Chemical Science Spin-outs from UK Universities

Review of Critical Success Factors

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Foreword

Financial pressures to curtail costs coupled with consolidation of ownership of the British chemical industry have eroded its collective ability to be an engine room for future invention and innovation. Consequently, new mechanisms for the regeneration of the industry need to be established and fostered.

The Chemistry Leadership Council (CLC) identified a supportive climate for innovation as one of the major determinants of a healthy chemical industry and set up a sub-group to examine and make recommendations for how this climate could be established. The Royal Society of Chemistry (RSC) similarly recognised the concerns for the future of chemical science in the UK and the role that a healthy environment for innovation can play in fostering strong chemistry programmes in British universities as well as in creating career opportunities for chemical scientists of the future.

In a spirit of true collaboration, born of common goals, the CLC Innovation Group and the RSC have combined their resources to examine the climate for spin-out of invention from British universities and the factors which influence the success or failure of such spin-out ventures, especially when they take the form of new enterprises. This includes the role of the British venture capital community in providing funding for growth of these enterprises. This endeavour, with its conclusions is, the authors believe, a valuable contribution to the maintenance of a robust chemical sector which will continue to make a substantial contribution to the national wealth. However, it will only make a lasting contribution if its recommendations are vigorously followed up by those with the power to effect change.

Since many of the conclusions and recommendations apply to a wide range of industrial sectors, the payback for vigorous implementation will be substantially greater than just the chemicals sector.

The authors are indebted for the support of the Department of Trade and Industry (DTI) in making this study possible.

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Executive Summary & Recommendations

I. Major clusters of chemical science spin-out activity in the UK have been clearly identified. These are based primarily around Cambridge, Edinburgh, Glasgow, London, Manchester, Oxford, Yorkshire (Sheffield, Leeds and York) and the Midlands (Nottingham, Loughborough and Leicester). In general, each cluster can be fostered by a single Regional Development Agency (RDA). However, we see commonality of interests between clusters which will need a pan-regional perspective for maximal effect from limited resources to be achieved.

II. Our findings support Lambert's assertion that proximity of spin-out and university is particularly important[1]. Chemical science based spin-outs, in general, remain close to the university from which they were started. This enables the new venture to maintain close links with the initiating university which, in turn, provides direct access for the spin-out to supportive research, skilled graduates, specialist equipment and effective networks.

III. While there are a surprisingly large number of chemical science based spin-outs and evidence of real clustering, the proof that this leads to significant numbers of successful commercial ventures is weak; the majority of spin-out companies supplied data which implied limited growth over the last three years.

IV. It seems that there may be an element of 'spin' about some of the spin-outs i.e. there is a 'soft underbelly' of spin-outs which seem to be more vehicles on which to focus further research rather than genuine attempts to set up spin-out companies which take invention to commercialisation. Similarly, too many companies are considered to be formed on the basis of a single idea or patent, leaving them with a weak base on which to establish a viable business. Aggregation of intellectual property (IP) from several universities through some networking mechanism would, in some cases, strengthen the chances for success of the ventures.

V. Chemical science based spin-outs provide excellent employment opportunities; due to the multidisciplinary nature of many chemical science spin-outs they employ people across a wide spectrum of scientific disciplines at all levels.

VI. Knowledge transfer from an academic institution to the business world is a complicated process which is influenced by several, often conflicting, factors. There are some excellent Technology Transfer Offices (TTO) in UK universities and there is a maturing approach to the commercialisation of invention from the research base through the development of clearer policies and procedures to determine the most effective route (e.g., in the consideration of licensing vs. spin-out creation). Nevertheless, it was generally found that TTOs lack credibility and expertise due to the shortage of staff who have substantial industrial experience and hence, an awareness of, and experience in dealing with, commercial, financial and funding issues.

VII. There is huge potential to increase the flow of ideas from the science base in British universities into business and the wider community, but this process is significantly constrained by lack of resources. In particular, the effectiveness of the interface between universities and industry would be significantly enhanced if there were more competent knowledge transfer executives who not only have a wide breadth of experience but are trusted by both academia and industry.

VIII. A major hurdle to spin-out creation is the lack of 'seed capital' funding. With most universities having invested their University Challenge Seed Fund monies, they now have no mechanism for seeding new companies after the proof-of-concept stage. This is exacerbated by a shortage of seed investors coupled with difficulty in attracting private investment into proof-of-concept funding. In the recent past, in order to alleviate both their own lack of resources within TTOs and the difficulties of attracting seed funding, some universities have formed a preferred relationship with a single venture capital entity. Early indications are that this approach may work well.

IX. Government has sought through a number of initiatives to provide early stage funding. However, most current, government backed, initiatives require the company to put up matching funds, and

since debt finance is very difficult to obtain, unless the founders can put up the money or a new angel investment can be found, government initiatives will be diluted in their effectiveness.

X. As they mature, companies often find it difficult to raise follow-on funding and the data reported here infer a 'funding gap' at the 'intermediate' size investment (defined as £0.5-2m). Substantial differences in the availability of funding for different technology segments are also highlighted. Chemistry/materials related businesses have particular difficulties in this respect.

XI. The nature and clarity of a university's commercialisation policy influences both the level of spin-out activity and the effectiveness of it when it does take place. UK businesses maintain that universities overvalue their IP and as a result negotiations are often protracted or even aborted. Similarly, a lack of clarity in the ownership of IP in research collaborations deters some organisations, especially Small & Medium Enterprises (SMEs), from trying to collaborate with universities in research[1]. There is also strong evidence that once the spin-out has taken place, continued support and addition of follow-on IP to the venture from the initiating university is often weak. This diminishes the chances that the spin-out will be successful, either resulting in outright failure or in the spin-out becoming one of the 'living dead' with little prospect of success.

XII. Almost uniformly these days ownership of IP is held by the universities rather than by the academics. This means that the cost of initial national filing, PCT (worldwide) filing and maintenance of patents in multiple jurisdictions will fall on the shoulders of the universities. Oversight to ensure that patents are not being breached is also necessary; this may well involve third party monitoring costs. If patent infringement is found and the infringing party fails to take a licence to practise under that patent, then potentially expensive litigation may have to be undertaken. Similarly, if patents held by a university are challenged, expensive defence may be required. We strongly suspect that the longer term budgets and resources needed to properly administer growing patent estates are not clearly understood by some universities and that a crisis of IP management may already be in the making.

XIII. Spin-outs in their early existence are almost inevitably in the pre-revenue phase of their life or at the very least are burning considerable cash resources. As such they are in a poor position to carry the costs of prosecution or defence of patents and indeed, may be forced to restrict the geographical coverage of filings to match their financial means. This parsimony could prove very expensive as the technology development evolves into commercialisation on a global scale. A recommendation is made to help alleviate this problem.

XIV. There is a significant shortage of suitable and cost-effective incubator facilities which offer access to 'wet chemistry' facilities and specialised equipment. Our findings fully support a recent report by Professor Mike Wright of Nottingham Business School[2] [Wright report] that this will ultimately affect how quickly a university spin-out can move off the university site and may also actually influence its credibility as a viable business entity with potential investors and customers as a result.

XV. Within universities a mismatch exists between academic and commercial cultures. Universities by their very nature reward academics for their research and teaching efforts and do not generally encourage or reward entrepreneurship. This weakness is compounded by the Research Assessment Exercise (RAE) which favours academic publication over commercialisation of research and therefore ties funding in a way that does not reflect overall government objectives. Universities must therefore attempt to create a more accommodating culture for those academics which wish to participate in commercialisation activities. In addition, the government should reconsider the structure of the RAE to provide and develop a better recognition of the balance between academic research and entrepreneurship.

