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**UNIVERSITIES, TECHNOLOGY TRANSFER AND
SPIN-OFF ACTIVITIES
– ACADEMIC ENTREPRENEURSHIP IN
DIFFERENT EUROPEAN REGIONS**

EXECUTIVE SUMMARY

Dylan Jones-Evans
Professor of Entrepreneurship and Small Business Management
Welsh Enterprise Institute
University of Glamorgan Business School
Pontypridd
South Wales
CF37 1DL
United Kingdom

Tel: +44 1443 482547
Fax: +44 1443 482380
E-Mail: DJEVANS2@GLAM.AC.UK

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INTRODUCTION

As the recent Green Paper on Innovation suggests, the European Union must be more effective at placing its technology-base at the service of industrial competitiveness and the needs of the market. In particular, it is recognised that one of the greatest challenges facing European firms is the comparatively limited capacity to convert scientific breakthroughs and technological achievements into industrial and commercial successes. As a result, there is growing awareness of the proactive approach that needs to be undertaken by academic institutions, with a number adopting a direct entrepreneurial role in collaborating with industry. Such activities can include the licensing of patents to industry and the creation of spin-offs that are based on technology developed within university laboratories.

This report presents a summary of research, funded by the European Commission's Targeted Socio-Economic Research Programme, which has examined the process of technology transfer from universities to industry within seven different regions of Europe namely Ireland, Sweden, Portugal, Northern Ireland, Wales, Spain and Finland. At an institutional level, the research examined university policy and practice towards academic entrepreneurship, focusing in particular on the role of the industrial liaison function. It also identified and analysed specific cases of 'good institutional practice' of university initiatives to develop closer links with industry. On an individual level, it has undertaken one of the largest surveys of academics' links with industry, and supported this research by investigating specific cases of academics' entrepreneurial activities (where academic entrepreneurship includes contract research, technical consultancy, patenting and licensing activities, as well as the creation of spin-off firms, by university staff). The research therefore represents one of the most comprehensive studies of academic entrepreneurship undertaken within Europe.

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Dylan Jones-Evans
Project Co-ordinator

BACKGROUND AND OBJECTIVES OF THE PROJECT

- In the medium to long term, sustained competitiveness in the global economy will depend on technological or innovation-based strengths. These include the ability to develop new products, to access successfully new markets, to apply new technology, to incorporate best practice in the management of enterprises and to develop skill levels across the full spectrum of the labour force.
- Universities, in particular, have an important contribution to make in this process. The perception of universities as merely institutions of higher learning may be gradually giving way to the view that they could be important engines of economic growth and development. Research from the US and some parts of Europe has shown that universities can play a variety of roles in developing the local economy. These include the creation and enhancement of employment opportunities, initiating new technology-based firms, technology transfer via consultancy and patenting/licensing, provision of technical facilities for local small firms, and development of entrepreneurial graduates
- Despite this, there is little evidence from previous studies into this area to suggest that there is substantial interaction, within many European regions, between the local science and technology infrastructure and the indigenous technology sector. As a result, there continues to be little co-operation in the exchange and absorption of knowledge between industry and third-level institutions such as universities.
- If the situation does not improve, then the limited capacity of Europe's research and technology base to convert scientific breakthroughs and technological achievements into industrial and commercial success will continue. This is particularly the case on the periphery of Europe, where countries such as Ireland, Spain and Portugal need to have a much broader spectrum of R&D capabilities if they are to successfully exploit technologies in industry.
- This research examined the process of technology transfer from universities to industry within seven different regions of Europe namely Ireland, Sweden, Portugal, Northern Ireland, Wales, Spain and Finland. Through a multi-methodological approach, the study was undertaken in five distinct phases:
 - the previous evidence and factors affecting the development of academic entrepreneurship in seven regions of the European Community
 - a study of university policy and practice towards academic entrepreneurship, focusing specifically on the industrial liaison function
 - the identification and analysis of specific cases of 'good institutional practice' of university initiatives, within each region, to develop closer links with industry
 - a study of academic entrepreneurs in universities in different regions of Europe - this gives a profile of academics in science and engineering departments; the degree to which they are involved in academic entrepreneurship; the type of entrepreneurial activities undertaken; and the influence of personal, occupational and university factors
 - the development of specific cases of academics' entrepreneurial activities (where academic entrepreneurship includes contract research, technical consultancy, patenting and licensing activities, as well as the creation of spin-off firms) by university staff.
- The research examined the growth and development of the phenomenon of 'academic entrepreneurship' not only from the viewpoint of the institution (university), but also from the

viewpoint of the individual (academic). The study focused on developing an understanding of the role of universities in developing innovation and entrepreneurship. In particular, it examined whether universities are undertaking a proactive role in encouraging the growth of academic entrepreneurship. It also discussed the different factors which lead to the success or failure of academic entrepreneurship, taking into account the different clashes that may exist between business and scientific cultures.

