example of this has been a company that has developed over a 6 year relationship a doubling in the staffing levels of the business to over 400 staff, a whole new business area and enhancements of its traditional offerings. The business was seen as a leader in its delivery of its services.

In their study on technology intensive small firms and partnering, Varis et al (2004) found that these firms are looking for resource alignment in partners that can complement their weak sides whilst helping to leverage the strong sides in the technological capabilities and resources. This offering both opportunities and cautions for the University partner, on the one hand it will give scope to match the University's capabilities to meet the firms, but on the other hand, it means the emphasis of research will be placed on the University; hence ownership of Intellectual Property will need to be shared appropriately. As a cautionary note Das and Teng (2000) identify that there is a need for the resources to be dissimilar and complimentary in the partnership, otherwise they will be wasteful.

Intellectual Property

One of the key issues that affect a high technology small firm from developing a relationship between a University and an SME is the protection of Intellectual property and protecting proprietary knowledge Hendry et al (2000). Hall et al (2000) identified that intellectual property issues between firms and universities do exist and they can in some cases provide insurmountable barriers to achieving the sought after research barrier. In practice negotiations for major research contracts have been found to hinge around ownership of intellectual property, where it can be a barrier in finalising contracts. In other cases high technology small firms have developed products for which they own the intellectual property and the University has the knowledge to enhance the product through innovative technologies. Here there is the need to divide the intellectual property in to two clear categories. The application of the technology into a specific product for which the firm maintains ownership and the technology for which the university maintains the ownership. This protects the firm from the university working with competitors, who could compete in the application area of the technology; whilst enabling the university to work with firms who can exploit the technology in unrelated applications, outside the scope of the original firms patent.

Hall et al (2000) gives clear outlines as to how the objectives of industry and universities regarding intellectual property differ, with these conflicting objectives causing the partnership to fail, or even not start. Drawing on the work of Brainard (1999),

“The goal of business and universities in producing and protecting intellectual property is innovation for the protection of revenue. Beyond this ultimate shared goal, the interests of universities and business diverge. Universities value intellectual property not only as a revenue-producing resource, but also as a tool in the advancement and dissemination of knowledge. These divergent interests can result in conflicts...”

With high technology small firms this is more complex, as both parties posses intellectual capital on the technology being developed. Intellectual property rights need to reflect this, giving both parties the flexibility to do unrelated development work without infringing the original patent. Transparent negotiation to scope each parties access and use of the intellectual property is required, with the use of intellectual property specialists being

recommended. A good intellectual property agreement will aid in the natural expansion of the intellectual property through the collaboration.

High technology small firms also have the characteristic of often having been specialists who have moved out of larger firms; hence they are either likely to have limited knowledge of intellectual protection, or in the converse to be very protective of their intellectual property, as they may have had to go through legal proceedings to wrest the intellectual property from their previous employers who may have laid claim to it. Small firms are consequently very cautious and protective of their intellectual property, having had 'their fingers burnt before'.

Hall et al (2000) found that where previous experience has occurred, of working on joint partnerships between universities and firms, where intellectual property has been involved, there is less likely to be insurmountable barriers to the agreement of intellectual property; as both parties will be aware of the difficulties that may occur. In addition, they identify where there is a lower desire to make intellectual property public, for say as part of academic papers, and where there is less certainty over the intellectual property characteristics of the research, the barriers to intellectual property agreements are less.

Running the Project

Typically project teams follow Tuckman's (1965) stages of forming and hence the first few months are critical in developing a performing working relationship. Academic partners are familiarising themselves with the commercial focus of research; whereas the firm is looking for immediate results. These initial stages can be facilitated by i. defining clear guidelines of the work to be undertaken and the expected outcomes with their commercial and academic benefits. ii. short term projects can give a focus for the relationship to gain quick wins and reassure parties of the benefits of collaborative working. Ideally these are part of the main research. iii. close collaboration between academic and commercial staff should be planned, e.g. regular meetings and facilities where staff can come together and work.

Todorovic et al (2005) identifies the need for the university to have the right people involved to develop entrepreneurship. It has to modify its structure so the organisational culture moves to the outcome of innovation. The staff being involved requiring a significant tolerance to risk.

In order to facilitate the University-Industry partnership in terms of ICT Nordstrom & Riddersdale (2000) gives a general overview of managing stating it cannot be managed through traditional academics or through financially focused MBA graduates; It needs a virtual community where knowledge flows are empowered and minds and strategic visions are aligned.

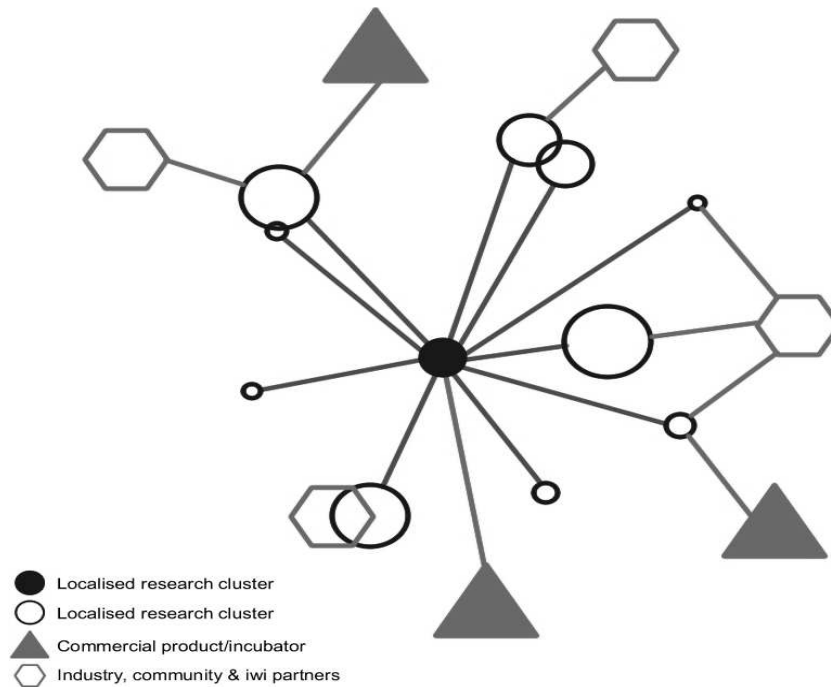
Williamson and Mann (2002) more specifically describe the CITRUS model, which was implemented for the ICT community of New Zealand in order to develop the relationship between university and industry, they describe it as