XVI. A general lack of experienced business management in spin-outs significantly undermines their prospects for success. This business management expertise should be generally sought at an earlier stage in the development of spin-outs than it often is, as inventors with academic backgrounds are not always equipped to deal with the range of issues faced by a start-up venture. In the USA the angel investing community performs this role effectively.

XVII. A significant number of chemical science based spin-outs stated they had little or no contact with the DTI or with their RDA. The main barriers to a constructive relationship were stated to be the

bewildering plethora of different initiatives and schemes available, coupled with inadequate resources to offer guidance through the 'labyrinth'. Even inside the labyrinth the processes involved often are said to be too time consuming and bureaucratic.

XVIII. The majority of TTO respondents agreed with Lambert's assertion that the Government's investment in third stream funding has led to an increased capacity and propensity for UK universities to engage in knowledge transfer from the science base[1] but grave concerns were often expressed about the methods of allocation of third stream funding. Differences in approach clearly exist between funding councils and some initiatives are clearly more successful than others.

XIX. Lambert's[1] assertion that universities should focus on the overall public good and less on making money from the spinning out of IP (viz., focussing on licensing and less on spin-outs) provoked a mixed response. Most agree that public funded research is intended to benefit the economy and we should never end up in a situation where technology does not get exploited because commercial terms cannot be agreed. However, universities are increasingly required to have independent sources of funding and it is therefore appropriate for universities to get a return from IP they generate. This conundrum needs to be addressed.

XX. As to another Lambert[1] assertion, that there is too much emphasis on developing university spin-outs and not enough on licensing technology to industry, university TTOs generally feel that rather than trying to prejudge the balance, it is essential for the right approach to be taken - the one that will ensure success. University TTOs generally feel that they do attain this optimum approach.

XXI. There is a universal belief in the TTOs that they are resource-constrained and there is much more they could achieve with the IP they have at their disposal, if only they had enough resources to do so.

Turning to the conclusions reached from a number of discussions from UK venture capitalists:

XXII. Chemistry other than biochemistry is not a very attractive area for venture capitalists (VCs) to invest in. This is true for a number of reasons, among which are the difficulties that VCs have in seeing a clear business model by which a materials invention can make money. They perceive that it is far from the market both in terms of the value chain and in time to market, because materials invention usually requires other elements of the 'technology ecosystem' to be developed to allow the materials invention to be realised commercially. They also see that the UK chemical segment has become relatively weak and unprofitable and therefore presents a poor opportunity for them to exit their investment. This remains in contrast to the pharmaceutical industry which is seen as a good exit route, being still very inventive, innovative and well-resourced financially.

XXIII. In general, early stage technology investment is now out of favour with UK VCs with the exceptions of software, semiconductors and biochemistry. The industry is not in very good shape for early stage investment as angel investors have been badly burned with failures in the tech downturn after 2000 and since then have been subjected to predatory actions by VCs willing to fund the technology survivors. UK pension funds have turned away from technology investing as they see a poor track record of return over the past 20 years compared to funds invested on turning around businesses with established market positions, products and physical assets.

XXIV. The reasons for this poor track record of technology investment need deeper analysis but there is a clear feeling among VCs that there is a shortage of serial technology entrepreneurs in the UK. Consequently, making it attractive for those who have sought their fortunes in the USA to return to the UK would be well worthwhile from the standpoint of the national interest. More encouragement for individual investment in early stage technology ventures is also needed and here government policy initiatives, such as relaxing the requirements for accredited investor status, could be very helpful.

Recommendations

1. More needs to be done to share best practice between TTOs. It is evident that commercialisation offices are undergoing considerable change and evolution but, there is a clear need for them to be staffed with industry/start-up 'savvy' individuals and not purely by university administrators. It may be necessary to 'commercialise' the whole function of knowledge transfer from universities and free it from university constraints (e.g., salary structures, in order to attract the right level of individual experience).

2. The realistic provision of resources for IP filing and protection needs to be addressed. No university or university spin-out could realistically finance the costs of prosecution or defence of patents and we suspect that international filings may be being restricted to match the financial resources available for filing and patent maintenance.

3. With respect to management of IP by the spin-outs themselves, one idea that should be considered by Government is that the costs of patent filling should be regarded as 'R&D costs' for purposes of calculating a rebate due under the R&D Tax Credit scheme. This would be an effective encouragement to file. Business these days is global and important patents need to have wide coverage.

4. We need science parks UK-wide with more multi-occupancy buildings where 'wet chemistry' facilities and specialist equipment can be shared in a cost effective manner.

5. Lack of experienced business management significantly undermines spin-out activity. Schemes such as the secondment of commercial managers into university spin-outs and/or mentoring from successful Chief Executive Officers (CEOs) should be considered.

1 Background to the Project

1.1 Over the past decade there has been a marked cultural change in the UK's universities and higher education colleges; with many making greater efforts to engage the wider community. Additionally, in recognition of the amount of public funding received to support teaching and learning, research and the associated infrastructure, universities are being actively encouraged to increase the economic and social return on this investment through knowledge transfer. By knowledge transfer we mean the exchange of knowledge and skills between universities and business, and the wider community[1].

1.2 This objective has led to the emergence of a third stream of Higher Education (HE) activity and funding alongside the traditional streams of teaching and research. This new stream has its own performance indicators and funding streams to promote the development of effective means of knowledge transfer, which encompass a broad range of activities extending from reach-out to business, collaborative and contract research, establishment of joint ventures, licensing-out of IP and the formation of spin-out companies.

1.3 The emergence of this third stream of HE activity and funding has occurred at a time when several trends, as identified by Lambert[1], are reshaping the way businesses around the world are undertaking research. Companies are moving away from a system in which most of their R&D is done in their own laboratories to one in which they are actively seeking to collaborate with others. In addition multinationals are locating their research centres in their most important markets, especially if those markets contain centres of outstanding research. These trends could provide UK universities with significant opportunities to extend their knowledge transfer activities.

1.4 Commercialisation activities in the university sector have already substantially increased over the last five years[1]. Data from the Higher Education Business Interaction Survey 2003-04[3] shows that in general, collaboration between business and universities is on an upward trend. The UK has witnessed a sharp rise in the rate of spin-out enterprise creation from an average of 98.8 per year in the four years prior to the end of 2000 to the 175 created in 2001[4] and, in spite of a slight decrease in spin-out company formation in 2002, UK universities spun-out nearly twice as many new companies per unit of research funding as did US universities[5]. The number of spin-out companies created in 2003 has remained relatively constant at 151[3].

1.5 Although UK institutions executed more licences in 2002 compared with US and Canadian institutions, the worrying fact is that despite this, UK had far fewer licences yielding income, and a lower gross licence income, than these two countries[5]. In addition, the Universities and Companies Association (UNICO) estimates that the number of UK university spin-outs has dropped significantly from 172 in 2002-03 to 89 in 2003-4 as a direct result of ill-thought out changes to tax regulations which are regarded as punitive to the founders of a spin-out and a severe deterrent to spin-out activity[6,7]. However, a recent report by the DTI demonstrates the breadth and success of knowledge transfer activities from Public Sector Research Establishments[8]. The report shows that knowledge transfer takes many forms and provides a number of benefits to business and the wider community.

1.6 Despite some encouraging trends it is therefore widely accepted that the UK still lags behind the US in many aspects of knowledge transfer. Michael Porter's report argues that the UK is still relatively poor at commercialising its research[9] and a recent report from Professor Mike Wright of Nottingham University Business School [Wright report] concludes that unless universities are prepared to back their spin-outs with appropriate resources, many will fail[2]. Thus while, as the Lambert Review points out, there is much good collaborative work underway already, it is clear that there is more to be done[1].