THE INDUSTRIAL LIAISON FUNCTION

- There has been a growing amount of research undertaken during the last few years that has attempted to examine the relationship between academia and industry. These studies have failed to discuss, in any real depth, the important role that the industrial liaison office (ILO) or its equivalent function within the university system, can play in the technology transfer process.
- There is, therefore, very little information to suggest that universities, through the ILO, are undertaking a proactive role in bridging the gap between academia and industry and that, at most, industrial liaison offices at higher educational institutions are merely providing marketing services for their parent organisation.
- For example, it has been suggested that the majority of university R&D co-operation with industry is based on direct contact of researchers and their industrial counterparts. Therefore, whilst the ILO function may, in theory, be considered as essential, practice demonstrates that many industrialists tend to bypass these contact points, often because of an unsatisfactory earlier experience with comparable institutions.
- The first part of the research examined the industrial liaison function to compare and contrast the general policies for developing academic entrepreneurship within a sample of universities in a number of European regions and small countries on the periphery - Ireland, Northern Ireland, Sweden, Finland, Wales, Spain and Portugal. The research will therefore illustrate whether there are significant differences and similarities in the approaches undertaken by the university sector in various European regions with regard to bridging the gap between academia and industry.
- The universities studied were chosen to reflect the possible diversity of academic entrepreneurship that may exist within each country. The main method of gathering data during this study was face-to-face semi-structured interviews with individuals representing the industrial liaison function in each university. This focused on the general role and function of the industrial liaison office and how has this changed, direct involvement of the university with industry, the main opportunities and barriers to the development of links between university and industry, and the benefits to the university from industrial links and the perception of industry's assessment of the relationship with universities.
- The research shows that in all of the universities studied, the general mission of the ILO function is broadly similar, namely to devise and increase the links between the university and external organisations. However, the study has indicated that there are a number of different models of organising the industrial liaison function within different regions of Europe. Within countries such as Spain, Portugal and Finland, only the most basic tasks are undertaken by the ILO function, whilst in countries such as Wales and Ireland, where the ILO function is an integral part of the university administrative system, there may be higher level tasks undertaken. However, it is clear that these particular models have not been deliberately chosen as part of a definitive strategy, by the institution, to develop linkages with industrial firms.

Rather, the process has been largely reactive, reflecting current administrative models or, in some cases, being driven by European funding initiatives to work with industry.

- The ILOs undertake a number of functions, which also tend to vary across institutions. Many of these technology transfer functions have been developed reactively rather than proactively as part of a coherent strategic aim of the university to match its particular institutional strengths to the needs of the firms. Whilst there are successful models of a strong ILO structure, particularly in Sweden, there is no guarantee that such a model could be transferred successfully to a rural region or a smaller, less technologically-oriented university, as the local needs for technology transfer differ widely across regions. In addition, the ability (and structure) of institutions to provide technology transfer capabilities to local firms can also vary.
- Given the lack of funding and support for such activities, it is evident that within many institutions, the industrial liaison function is not seen as an important part of the overall administration of many universities. This is despite the ILO function being the primary official route by which links between the academic institution and external organisations are formed. Within some universities, the linkages with industrial firms are driven at the departmental level, often because of an absence of any substantial administrative support by the core. In many instances, this is due to a lack of resources being made available to support the industrial liaison function.
- Internal marketing procedures were also considered to be inadequate in the majority of universities examined. The minimum degree of internal effort towards this process should ensure that the university should be geared towards further integration between the industrial liaison function and academic departments so as to encourage a two-way process of communication. Whilst ILOs need to be informed of academics' specific expertise and requirements, academics must also be aware of the full range of facilities and services offered at their institution to help them in their industry-related activities. One option is for an accreditation system, administered from the Commission, which would deliver the minimum standards for the role of industrial liaison function within European universities.
- Only a small number of the universities were working actively to develop links with local small firms. In Sweden and Finland, most of the funding for industrial research is generated from collaborative research with larger firms. However, the majority of universities also have a strategy of working closely with high technology SMEs. This is quite different to Northern Ireland, Wales and the Republic of Ireland, where technology transfer is undertaken predominantly with larger organisations. In Wales, institutional links tend to be established with larger firms primarily based outside of the region, whilst Irish universities tend to concentrate their activities in serving the branch plants of larger foreign companies. In Northern Ireland, the universities are closely linked with large local firms that tend to provide funding for fundamental high-tech university research. In Spain and Portugal, both large and small firms are seen as potential partners for R&D and industrial collaboration.
- It is not surprising that links such as research funding and sponsorship of chairs, research centres and researchers are to be found in nearly of the universities studied. Such links are the traditional methods by which universities and industrial organisations have become involved in the development of co-operative research and development activities.
- Training partnerships with firms are also present in the majority of universities studied, which reflects the industrial content of many science and engineering courses within these institutions. Indeed, there is very little difference among the regions examined in terms of access to resources and relationship with industry. However, one notable exception is the with regard to the establishment of 'industry clubs' involving organised networking activities as well

as a focus for management activities and support from the university to industry. This practice was most important within Swedish universities than any other country examined.