"..Research projects could be in-house or with industry partners but will always be focused on adding real economic and social value into the regional economies with particular focus on the SME sector."

They also identify the problem that what is cutting edge one year, is common practice the next year and outdated shortly afterwards; hence the model needs to be flexible and responsive to change.

In order to implement this they looked to create:

“..incubation and business development models and by building relationships with key business development organisations nationally and regionally.”



The CITRUS Model: Hub, clusters and partners (Williamson and Mann 2002)

The University of Wolverhampton model for developing University-industry relationships consists of a central department (BDE) which provides general project support, in terms of ICT related activities, this department provides specialist non-technical advice in areas such as grant applications and legal aspects e.g. intellectual property. This allowing the academic focus to concentrate on delivering the technical aspects of a project in order to meet the needs of stakeholders:

One of the key focuses the University adopts to ‘pump prime’ collaborative working is to obtain public sector funding to provide grants to assist SMEs in getting started in the creation of research capital through the partnership with academic researchers. This has provided both a caveat to encourage SMEs to engage with industry through free assistance and grant assistance towards the cost of research. This provides funds to free the academic from his normal duties in order to provide support to industry partners, as well as enabling the employment of staff to implement the research outcomes e.g. programmers and technical support staff.

Support mechanisms are put in place to identify and obtain funding to enable the commercialisation of ICT, as well as providing specialist staff in issues such as financial controls, intellectual property and application for grant funding. Thus helping to ensure the requirements of funding bodies are met and that agreements made with SMEs are appropriate to protect both parties. In issues such as intellectual property the focus is aiming to reassure the SMEs, thus helping to maintain a longer term relationship.

A structured quality manual within BDE incorporates a Service Level Agreement with all Schools detailing the scope of their involvement. This includes help in compiling the application; organising board meetings; undertaking the full recruitment drive etc... The rest of the manual details the operational parameters enabling 'new' members of staff access to information, should they require it.

Identification and targeting of potential partnership organisations is done through both the centralised department and school. Schemes that initially offer free assistance are used to primarily provide a beneficial outcome to the firm supported, but also make the industrial partner aware of the much greater potential that is available from longer term relationships. Once a longer term relationship is developed there is a continual focus on not only the current research / knowledge transfer that is being undertaken but also what is the latest technology that the parties can embrace in order to enhance the product; subsequently maintaining the working relationship.

Encouraging academics to engage with industry has proven to be a slow process; it has been seeded by a few academics that are confident about undertaking an industrial focused way of working. When academics hear about what their industrially focused colleagues are undertaking they are interested in engaging, but lack the support to engage. Thus mechanisms are needed to support academics in developing these relationships and freeing up their time to undertake industry related work. Currently these are informally done, although it is believed a more structured approach could be used.

Funded methods for collaboration include i. the Knowledge Transfer Partnership where a high calibre graduate is employed to undertake a major strategic project over two years. ii. European funded projects that can provide 5 days free assistance and development facilities, the problem here is the limited amount of research that can be done in 5 days. iii. Spinner project that enable the partnering with academic expertise to spin out expertise in to new companies, in relation to ICT there is a need to act quickly in order to overcome the problems of the rapidly moving market.

The key to this collaboration is public sector funding, but the project and methods of working are starting to develop links that are fully funded joint ventures, these being in their infancy stages and primarily consist of consultancy and post-graduate projects. The longer term relationships have also increased the number of opportunities for working with industry and subsequently increased the academic engagement. In 2000, within the School of Computing and IT, there were approximately 3% of academics actively involved in industrial partnerships, whereas now the figure is closer to 20%.

Conclusion

High technology small firms and University partnerships are different to normal research partnerships in that both parties provide intellectual capital and the High technology small

firm is likely to consist of experts in their field. This doesn't necessarily mean a more complex project, but it does require a more equitable way of sharing the intellectual property rights, so as to not restrict either party in their future research and its application.

Conflict can exist between the academic focus of developing research in order to enhance academic standings and the industrial partner's commercial focus. In contrast the benefits can far outweigh the negatives, through giving additional research funding, enhancing the commercial focus of teaching and providing research / career opportunities for post graduates. Where projects are suitably structured these negatives can be mitigated.

Various models have been put forward to develop University-Industry relationships. These primarily consisting of two broad aspects; one is developing the academics and industrial partners awareness of the needs of the partners drivers so they can plan and assist each other in meeting them; the other is to put into place support structures that can assist in the financing and management of the non-technical aspects of the project.

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