1.7 In light of the recommendations in the Lambert Review[1], the DTI Innovation Report[10] and other sector specific reports[11] (all setting out policy for knowledge transfer for the next decade), several industrial sectors are placing greater emphasis on business-university collaboration. One such area is the chemicals and chemicals-using industry sector.

1.8 The Chemicals Innovation and Growth Team (CIGT) was established by Lord David Sainsbury of Turville, the Minister for Science and Innovation, to make recommendations to ensure the long-term

development of the chemicals and chemicals using industry sector. One of these was the setting up of the Chemistry Leadership Council (CLC).

1.9 One of the CIGT recommendations addressed the need to promote the UK as the location of choice for start-ups in chemistry-related technologies and for new chemical ventures within the existing industry. This has been taken up, amongst other initiatives, by the CLC's Innovation Sub-Group which is determined to focus on the climate for IP spin-out from British universities and the support for start-up companies from the British venture capital community.

1.10 In parallel, the RSC had established a focus on encouraging the commercialisation of chemical science and technology through the formation of spin-out enterprises and other new ventures, as well as to support and encourage SMEs that have chemistry as the principle contributor to the science base. As a first move in this initiative, in 2003, the RSC published a report entitled 'Spin-out Companies from UK Chemistry Departments'.

1.11 The CLC and RSC agreed to collaborate in the execution of a survey to identify the factors which encourage and discourage new ventures based on the exploitation of chemical science. The over-arching aim of this project is to examine the potential to structure a national initiative in the UK that will maximise the creation and development of new ventures based on the exploitation of chemical technology.

1.12 The RSC was commissioned by the CLC to research the contributions made by university technology transfer offices (TTOs) and to survey data from as many university chemical science based spin-out companies as possible. The results of this survey are found in Part I of this report. In parallel, members of the CLC Innovation Sub-Group interviewed selected venture capital organisations and this is reported in Part II.

PART I

2 UNIVERSITY SPIN-OUTS

Methodology

2.1 A total of 128 chemical science based spin-outs* were identified from the top forty Higher Education Institutes (HEIs), ranked in terms of the total amount of external income they procured for 2001/02. In addition, all UK and Republic of Ireland chemistry departments were included in the initial survey. For the purposes of this report, chemical science based spin-outs are defined as those ventures which have chemistry as a critical contribution to the science base of the venture. All the companies examined in this study were formed in the period 1997 to present day, with the exception of companies from

i) Chemistry departments and
ii) Oxford and Cambridge Universities,

where we have included all companies formed. (In the case of Oxford and Cambridge Universities this approach was taken since these are uniquely large and long established 'clusters' and to have adopted a 1997 cut-off would have eliminated some important examples of spin-outs).

2.2 The companies deemed to fit within this definition and hence be included in this study were determined by the project steering group. A qualitative selection process was adopted, in which profiles for all science based spin-outs from the top forty HEIs and all UK and Republic of Ireland chemistry departments were compiled from the companies' web sites and university TTOs. These were then assessed, and chemistry content estimated. The 128 companies selected for inclusion in this study incorporate a wide cross-section of technologies and sub-sectors which define the chemical science sector (see Section 2.8).

2.3 Founders, CEOs or other appropriate managers from all 128 companies were contacted individually, briefed on the survey and sent a questionnaire to obtain financial and employment data. Fifty-six companies replied. A sample of eight was selected with which to conduct more detailed in-depth interviews. This selection was made to cover successful, unsuccessful and 'living dead' examples. Nine TTOs covering the whole of the UK were also briefed on the survey and asked to participate in a series of in-depth interviews.

Data Analysis
Geographical Location – Chemical Science Clusters

2.4 Analysis of the geographical spread (see Figure 2.1) of the 128 chemical science based spin-outs identified for inclusion in this report clearly identifies clusters of high-technology chemical science based spin-out activity. These clusters are, as might be anticipated, centred predominantly around research-intensive universities. Cambridge, London, Oxford and Manchester are the most prominent, but Figure 2.1 is clear evidence that several other chemical science based clusters are developing across the UK.

2.5 Figure 2.1 suggests that chemical science based spin-outs remain within close proximity to the university from which they originated. This is hardly surprising as this proximity enables the new venture to maintain close links with the university, providing direct access to research in the chosen field, a ready supply of skilled graduates, access to specialist equipment and effective networking.

2.6 These specific findings support Lambert's general assertion that proximity is particularly important for university collaboration[1]. Our findings are further evidence that SMEs generally do not have the time or resources to identify relevant expertise far from home and will often associate themselves with one or more local universities whether or not this is ideal.

* A spin-out is the term used to define a new venture set up to develop and exploit intellectual property (IP) commercially. In the context of this report a university spin-out is a venture in which the IP has been owned by the University, the founders were employed by the University, the University took a substantial equity shareholding or the University assisted in some way.