- The major benefit, perceived by the university, of working with industry was that an increase in collaboration activities would result in greater funding for research from industry. This, in turn, would lead to better teaching and research facilities, as well as access to new ideas, techniques and the development of specific research initiatives within industrial firms. In addition, it was believed that the widening of the scope of academic activities would result in the university being able to make a greater and more relevant contribution to the economic needs of the region.
- It was also felt that closer collaboration with firms gave researchers the opportunity to focus on real-world problems and to broaden the researchers' experience. In particular, close partnership with industry can also add to the quality of research, especially through feedback on the applicability of research results. This is because firms, as customers, play the role of "efficient testing instruments", and can be used to reveal the relevant research areas that are of interest to the industry. These experiences can then be exploited for learning opportunities for students and researchers.
- One of the main barriers in developing increased collaborative links with industry was a lack of internal resources at both an individual and institutional level. On an individual level, academic staff have increasingly less time to both establish and undertake collaborative projects with industry in addition to their teaching and administrative duties for the University. In addition, the continued emphasis on traditional outputs for academic work, such as publications, has meant that collaborative industrial R&D is not valued, except as a source of income.
- Therefore, there is a distinct lack of motivation to undertake applied research or technology development activities related to firms. Indeed, the general lack of academic recognition for commercialisation and rewards for publications, as opposed to patents, was a major barrier in many countries. As a result, many academics have been faced with the dilemma of either publishing their results for short-term revenue and academic recognition or withholding them until they are patented, with the risk of the technology becoming obsolete.
- On an institutional level, it was considered that there was not enough emphasis, especially in terms of internal funding within the university, to sufficiently develop linkages with industry. As stated earlier, it was considered that there was a lack of a proper infrastructure for developing academic-industry collaborative activities, especially in the marketing of research expertise. It was felt that universities were not proactive enough, with not enough promotional activities to ensure businesses' awareness of the expertise available.
- Another finding, which reflects previous research in the area of university-industry links, is the gap of knowledge, by researchers and industrialists, about each other's organisational cultures. These cultural differences are mainly down to a lack of communication by both researchers and industrialists about the advantages (and disadvantages) of collaborative activities.
- It was therefore evident that there was a need to set up guidelines as part of a policy for industry working with a university, with a particular need to increase awareness, and to market the university in a more professional light. Great potential does exist within many countries for increased university-industry collaboration. The reasons why this potential has not been fully realised include a lack of information about these activities, coupled with the fact that such arrangements have never been previously considered by university authorities. This is clearly one area where policy makers can influence further developments by providing more information on the potential benefits of such relationships. For example, one clear benefit for

industry from universities is the provision of highly trained and technologically literate graduates who will become the labour force of scientists, engineers and technicians, and provide the key ingredient for the growth of technologically advanced industrial centres.

- There can also be a gap in the priorities of each partner relative to the research results produced from collaborative projects. Whilst firms require research results either to be patented or, in some cases, to be kept confidential, the career structure of academia, based on published works, requires that the collaborative R&D is placed within a scientific journal. Therefore, links with industry can, in some cases, restrict the free flow of information between academics and institutions. As a result, the impression existed, within both countries, that the lack of academic recognition for commercialisation, and rewards for publications as opposed to patents, was a major barrier. Finally, universities, by their nature as large public-sector organisations, are bureaucratic. As a result, many smaller firms can have problems in dealing with the labyrinthine procedures of the academic institution.
- Universities were not always the problem in developing a collaborative culture with industry. There was an underlying theme, throughout the interviews, that the clash of different cultures was also due, in part, to the attitude of business (especially smaller firms) towards academic institutions. Whilst the universities had an open door policy to co-operate and work with all types of industry, industry's perception was rather dependent on the type of industry and the nature of the link with the university. In particular, the 'ivory tower' stereotype of academics - as inefficient, out of touch with the real world and impractical - was found by the ILOs to exist in many firms. This was especially the case in low technology SMEs, where the owner-managers tended not to have any previous experience of academia. This usually led to a lack of trust in the ability of academics to perform tasks efficiently and to a pre-determined time-schedule.