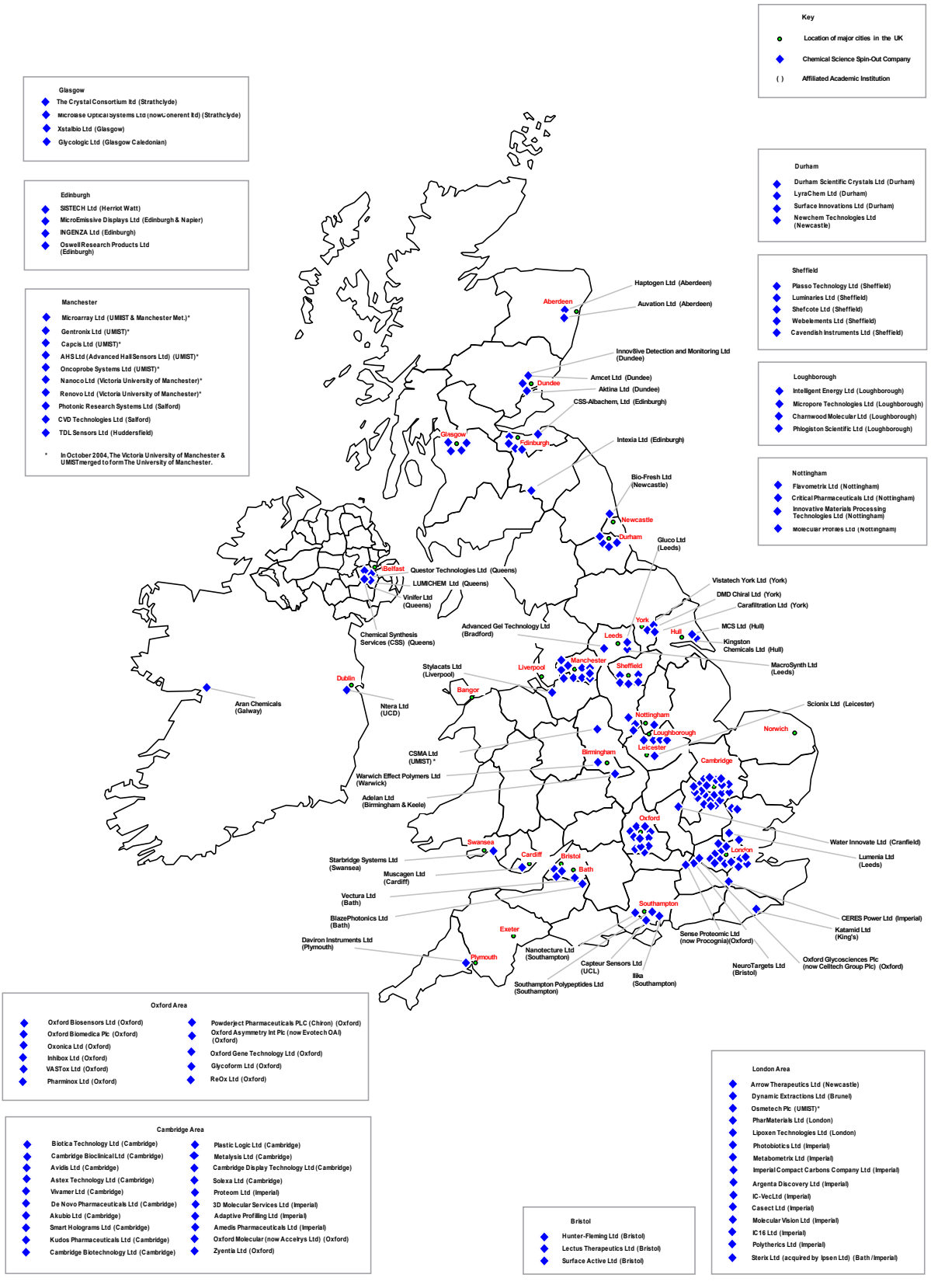

Figure 2.1 Location of chemical science spin-out companies from UK universities

Spin-out Company Characteristics

2.7 The data in this section refer to answers collated from questionnaires returned by the 44% (56) of the spin-out companies that were identified for inclusion in this study by their agreeing to provide appropriate financial and employment data.

2.8 The sample of 128 companies surveyed (see Figure 2.2) primarily consists of high technology start ups. 45% (57) of the companies are in the area of biosciences and pharmaceuticals, 21% (27) are in functional materials, optoelectronics and polymers, whilst only 6% (8) are in the conventional (fine) chemicals sector. 20% (26) of the companies are split evenly between food, contract services, water, process & engineering, energy, sustainable development, medical devices, environmental and other. The remaining 8% (10) are in analytical services and micro-technologies.

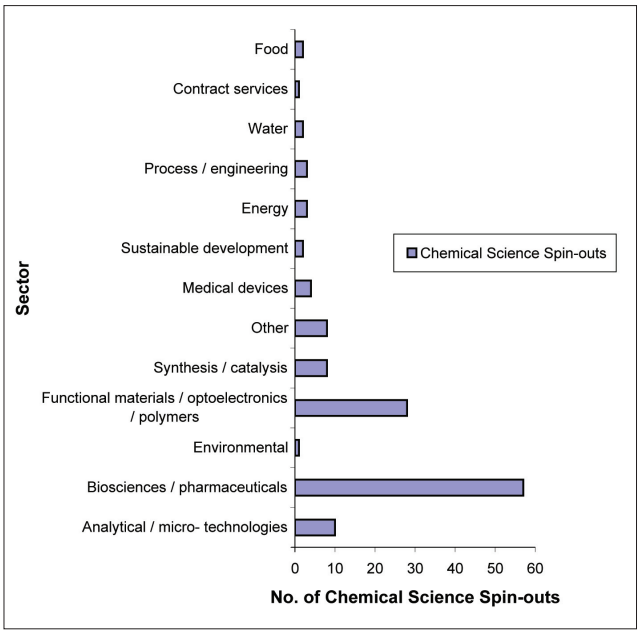

Figure 2.2. Chemical science based spin-outs by sector

2.9 All the university spin-out companies surveyed are privately owned; none have grown to the point where Initial Public Offering (IPO) was the exit point for investors (although, since the report was completed two have undertaken IPO, one on NASDAQ and one on AIM. Interestingly, both are focussed on the application of chemistry to displays).

2.10 Analyses of the data suggest that a wide range of types and sources of finance are explored and used by university spin-outs (see Figure 2.3). As companies invariably use more than one stream of funding in their development, it follows that Figure 2.3 reflects popularity of one source against others. venture capital, founder's funds and Grant for Research and Development† (previously SMART Awards) are marginally more popular than are private investors, university challenge funds and business angels. The least popular mechanisms are friends and family and the Small Firm's Loan Guarantee Scheme (SFLGS)‡.

2.11 Other sources of funding include RDA grants, participation in EU and DTI funded projects and joint Research Councils business plan competition§ winnings. Private funding came from investment by industrial partners, either as passive stakeholders or as joint venture partners.

† Grant for Research and Development is the Department of Trade and Industry's (DTI) initiative that provides grants to help individuals and small and medium-sized businesses to research and develop technologically innovative products and processes. http://www.dti.gov.uk/r-d

‡ Small Firm's Loan Guarantee Scheme operated by the DTI guarantees loans from the banks and other financial institutions for small firms that have viable business proposals but who have tried and failed to get a conventional loan because of lack of security. http://www.dti.gov.uk/sflg/

§ Joint Research Council Business plan competition. £20,000 is awarded to the winner plus a portfolio of business support and services http://www.rcuk.ac.uk/businessplan/

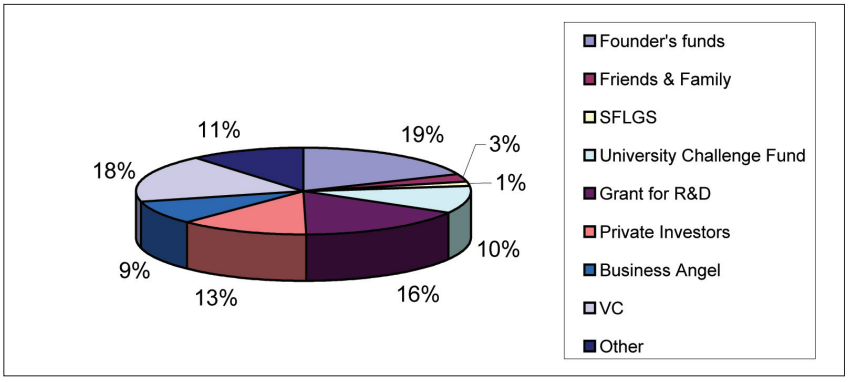

Figure 2.3. Sources of finance explored and used

2.12 Age Profile of Ventures

Year of Incorporation	Number of Companies Formed
1991	2
1992	1
1996	3
1997	3
1998	5
1999	8
2000	8
2001	9
2002	8
2003	3
2004	3
Unavailable	3

Table 2.1. Year of incorporation

2.13 Nearly all the companies surveyed reported an annual turnover of £0-5M for 2001-2003 (see Figure 2.4). However, it is possible that a number of these companies have no turnover at all. Of particular concern was that only two companies reported a significant increase in turnover in the reported period.

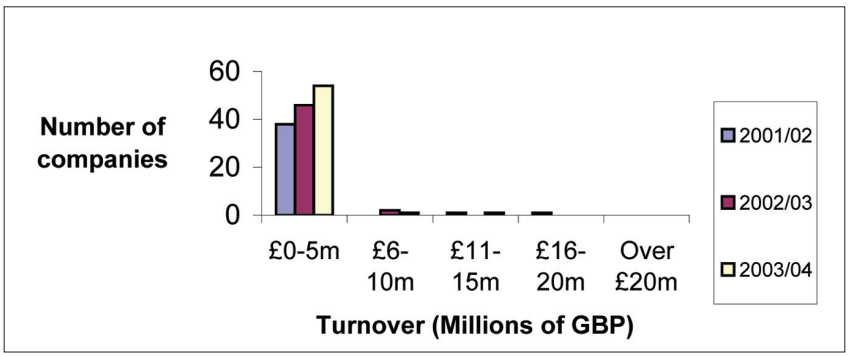

Figure 2.4. Company turnover in the past three years

2.14 Company size ranged from a single founder to 250 employees (see Figure 2.5). 65% (36) of the companies employ between 1 – 10 people whilst 21% (12) employ between 11 – 50 people and 9% (5)

employ between 51 – 250 people. None of the companies surveyed employs over 250 people and of the fifty-six companies 5% (3) reported they had no employees. This could be attributed to several potential causes: either that the company was new or that it relied on contracting work on a project-by-project basis. In one case, the company stipulated that it was not an operating company but rather owned patents on their key technology.

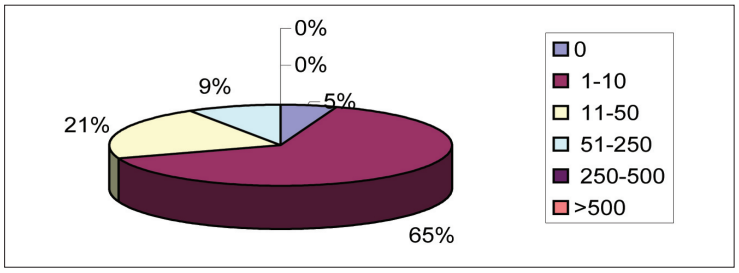

Figure 2.5. Total number of people employed

2.15 79% (44) of the spin-outs reported similar employment profiles (see Figure 2.6), citing that the number of people employed over the past 12 months had remained static or increased. Only 21% (12) reported a reduction in numbers.

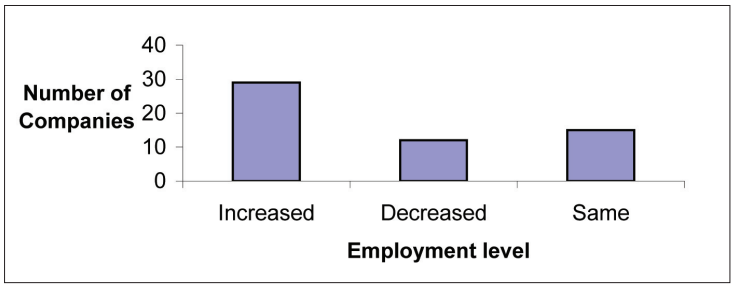

Figure 2.6. Levels of employment over the past 12 months

2.16 Since 65% (36) of the companies employ between 1 -10 people (see Figure 2.5) it is not surprising that 56% (32) of the spin-out companies employ only between 1 and 5 chemists (Figure 2.7). 24% (13) employ between 6 – 50 chemists and only one company employs over 50. 18% (10) of the companies reported no chemistry graduates employed; either because they employed no staff (see Figure 2.5) or because they were focussed on the biological sciences.

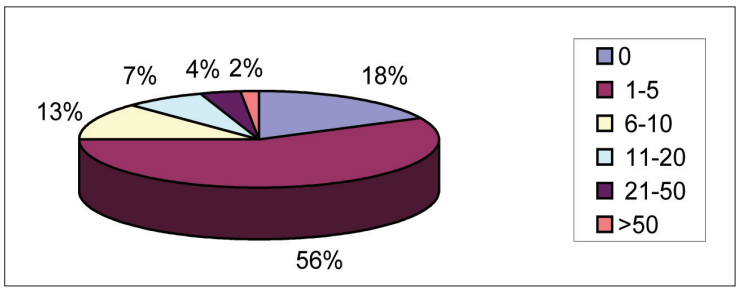

Figure 2.7. Number of chemists employed

2.17 Due to the multidisciplinary nature of many chemical science spin-outs, it is hardly surprising that they employ a very wide spectrum of scientific disciplines (see Figure 2.8). Biochemists and biologists are particularly popular. Other fields of employment include: molecular biologists, engineers, electrical engineers, mechanical engineers, process engineers, instrumentation scientists, mathematicians, microbiologists, pharmaceutical scientists, environmental scientists, electronics engineers, bioinformaticians, immunology, clinicians, formulation scientists, geneticists, astronomer, virologists, computer aided drug discovery (CADD) scientists, pharmacokinetics, business, IT specialists & programmers.

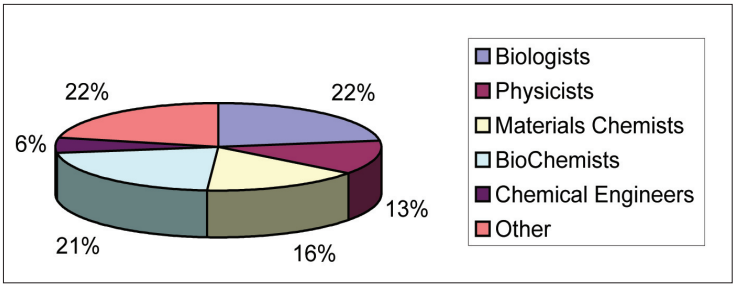

Figure 2.8. Other fields of employment

2.18 PhD students are overwhelmingly cited as the preferred recruits of spin-out companies (see Figure 2.9). However, several companies had no preference, instead placing greater emphasis on competence in the required field and getting the right person. Over three quarters of the companies claimed they had no problems in attracting high quality applicants.

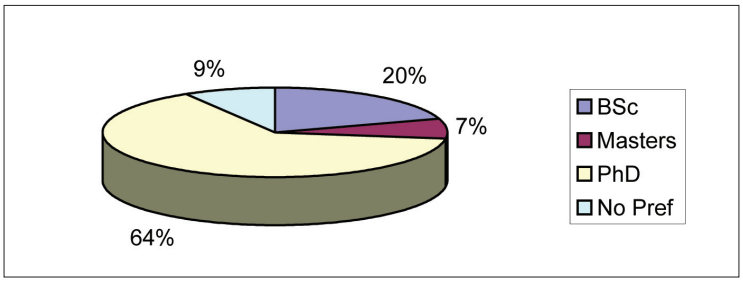

Figure 2.9. Preferred recruits of companies

3 Interviews with Chemical Science Based Spin-outs

3.1 This section of the report concentrates on the spin-out companies themselves. Of the fifty-six respondents to the survey thirty-four indicated a willingness to participate in an in-depth interview.

3.2 A sample of eight companies was selected, comprising:

- Argenta Discovery Ltd [1998];
- Cambridge Display Technology Ltd [1992];
- Charterhouse Therapeutics Ltd [Liquidation];
- Ingenza Ltd [2002];
- Inhibox Ltd [2001];
- Lyrachem Ltd [2004];
- Solexa Ltd [1998], and
- Warwick Effect Polymers Ltd [2001].

These were selected from the thirty-four to give a spread of representation by industry sector, university affiliation and stage of development (see Figure 2.2). The year of incorporation is shown in brackets.

3.3 Questions to each company used the same template and sought to investigate the personal experiences of key individuals of knowledge transfer processes in the UK from these chemical science based spin-outs. Answers to the questions featured in the interview template are reported below and are therefore generally interpreted qualitatively.

Commercialisation Process

3.4 How was commercialisation realised? Was it through the help of the University Technology Transfer Office (TTO) or similar university organisation?

In general, commercialisation had been realised through the help of the TTO or equivalent university organisation. This is particularly true for spin-outs formed in the last four years. This is not surprising as the number of institutions dedicating staff towards commercialisation activities has increased from the early 1980s and this process has continued throughout the 1990s[3,5], with the majority of institutions creating a specific team to act at the interface between the university and business between 1995 and 2002[5].

Exceptions do exist. One spin-out cited the successful use of an independent firm regulated by the Financial Services Authority (FSA). This firm provides a range of specialised services for founders and managers of high-growth companies requiring advice and venture capital. Another was fortunate to have had the backing of a venture capital firm from inception of the venture which provided the necessary support and advice. Prior to the creation of TTOs, companies relied heavily on whatever commercialisation services were available from their individual university (and this varied widely between universities).

3.5 What services and support did the university/TTO provide? Would you say the relationship was 'satisfactory' or 'unsatisfactory'?