CASES OF UNIVERSITY GOOD PRACTICE

- Twenty four different 'good practice' initiatives (developed by the university to strengthen academic-industry relationships) were identified. These included innovation networks, campus companies, enterprise training, research contract management, patenting/ licensing support, career and training services, service provision and industrial professorships. Hence they can be regarded as reflecting eight different approaches which will be outlined in this report. In addition, the nature of those initiatives is strongly linked with the national and/or regional institutional context, the profile of the regional economic fabric and the role that individual agency or higher education institutions' (HEI) organisational culture plays in stimulating their emergence and design.
- One of the key factors contributing to the success of the different initiatives examined appears to be the acknowledgement and incorporation of mutually beneficial activities for all partners involved and an awareness of the economy in which they participate. It is important to note that such initiatives have not been developed on an ad-hoc basis. They have been carefully planned to take advantage of the particular strengths of each university, and a system of procedures, programmes, incentives and policies are necessary to form a successful technology transfer mechanism between universities and businesses. As a result, if any single initiative is to succeed, it must fully acknowledge the economic implications for all parties and the kinds of approaches that would be most beneficial to all partners in view of their position and role within the economy.
- The keyword for success seems to be 'mutual benefit'. The various university initiatives all illustrate this in practice as they addressed the problem in a different way in relation to their

specific needs, specialisms and resources. This is naturally a practical technique that could be transferred elsewhere, as innovation is evidently the key in responding successfully to a lack of resources (especially within the university sector). This reinforces the creation of a specific policy instrument that will aid universities in determining a strategy towards the development of academic-industry linkages within their locality.

- It is therefore imperative that there is both an awareness of the structure of the local and national economy and of mutually beneficial activities for all partners within any initiative aimed at further developing universities' collaboration with industry. As stated earlier, there can be considerable cultural problems in developing such relationships. However, as some of the cases demonstrate, whilst industry's confidentiality and ownership requirements need to be respected, compromises should be sought wherever possible.
- It can be argued that many successful initiatives require originality if they are to be interesting and attractive to potential participants. Despite this, the study indicates that there are common 'types' of initiative, all of which have been developed independently of each other. Many of these initiatives could have learnt from each other's development - for example, campus companies development programmes usually have very much the same content, although the context is adjusted to local or regional circumstances. A membership organisation of ILOs could be one policy instrument in ensuring that universities can learn from each other's initiatives.
- The research suggests that on the whole, policy-makers at European and national levels have tended not to focus on developing mechanisms or instruments to strengthen the links between academic institutions and other actors in the innovation system, leaving much of the activity to individual universities. As a result, there has been a considerable 're-inventing of the wheel' in the development of various initiatives by universities working independently of each other. Therefore, 'good practice' of technology transfer initiatives should be disseminated to other institutions.
- The various university initiatives examined during this stage of the research also reveal a diversity of mechanisms to reinforce linkages with industry. As the results have shown, these can be grouped according to the different types of initiative developed. Although not possible during this research project, further research needs to be undertaken to examine the characteristics of each type of technology transfer mechanisms, and concentrating on similarities and differences in each scheme. This may lead to a 'good practice' guide for each particular type of initiative, especially if this is based on case study material from different institutional settings. However, the institutional (as well as regional) context needs to be taken into account when developing a new initiative.
- The detailed analysis suggests that three main 'customer groups' can be identified in relation to developing closer academic-industry links, namely students and graduates (training/career services; graduate enterprise programmes); academics (campus companies, entrepreneurship training, patenting/licensing), and firms (firm birth, networking and technology transfer, research contract service provision and training). Two of these markets - students/graduates and academics - are essentially internal. As a result, these are probably the types of initiative that many universities would be most comfortable in establishing, assuming that some of the barriers to technology transfer, as discussed earlier, are overcome. The third market - industrial firms - is probably where the university can have the most problems in developing different initiatives, mainly due to the clash in institutional and organisational cultures which exists. This could indicate that the industrial liaison function within the university sector should concentrate on the two 'markets' with which it has direct contact.

- Liaison activities with firms should be left to an external organisation that acts as a true bridge between the two institutions. However, given the plethora of such organisations already in existence, then this could lead to further confusion among potential customers for university services. Indeed, as the Action Plan for Innovation points out, businesses, particularly smaller firms, often get lost amongst the plethora of support services which have burgeoned at local, regional, national and Community level.
- Given their reluctance to become involved with the university sector for other reasons, the emergence of another support organisation may add to the confusion. However, if such an organisation was operated on a regional basis (and within a regional innovation strategy), acting as the 'liaison-animateur' for all universities, then such an organisation may be possible.
- Another option would be for the universities to form closer links with Business Innovation Centres (BICs) which have been shown to be a successful vehicle for technology transfer in Europe - the study shows that this approach has been very successful in Dublin. Therefore, collaboration between universities and enterprise support organisations may be a strategy for future development, particularly within smaller countries.
- SMEs are an important characteristic of the economy and universities in all regions in the study have acknowledged this fact through the development of initiatives to support technology transfer to this sector. However, it is clear that this kind of effort requires considerable resources from both partners - the university and the small firm.
- This is another area where the European Commission could make a direct policy intervention - by making finance available to support interaction between local small firms and academia (without the concept of subsidiarity applying as it does for numerous European Framework IV programmes). It is imperative that universities develop links with local firms first, before attracting international SMEs to any future research project.
- While the cases examined can be grouped according to function and market, the diversity encountered in this study actually reveals a deliberate effort to adapt to both structural and regional circumstances. In particular, the nature of initiatives examined is affected by differences existing in national and regional institutional contexts, namely in what concerns either the role of central, regional and local government or the role of the private sector. Therefore, the diversity stemming from both different target groups and the need to adapt to structural and conjunctural circumstances leads to the conclusion that the European Commission should define strategic objectives and guidelines for academic-industry linkages, but the design of policy should be left to either regional bodies or the universities themselves.