In agreement with the findings of the Lambert Review[1] the spin-outs interviewed reported widely varying experiences of university TTOs. Some were said to be of a high quality and to offer an extensive portfolio of services and support to spin-out creation, whilst others were seen to be supportive but to simply lack the necessary commercial expertise and resources to be of much help.

It was generally felt that university TTOs lacked credibility and expertise due to the shortage of staff who have substantial industry experience and hence, an awareness of commercial issues. The skills gap was reflected most sharply in the areas of deal-making and the effective negotiation of spin-out company agreements, skills usually learnt in industry.

It would be easy to criticise the underperforming TTOs, but half of universities have less than four dedicated staff employed in commercialisation activities[5] and knowledge transfer by its very nature requires a broad set of skills with specialists in areas as diverse as IP filing and funding, which are difficult to cover in a small group and expensive to buy in.

3.6 What did the university take in return in terms of equity?

The amount of equity taken in chemical science based spin-outs by the founding university varies between institutions. On the whole, universities expect to be a significant shareholder in a new venture considering the resources and permissions it is prepared to make available to the spin-out.

Every university seems to have a different mechanism for the distribution of equity in a new spin-out company. Some universities work on a case-by-case basis and take varying levels of equity, subject to negotiation. This is often conditioned by the level of venture capital involvement, and the quality and experience of the founders, and the management subsequently recruited.

Others stipulate a set percentage, which is usually no more than twenty five per cent. According to the rules governing the Grant for Research and Development (formally SMART), the definition of an SME is: 'less than EUR40 million per year revenue and less than 250 staff'. However, if one shareholder owns more than 25%, then the SME test has to be performed on that shareholder. Whilst there are exceptions, some universities stipulate 25% as this avoids subsequent problems when applying for grants. Some universities simply divide the founding equity equally between the founder(s), department and university. At the first funding round investors negotiate their share of equity and some set aside a small percentage for managers (usually no more than 15% of the shares are set aside for employee participation). At this point, the founding shareholders are diluted concerning their percentage share of the company's total equity. Resistance to this dilution has been a problem in the past and has inhibited growth in some cases.

Amongst spin-outs who considered that their university TTOs lacked the necessary resources and skills, there was a general feeling that the percentage of equity held by the university was too high given the support and services that the spin-out ventures received post spin-out. They often felt there was no room for negotiation, which impacted significantly on their future relationship with the university.

A substantial conclusion of this study is that consideration should be given to how assiduously universities follow through with help after the spin-out has been formed; especially in terms of the availability and use of follow-on or related IP. Too often, it appears, the spin-out has the experience of being 'cast out' with little follow-through by the university.

There was also a consensus that spin-outs often were forced to defend the university from criticism by other potential investors who saw the university as a major shareholder who did not add any real value. Potential investors were reported to be put off also by universities who ring-fenced their shareholding, stipulating that it could only be diluted once specific milestones had been reached. The irony is that the venture needed new investors in order to meet these milestones.

One university has adopted a slightly different approach, taking generally less than ten per cent equity in a new venture. The main reason behind this approach was that in the view of the university it gives a positive message to potential investors: the university wanted the venture to be a success. Simultaneously, this university, via its TTO, builds up a good rapport with the new venture, which is regarded as an ally and not an impediment. If the university continues to offer support and guidance it is further believed that the venture will reinvest in the university in the future. Although in the short to medium term the university will generate less income, it is considered a better mechanism in the long term and one which gives the venture a greater chance of success.

Funding

3.7 How do you view your relationship with the DTI?

This question provoked a mixed response. A significant number of spin-outs cited they had little or no contact with the DTI. The main criticisms were that the number of different initiatives and schemes available and the processes involved were often far too time-consuming and bureaucratic. For example, there is a general perception that the applications process for the Grant for Research and Development (formally SMART awards) is long and time consuming, and could be simplified. Accountability is essential, but the process needs to be less bureaucratic. There were some concerns about the current method of allocation; it was felt they need to revert back to their original format and not be awarded as a competition.

However, those that reported a good working relationship with the DTI had evidently used to their full

advantage a whole plethora of different schemes and initiatives. These companies were very proactive in their approach and made it clear that they would be looking for further opportunities to work with the DTI in any future schemes that became available.

The most popular schemes seem to be the Grant for Research and Development (formally SMART), R&D Tax Credits, Global Watch Missions (see Case Study 3.1) and links with UK Trade and Investment 'Passport to Export Success' programme (see Case Study 3.2).

Case Study 3.1: Global Watch Missions

Each year the DTI's Global Watch service part-funds thirty to thirty five short fact-finding missions, by small groups of technical experts from UK companies and academia, aiming to identify, access and transfer knowledge and technology developments from around the world. For further information visit: www.globalwatchonline.com

Case Study 3.2: UK Trade and Investment 'Passport to Export Success'

This scheme guides you through the mechanics of exporting. An International Trade Advisor provides professional advices on a range of services including; utilising financial subsidies; exporting documentation; contacts in overseas markets; undertaking market visits; translating marketing materials; subsidised export training and researching markets. For further information visit: www.uktradeinvest.gov.uk

3.8 Have you had any interaction with your local RDA? If yes, what has the experience been like?

Most spin-outs claim to have had no or very little interaction with their local RDA. On the whole the general perception of RDAs was that they are unwieldy and complicated organisations which incorporate under one umbrella a multitude of sister organisations. This results in numerous initiatives and schemes, and a general feeling by spin-outs that they are continually referred to different levels of the organisation. It is often unclear who they are dealing with and who does what. The quality of expertise and skills were also questioned.

It was generally felt that a small number of RDAs provide good schemes for those working in R&D (e.g. One North East's 'Five Centres of Excellence' (see Case Study 3.3)). However, in general, spin-outs either seemed unaware of local schemes to help them or found that it took them an eternity to find out. Only one company reported a positive experience.

Case Study 3.3: One North East - Five Centres of Excellence

One NorthEast has set up five Centres of Excellence: Nanotechnology; Photonics and Nicrosystems (CENAMPS); Life Sciences (CELS); Digital Technology & Media (Codeworks); New & Renewable Energy (NaREC) and Process Industries (CPI).

The Centres of Excellence initiative is a critical investment in research and development aimed at creating wealth in the region. The principal function of the Centres is to 'condition technologies arising from the research base to a form where they can be utilised for commercial purpose'. For further information visit: www.onenortheast.co.uk

Whilst most RDAs are making significant investments in science and innovation, certain spin-outs expressed grave concerns that in some regions R&D did not appear significantly high enough on the region's long-term strategy, despite the clear correlation between a region's R&D intensity and its economic prosperity[1].

Concerns were also raised about the mechanisms used to allocate and distribute funds within the regions themselves. The general impression is that massive amounts of funding are going to the regions, but distribution appears *ad-hoc*. Local spin-outs have little feel for if they are taking full advantage of what is on offer.

The situation in Scotland seems significantly more positive than in England. Scotland created its own development agency some time ago, with the Scottish Development Agency (SDA) becoming Scottish

Enterprise in 1991. Spin-outs in Scotland reported good interactions with Scottish Enterprise and were fully aware of the different initiatives and schemes available to spin-outs. The venture arm of the SDA was 'privatised' as Scottish Equity Partners which invests as a profit-orientated venture fund but only in Scottish based enterprises. This model is well worth examining by other RDAs.

3.9 Have you used or are you aware of any local funding initiatives dedicated to SMEs?

Most RDAs and local authorities are making significant investments in SMEs. As a result, there are many different schemes and initiatives available from a variety of sources, in recognition of the fact that securing early-stage funding for innovative projects can be difficult.

Most RDAs offer small business grants and programmes to support R&D projects that are jointly undertaken between public sector research bodies and local SMEs (see Case Study 3.4). However, most initiatives require matched funding, which more often that not means reliance on debt finance to make up the match, unless the founders can put up the money or an angel can be found.

Case Study 3.4: SEEKIT

The Scottish Executive has recently introduced a new scheme aimed at encouraging greater co-operation between SMEs and the science base. The SEEKIT programme is designed to support projects that will promote co-operation in R&D and knowledge transfer between SMEs and the Scottish public sector science base.

The key objectives of this programme are:

- To help effective wealth creation from the science base;
- To increase the competitiveness of SMEs through their engagement with the science base, and
- To encourage productive knowledge transfer links between business and the science base.

For further information visit: www.scotland.gov.co.uk

3.10 How many people do you employ & what skills/expertise do they possess?

The number of people employed by chemical science based spin-outs and the skills and experience they possess varies between ventures. It is primarily determined by the stage of development and the skills base of the founding team (see Figures 2.5 to 2.9).

Management experience is brought in at varying times in the life of a venture and the timing is dependent on a multitude of factors. Whilst some ventures have had experienced management expertise available from the very beginning, others recruit key individuals with commercial experience (e.g. a CEO as the venture reaches a key development stage). This is coupled with the appointment of business development managers, finance directors, sales, marketing, IT, HR and IP specialists as the size of the business dictates the need. However, it should be noted that to build a team requires funding and this often generates a 'chicken-and-egg' situation in which business progress cannot be made without additional resources, but funding to pay for the resources cannot be achieved without business progress.

3.11 Is university training appropriate for your staff needs?

Although, industrial experience is preferable, university training is seen to be generally appropriate for the technical staff needs of chemical science based spin-outs. On the whole, spin-outs have no problems in attracting high quality PhD applicants (see Figure 2.9). However, some experienced problems at the leadership level and in the recruitment of graduate level scientists.

A small number of academic founders stated that some form of entrepreneurial training within the university would have been beneficial in preparing them for leading a spin-out as well as in recruiting commercially aware staff.

3.12 How easy was it to recruit qualified management and to form the Scientific Advisory Board (SAB)?

Chemical science based spin-outs report varied experiences in these key skill building areas. Formation of the management team was straightforward for those spin-outs which had the backing of a venture capital firm from the outset or where a credible TTO with access to large networks was available. Nevertheless, a large number of ventures experienced difficulties in gaining access to good management. Some TTOs

provided no direct help or guidance in forming the management team. As a result, a number of ventures are still run by the founding team who in many cases have little or no experience in running a commercial venture.

Few companies experienced problems with forming the SAB, as academic founders have access to extensive international networks of individuals. Problems arise when the company is working in a niche area and advisors are difficult to identify. In most ventures the SAB brings credibility and is continuously evolving as the venture matures and its needs change.

3.13 How easy has it been to procure premises and equipment?

In general we emphasise that chemical science based spin-outs who do not have the backing of a venture capital firm, or significant other first round funding, find it exceptionally difficult to procure premises and equipment and move outside the university.

The majority of chemical science based spin-outs are located within the confines of the university. They rent space on a fully commercial basis and pay for access to highly specialised equipment. Certain universities are uneasy with this arrangement as there is a mismatch between academic and commercial cultures; there is a general concern that such agreements could impact on the charitable status of universities.

Although academics have plenty of experience in the logistical aspects of setting up research groups and fitting labs, the provision of premises and the kitting out of research labs is unfeasibly expensive for the majority of start-ups and requires significant funding at a very early stage. In the UK there is a significant shortage of incubator facilities available which can offer access to 'wet chemistry' facilities. Many chemical science based spin-outs would find it incredibly difficult to survive if they were forced outside the university. The Scottish Microelectronics Centre in Edinburgh shows what is possible in the regard of providing specialist assistance and facilities as a spur to spin-out growth.

The Wright report concludes that the most important infrastructure related impediment to spin-out development is the availability of suitable space on a science park[2]. This conclusion is reinforced in this study. We agree with the assertion that a lack of suitable space outside the university may impact on how quickly these firms are recognised as credible business entities by suppliers, customers and investors. But, for most, the benefits of remaining within the university offer the only chance of survival.

3.14 What professional services have you used in the past and what services are the board currently using?

The most commonly used professional services are accountants, lawyers and specialists in IP and patents. Established companies tend to use an extended portfolio of services from both large and small companies which include training, PR and marketing services.

3.15 Do you belong to any networks/organisations?

The Lambert Review[1] concluded that the best forms of knowledge transfer involve human interaction; it is therefore not surprising that the majority of chemical science based spin-outs belong to a sector-specific network or organisation. Eastern Region Biotech Network [ERBI] (see Case Study 3.5) and Faraday Partnerships (see Case Study 4.3) are common examples.

In terms of non-sector specific networks many spin-outs belong to informal networks of local businesses and maintain close relationships with the founding university. This is particularly prevalent for those companies spun out of either Oxford or Cambridge (e.g. the Cambridge Network).

Case Study 3.5: Eastern Region Biotech Network (ERBI)

ERBI is the biotechnology network for Cambridge and the East of England. It is a comprehensive business network for the cluster, with activities including:

- Regular networking meetings;
- Annual networking conference - now in its 6th year;
- Purchasing, Human Resources, Business Development and Finance specialist groups, and
- Cluster promotion on a global scale.

For further information visit: www.erbi.co.uk

Barriers to growth

3.16 What barriers have you already had to overcome in order to reach your current status? If you could do things differently what would you do?
The biggest barrier to university spin-outs in the UK is the availability of very early stage funding. There is a big shortage of seed investment for activities such as market surveys. In addition, many universities have now fully invested their University Challenge Fund monies and now have no mechanism of seeding new companies after the proof-of-concept stage.

A common barrier to development is the lack of expertise, support and resources found in university TTOs. Whilst there are a number of well known exceptions there is a general consensus that universities are too eager to parcel up know-how in expensive patents and then let the company run with them, in the hope that there will be a huge return for the university five years down the line. There is seldom any prior consideration as to whether the technology is ready for market, and if it is, realistically how it is going to get there in terms of development milestones and the funding needed to achieve them.

On reflection, several of the companies felt that they did not do sufficient market research early on. They concentrated predominantly on background R&D rather than assessing the market and focussing efforts on commercially driven research; if there is no market for the product there is essentially no business. Others commented that in the company's history there were periods of underinvestment in both infrastructure and people due to a lack of financial resources. This later impacted on the competitive position of the company. A common problem is the emergence of a mismatch between the number of staff employed and the breadth of technology which needs to be developed. This also results in limitations in growth. However, management teams are required to be cautious, as an increase in staff equates to an increase in overheads which need to be covered by the company through additional equity raises. This represents a non-virtuous circle.

3.17 What is the next step for your company? What potential barriers do you see to achieving this and in your view what would help overcome them?
The spin-outs interviewed in this report are at various stages of development. Some are in the process of trying to get their technology into the market place through industrial scale up, whilst others are trying to make the transition from technology development to product development. The barriers to achieving progress are essentially the ability to raise funds, the presence of technical barriers and the ensuring of sufficient people resources.

To a certain extent technical barriers can be influenced by placing more people on a specific project but the barriers associated with raising funds cannot be overcome with such ease. A common problem is that some fund managers have a certain quota of companies to invest in with a set amount of money. For example, a large fund may be looking to make ten investments in the region of £5 million where a small fund maybe looking to make ten investments of £500K. If the spin-out requires £1.5 million they don't fall into either category and miss out; this results in a 'funding gap' at the intermediate size investment. Problems are also encountered when dealing with fund managers who do not have a strong chemistry background and rely on their chemistry expert, who often may only be educated to degree level.