A SURVEY OF ACADEMIC ENTREPRENEURSHIP

- Whilst the first part of the project has examined the infrastructure reforms and institutional innovations that promote a culture of entrepreneurship within the institution, the other major part of the work is to discuss the role of the individual academic and the different types of entrepreneurial activities s/he can undertake to develop linkages with industry. These activities include not only the creation of spin-off firms, but also large scale science projects, contracted research, consulting, patenting/licensing, external teaching, sales and testing. Such activities are outside the two main duties of academics, which are recognised by educational establishments in many countries as being teaching and personal research.

- A questionnaire survey was administered during 1997 to all researchers and teachers at the faculties of Science, Engineering and Medicine in three regions in each country. A total of 4,672 respondents answered the questionnaires giving a response rate of 38%. This questionnaire examined the background of the respondents on an aggregated level such as dispersion between countries, sex, age, job classification, academic qualifications and previous employment outside the university sector. It also discussed issues such as direct contact with industry and the kind of academic entrepreneurship activities being pursued in the universities. In addition, the support of the university environment towards industry collaboration is of particular interest as well as the academics' attitudes about the industrial liaison services.
- Overall, 77% of the respondents are male, although this may reflect the faculties targeted for the study - Science, Engineering and Medicine. The age of the average respondent is 41 years old, which is higher than the average age of other entrepreneurial types (usually mid 30s). This is to be expected, given the additional postgraduate work. In terms of academic job classifications, approximately a quarter are lecturer/senior lecturers, with about a third working as research assistants/fellows, and 17% having a professorial appointment. In terms of the highest academic degree achieved, it is not surprising to find that the majority of the academics are Ph.Ds. The second largest category is postgraduates followed by a small number of graduates. In terms of previous industrial experience, half of all respondents have been employed, prior to their academic appointment, in a full-time position outside the university, most commonly in the public sector.
- Much of the early research examining entrepreneurial behaviour has indicated that owner-managers tended to have fathers who were themselves entrepreneurs, and that this was a major factor in influencing the decision to establish a new venture. Despite this, it is still surprising to find that overall, 56% of the respondents have had some kind of previous small business or entrepreneurial experience. Such a large degree of previous entrepreneurial experience has not been noted in other studies. In terms of the type of prior entrepreneurial experience, there were almost as many of the respondents who had worked in a small business - 35% - as those with immediate family members who are owner-managers. However, the most surprising finding is that 18% of all the academics questioned having either started or owned their own business. Whilst it is probable that many of these businesses are 'convenience' consultancy firms for channelling external income earned through various activities, they do, nevertheless, constitute an act of organisational creation. This was a completely unexpected finding.
- The study also demonstrates that previous employment outside the university sector or previous small business experience has a positive effect on the likelihood of academics engaging in contact with industry. This is not surprising, as it would be expected that academics with previous industrial experience would utilising industry contacts made during their employment or, in some cases, be given contract work directly by their previous organisation. Previous small business experience would also encourage academics to become entrepreneurial, especially outside of normal duties such as teaching and research. This finding suggests that experience of industry is highly important in developing linkages with firms.
- Approximately 70% of the respondents have had some type of contact with industry during the last five years, with nearly a third of those questioned concentrating solely on either their teaching or basic research activities. The study shows that in terms of initiating contacts with industry, universities tended to be slightly more reactive (than proactive) to the needs of industry. While this may suggest a demand-led technology transfer system, it is also probable that there is a distinct lack of marketing, by universities, of the services they can offer, as academic institutions, to industry. However, this figure is still quite high for a sector that has been accused of being passive in forming linkages with industrial partners

- Overall, 70% of the respondents are involved in academic entrepreneurship activities. The main types of activities undertaken by academics were (in order of popularity) contract research, consulting, large-scale science projects and external teaching. The less popular activities were those of testing, patenting/licensing, spin-offs and sales. The fact that consultancy and contract research are the most popular form of activities is not surprising, as both have been recognised as effective means of linking universities with industry. However, it is surprising, given the importance that policy-makers place on patenting and spin-off developing, that the incidence of these activities in both countries is relatively low.
- In terms of general policy implications, this is probably one of the most interesting findings of the survey. Consultancy and contract research activity have been identified as the type of entrepreneurial activity, which can, if the right mechanisms are in place, lead to a technology-based spin-off being established. However, given the low degree of spin-off incidence in this study, it would seem that the programmes and support might not be in place in sufficient quantity for this to occur.
- On the other hand, many academics may be satisfied with undertaking 'low-level' activities such as consultancy to gain extra income without the trials and tribulations of starting a new business. Obviously, it is in the interest of both the academic institutions and industrial partners to determine which activities can be further developed within their own institutional and regional setting. More importantly, they need to determine whether the support mechanisms in place will encourage or hold back certain types of entrepreneurial activities. Given that most of the support mechanisms at a European and national level encourage the establishment of spin-off firms there needs to be a thorough understanding of the activities which academics wish to become involved with prior to moving to organisational development.
- The majority of academic entrepreneurship activities tend to be undertaken by professorial or senior lecturing staff with a Ph.D. This is not surprising as senior academics with a higher degree should be individuals with more experience, influence and position where it is easier to attract resources for undertaking external activities. It is also worth noting that building up a personal network (which is important for all kinds of contacts and collaboration) can take a number of years. However, institutions should consider whether younger staff members could become increasingly involved in entrepreneurial activities as part of their training process.
- About half of the respondents considered their university environment supportive for academic entrepreneurship, with only one in ten stating that the environment is a direct hindrance for such activities. The high proportion of academics - 40% - describing their university environment as having no effect, despite the existence of an industrial liaison function at each institution, is particularly surprising.
- Therefore, whilst half of the respondents considered their university environment to be supportive, the remainder consider themselves not supported at all in their entrepreneurial activities. This is unexpected, considering the present climate described earlier with institutions actively developing linkages with industry through proactive technology transfer initiatives. Another interesting result is that the respondents from Sweden were most negative towards the university environment. This is despite the fact that it is the one country in the study where linkages between universities and industry are well developed.
- Whilst 65% of the respondents were aware of the ILO function, only a small number actually utilised the ILO in developing external links. This suggests that many academics are bypassing the industrial liaison function within the university and dealing directly with the industrial firms themselves. This calls into question the actual role of the ILO within the university. If

academics and university departments are most comfortable in working directly with industry, then the industrial liaison function should be left merely as an administrative position to deal with issues such as contract management and information on European programmes.

- The use of their university's industrial liaison function has a direct influence on academics' perceptions regarding the supportiveness of their university environment towards academic entrepreneurship. This finding is particularly interesting because it enables an informed evaluation to be made as to respondents' opinions about their university environment by considering the opinions of only those who have used their ILO in developing external linkages. This suggests, as other parts of the study have indicated, that whilst the services offered by the ILO function may be relevant to developing technology transfer linkages with industry, there needs to be a greater awareness, through internal marketing, of the role of the ILO in facilitating such relationships.
- This result is of varying importance to different countries. For example, in Finland and Sweden, the contacts between academics and the ILO are very rare, with very few of respondent group using the ILO services. On the other hand, in Spain and Northern Ireland, where many respondents have used the ILO services, the result is more relevant. As a result, the ILO could be increasingly utilised as a catalyst for developing a more positive university culture towards academic entrepreneurship.
- Given the more sophisticated level of policies and mechanisms to support university-industry links within Sweden, it was an unexpected to discover that Irish, Welsh and, to some extent, Spanish, academics (with a relatively less-developed system of support) had a similar, if not higher, involvement in significant entrepreneurial activities such as contract research, large scale science projects and consultancy. However, it is clear that the Swedish system does support the creation of spin-off more successfully than any of the other countries in the study. Therefore, if spin-offs are to be encouraged, then the relative success of Sweden in generating such organisations may generate models of 'good practice' of such business development, as other parts of the research has demonstrated.
- The implications of the increasing pressures to institutionalise entrepreneurship (especially informal activities such as consultancy) within the university environment may actually result in a decrease in these activities. This may be particularly the case within economies such as Ireland, where universities have tended to exert little control over university-industry links and, as a result, entrepreneurial activities have developed naturally as a result of the needs of both the individual academic and the industrial firms.
- Therefore, whilst academic entrepreneurship in Sweden has been encouraged as a result of 'top-down' strategies through institutional reforms and initiatives, the Irish approach has been one of 'laissez-faire'. As a result, academics have been allowed to develop their own initiatives relative to their own interests. However, it is worth noting that both countries have a high degree of academic entrepreneurship, and the differences observed may be due to cultural, as well as economic, differences.

CASES OF ACADEMIC ENTREPRENEURSHIP

- The final part of the research study was to build on the quantitative data presented in the previous section and present examples of good practice of academic entrepreneurship activities. Thirty-seven examples from six different countries were selected to illustrate a diversity of forms of university-industry interaction. These would highlight individual

initiatives to develop academic entrepreneurship, rather than institutional programmes. The cases would be based on the different types of entrepreneurial activities identified earlier in the study - large scale science projects, contracted research, consulting, patenting/licensing, spin-offs, external teaching, testing and sales.

- Analysis of the cases has found that one of the most important factors in the success of any academic entrepreneurial activity in any of the universities studied is the presence of motivated and driven academics. The presence of successful academic entrepreneurs can often overcome many of the internal obstacles in developing links with industry. The development of the initiative can also be helped enormously by supportive colleagues and a supportive department, which can allow individual academics to overcome any resistance from within the university.
- The attitude of the academic towards external organisations can also be an important factor in building linkages with industry. As the previous research has indicated, many firms are often reluctant to approach the university sector for solutions to technical problems. However, the correct approach by the individual academic can convince the firm to work with the university department.
- More importantly, the success of such individuals' endeavour could be utilised in increasing the links with industry within the university. The presence of such successful 'role-models' of entrepreneurial success can be used by the institution to encourage other academics to develop academic entrepreneurship activities. This should be undertaken by the ILO as part of an overall internal marketing process to encourage academic-industry links.
- As stated earlier, the benefits of industrial research to the academic can be additional funding for new equipment and other research resources. However, the cases also clearly demonstrate that entrepreneurial activities can result in a significant degree of personal gain for those individuals involved. However, it is clear that this is not universal across all cases. Whilst the attainment of commercialisation of ideas is often sufficient, the energy and effort expended by the academic entrepreneur in the creation of the new venture needs to be appropriately rewarded.
- As entrepreneurship is a relatively new phenomenon within the academic sector, many universities have yet to develop a reward system that is adequate in terms of pay and promotion. In many cases, the traditional reward within a university structure - promotion - is often not sufficient, as the motivation behind the development of the idea is often not career advancement. More importantly, entrepreneurs seldom make good academic managers, as they rarely have the temperament for coping with the university structure. One option for universities, therefore, may be to reward entrepreneurial academics through giving them a position of freedom within the organisation to develop new ideas, or even setting up the academic in a separate venture.
- Entrepreneurship can only be developed within an organisation by creating the right climate for such individuals to flourish. However, the evidence from this study indicates that, in general, the majority of the academics do not utilise the industrial liaison function within the university. Instead, they form a direct relationship with industry, with the university having little or no influence in setting-up contracts or in finding new potential clients. As a result, the gradual build up of trust between academics and industrial partners, based on the achievement of tangible mutual benefits seems to be the key of success. In some cases, the maintenance and development of co-operation activities is deeply rooted in the informality of relationships and in personal contacts.

- In most of the universities studied, the role of the ILO is restricted to mainly undertaking administrative functions, with many institutions lacking an infrastructure that is relevant to the needs of the academic entrepreneurs and, more importantly, the industrial clients. As a result, the management of technology transfer work is dealt with largely on an ad hoc basis.
- This report shows that there are significant barriers and difficulties experienced by individual academics when they become involved with industry. Principal among these difficulties is the considerable difference between a traditional university culture and an entrepreneurial culture, with the former having an emphasis on a system that tends to favour caution in decision-making. There are therefore considerable differences in organisations, cultures and missions, not only in the reality of the institutional framework, but also in the perception of the academics as to what their goal is and what are the resultant behaviours and decision-making processes.
- Industrial partners saw different problems compared to those seen by the academics, and as recent research indicates, the challenge is to match these. While academics frequently believed their technological ideas had commercial potential on a global scale, industrial partners often complained that these ideas had not been fully researched for commercial viability. This caused conflict as the industry players focus on marketing and balance sheets, while academics tend to place more emphasis on researching new ideas.
- However, albeit on a personal and ad-hoc basis, some academics are becoming more commercially aware, although universities (and other policy-makers) may need to develop specific programmes to encourage this further. This could involve a secondment or placement within an industrial organisation. Whilst it is clear that universities must not abandon teaching and basic research, it must, nevertheless apply the same professional standards to the transfer of technology to industry as it does to the other two functions.
- The cases described in this report show that university-industry linkages could be very successful for both the industrial and academic partners. There are considerable benefits for both partners, especially through a greater understanding of each others milieus, valuations and cultures which, as has been repeatedly emphasised, is fundamental to success in academic-industry partnership. The development of such partnerships do take time and patience and as a result, there needs to be a longer term philosophy towards the success of academic-industry collaborative ventures.
- The adoption, by the university, of a purely 'market-oriented' approach may lead to a focus on short-term market performance, in order to 'prove' the success of the new venture. Therefore, the university must be prepared to establish a long time horizon for evaluating the success of individual ventures as well as the overall entrepreneurship programme. An entrepreneurial climate should not be established within an organisation unless it is willing to invest money with no expectation of return over a number of years. It is also important that ideas are allowed to develop fully, and that the resources allocated to such entrepreneurial project are not withdrawn before that idea has progressed to commercialisation.
- Most academics emphasised the importance of identifying industrial linkages that provide a benefit to both partners. Consequently the choice of industry partner is critical to ensuring that the academic achieves the expected benefit from the project. The benefits identified by most of the academics in this study include the focusing of the research activities of the university on the needs of industry, funding for research activity, facilities and research staff, improved teaching within the university and increased job opportunities for graduates, and the development of new knowledge within the university.

- The benefits described by industry partners relate to the solving of specific industrial and commercial problems. In the majority of cases, the industrial partner measured the success of the university-industry linkage in terms of the delivery by the academic of a solution to a specific short-term industrial problem. Few identified the development of an ongoing linkage with the academic as a critical benefit of the project.
- Overall the industrial partners did not identify problems in working with universities and academics such as a lack of professionalism or poor project management. The industrial partners of those entrepreneurs were, obviously, aware that these particular academics are in possession of skills that can be commercially utilised and have thus placed a high degree of value on nurturing these relationships. However, a number of industrial partners did state that they initially had a 'culture-shock' when first dealing with universities, particularly in respect of time-scales and project scheduling.
- Therefore the examination of the case studies of academic-industry interactions supports similar findings from other parts of the research, that the most important condition for successful university-industry interactions is the ability to understand each other's cultures and values. This is a fundamental issue, among all participant countries, in the development of successful co-operation between the academic and the industrialist. There are still some basic misconceptions, by both parties, of each other's attitudes towards collaboration.
- The development of such an understanding, based on the achievement of tangible mutual benefits, seems to be the key to the success of any venture. From the examination of these cases, it is also clear that many of the initiatives have taken place despite the university and its industrial liaison function. As a result, the actual strategy of the university (and the role of the industrial liaison function) needs to be clearly defined.

MAIN POLICY RECOMMENDATIONS

- Universities must develop their own individual strategies that reflect their strengths and the needs of local (as well as international) industrial firms. The European Commission should facilitate this action by developing a programme similar to the RITTS initiative that would part-fund the employment of independent consultants to determine an appropriate technology transfer strategy for the university. This would overcome many other problems relating to academic-industry relations that have been encountered in this study, especially with regard to the structure for industrial liaison and barriers to closer collaboration. For example, recent research has called for universities to evaluate key researchers and facilities in order to develop industrially relevant research. Such an initiative would help to facilitate this development.
- The study also shows the importance of focusing on, and developing, the efficiency and effectiveness of the different forms of technology transfer in order to bridge the gap between university research, technological development activities and the commercial market. Whilst the impact of scientific research might be the formation of skills and competences necessary to develop and use science-based research, perhaps what seems to be missing in some of the universities examined in the study to date is a lack of experience and expertise in the exploitation of science and technology.
- Another complementary measure for this programme, again to be developed by the Commission, would be the establishment of a databank of good university practice, which the above initiative could draw on in developing relevant policy initiatives. The cases of good practice highlighted in the research of successful university-industry relationships could,

obviously, be adopted and adapted by other institutions. However, this diffusion of 'good-practice' may be dependent on whether these organisations are flexible and innovative enough to be able to absorb such policy changes. Indeed, whilst new forms of organisation are needed to interact with external actors, the analysis of the data from universities suggest that the skills related to co-operation and building relationships may be lacking in a number of universities.

- The Commission could also initiate a new professional body for European Industrial liaison Functions. This would play the same role that the European Business Network (EBN) does for the Business Innovation Centres (BICs) in Europe. It could take responsibility for minimum accreditation, thus raising standards among ILOs. It could also determine a set of guidelines for working with industry in an attempt to break down the cultural barriers that have been prevalent in all stages of this research project.
- In terms of more general policy issues, the European Commission could influence national educational bodies within member States to recognise the importance of collaborative work with industry. It could also encourage greater university-industry linkages through the Fifth Framework programme. Indeed, whilst it is widely acknowledged that the age of 'science push' as the dominant influence on innovation policy has passed, there remains a vacuum in terms of Europe-wide policy initiatives to address the crucial issue of increasing the dissemination of the technologies from the research sector to the commercial sector.
- To a large extent, this has continued through to the planned proposals for the Fifth Framework programmes. Whilst it can be argued that some of the horizontal initiatives, such as "Innovation and the participation of SMEs", and "Improving human potential" could be applied within the context of the development of closer links between industry and academia, there is no specific proposal which attempts to address, on a European policy level, this vitally important issue. In particular, the European Commission could make further resources available to support interaction between small firms and academia. However, this should be based at a local, rather than international level.
- The study also demonstrates that academic entrepreneurship is not merely related to the development of 'campus companies' or 'spin-off firms'. Many academics have no desire to establish a new organisation and to learn the new competences required to successfully manage an entrepreneurial venture. Instead, they wish to apply their existing technological skills and experience in the context of industry.
- Currently, one of the main foci of the First Action Plan for Innovation has been the issues of start-up and growth of technology-based enterprises, especially in relation to campus companies. Given that this study (supporting previous research) suggests that the most effective forms of technology transfer are consulting and contract research, the whole issue of the development of 'campus companies', at least in relation of effective technology transfer, needs to be considered in more detail. In particular, increasing the efficiency of collaboration between universities and existing high technology firms should be a priority.