As will be seen in Part II of this report, venture capital funds tend to specialise in specific sectors such as information technology, software and biotechnology. It is evident that chemistry is not a high priority area of investment for the vast majority of venture funds for a number of reasons, one of which is that chemical science based ventures rarely fall into a neat sector definition. Another is that they tend to be operating at points in the value chain relatively remote from the consumer.

General Questions

3.18 What factors do you think influence university knowledge transfer (both positively and negatively)?
Knowledge transfer is a complicated process which is influenced by a number of different and often conflicting factors. On the whole, universities don't know how to prioritise this activity and end up

portraying mixed messages. There is a clash between academic and commercial cultures. Universities by their very nature reward academics for their research and teaching efforts and do not convey the same regard for an entrepreneurial spirit in their midst.

In agreement with the Wright report[2], universities are deemed by the interviewees to need to create a more accommodating culture for those academics who are entrepreneurially orientated. Young academics must be given the opportunity to develop their careers whilst pursuing commercial activities. For example, offering a 'sabbatical' to enable academic staff to concentrate on starting up a new venture would be a step forward, not only in improving the chances of success for ventures but to send a message to the academic staff in general that entrepreneurial activity is valued highly by the university authorities (see Case Study 3.6).

Case Study 3.6: Royal Society of Edinburgh Enterprise Fellowship

The Royal Society of Edinburgh Enterprise Fellowship programme aims to increase the commercialisation of the Scottish academic research base, raise understanding throughout Scottish universities and research institutes, and to create sustainable companies with high-value jobs. The Enterprise Fellowship offers:

- A year's salary to develop a commercial proposition and product, hosted at the applicants university or HEI;
- Business training that will give the applicant the knowledge to prepare a viable business plan, and
- Access to networks of mentors, business experts and professional advisors.

For further information visit: www.royalsoced.org.uk

Mixed messages are reinforced by Government behaviour. By the very nature of the RAE; Government places no value on spin-out activity from universities by instead placing far greater emphasis on research and papers published. On the other hand, with the introduction of third stream funding, Government is actively encouraging universities to exploit their technology through the creation of new ventures. Such activities should eventually produce an important revenue stream which could ultimately relieve pressures on public funding.

Universities need to facilitate an awareness among the academic staff, of the potential of ideas resulting from the science base that can be exploited. This can be substantially enhanced by a credible TTO with staff who have experience in both academia and industry. This must be coupled with clear guidelines for the commercialisation of university research.

Following the Lambert Review[1] negotiation of IP and clarity of ownership continue to influence knowledge transfer. Businesses still maintain that universities have unrealistic expectations regarding commercialisation of their IP and place too high a price on it.

3.19 What are your views on universities setting up exclusivity deals with Venture Capital entities? Might this actually inhibit innovation and entrepreneurship?

There has been a development of late for some universities to 'sign-up' with a specific venture capital fund. This question sought to examine the pros and cons of such relationships.

There were mixed views from those spin-outs which had been formed without the help of a university that had established an exclusivity deal with a venture capital firm. On the whole, the immediate benefits for the university could be seen; access to additional resources, networks and a non-reliance on public funding. The venture capital firm was considered to instil from the outset, through its injection of experience, a level of discipline in evaluating spin-out prospects and by assisting them in their formative period.

There were concerns on how restrictive these agreements could be and a fear that good innovative ideas may fall through the net if the venture capital firm considers the idea is not worth investment capital. This in turn could stigmatise the venture when it seeks alternative investors.

The exclusive nature of this relationship may also be an inhibiting factor. There was a general feeling that a successful venture needs relationships with several venture capital firms, particularly as the venture

moves to later rounds of funding which do require multiple participations. Similarly, it should be up to the company to decide, not the university, with whom the venture enters into partnership.

Whilst it is attractive to have a lead venture capital firm which has the resources to take new ventures forward and can make connections to other members of the venture capital community, a further concern was that a vacuum would arise if the agreement between the university and the preferred venture capitalist came to an end.

Spin-outs which have been formed with the help of a university with an exclusivity deal with a venture capital firm are in the very early stages of development but, to date, the relationship with the 'in-house' venture capitalist is seen to be extremely beneficial to both the spin-out and university.

3.20 Would a national association of university TTO offices work?

It is widely recognised by business that commercialisation activities require a wide set of specialist skills, which some universities are finding hard to supply with the current resources available. There was general agreement with Lambert's assertion that increasing collaboration between the most experienced universities and those with less experience would make a big difference, and that sharing services in knowledge transfer with other universities in the region is the best way to make this type of collaboration happen[1].

It was generally felt that a national association of TTOs would enhance collaboration and ensure best practice. For example, complementary IP in a specific area could be identified and combined to form a stronger venture (it is believed that too many companies are formed in the UK on a single idea or patent and with little chance of developing a compelling IP position). It would enable more to be done with the same financial resources.

There were concerns that a national set-up is not compatible with how some universities are run and the idea would likely run into a lot of parochialism. The essential objective in promoting such an initiative would be to create generally a more comprehensive, professional approach to the commercialisation of university IP. However, some spin-outs feared that such a move would simply create more bureaucracy. They want the TTO to be as much an entrepreneur as they were themselves.

3.21 What else would help spin-outs?

There seems to be no obvious 'one stop shop' for SMEs. A single agency that can provide sensible answers to the questions new companies have, in order to prevent them being bounced from pillar to post in their quest to find out the basics, would be welcome. There are far too many 'quangos', all apparently doing the same job (technology transfer, knowledge transfer, start-up assistance, business development, commercialisation strategy, etc.) to the point where serious confusion reigns.

Easier access to financial resources is needed early on. Most currently available initiatives require matched funding, but more often that not this means reliance on debt finance to make up the match, unless the founders can put up the money or an angel can be found. Banks are reluctant to support high risk ventures, even with Small Business Loan Guarantee Initiative (SBLGI) involvement.

Resources for IP protection are a major concern for spin-outs. No spin-out could realistically finance the defence of a patent if it were challenged to do so. Since IP is the lifeblood of a spin-out and is chiefly the reason universities take such large equity stakes, it would be helpful if the university assisted with legal fees in cases of patent defences of Intellectual Property Rights (IPR) breaches, or if there was some form of assistance fund.

Almost uniformly these days ownership of IP is by the universities rather than by the academics. Formerly, some universities allowed IP to be owned by the inventors. This change now means that the cost of initial national filing, PCT (worldwide) filing and maintenance of patents in multiple jurisdictions will fall on the shoulders of the universities. Oversight to ensure that patents are being enforced is also necessary - this may involve third party monitoring costs. If patent infringement is found and the infringing party fails to take a licence to practise under that patent then potential expensive litigation may have to be undertaken. Similarly, if patents held by a university are challenged, expensive defence may be required. Are UK

universities really organised to do this effectively? A national repository of university IP, responsible for administration of such IP, would bring economy of scale as well as a bird's eye view of complementary IP opportunities.

Given that Government is encouraging IP filing by universities and that important patents need to be filed widely, we wonder how many TTOs are fully cognisant of the potential cost of maintaining extensive patent portfolios and whether contingency funding is available for prosecution of patent infringement and for defence of patents which are challenged.

Spin-outs themselves are almost inevitably in the pre-revenue phase of their existence and are in a poor position to carry the costs of prosecution or defence of patents, and indeed, may be forced to restrict the geographical coverage of filings to match their financial means: parsimony that could prove very expensive in the long run. One idea to be considered by government, which would ease the cost of IP for young, cash-strapped companies is that the costs of patent filing should be considered as 'R&D costs' for the purposes of calculating a rebate due under the excellent R&D Tax Credit scheme. It is perfectly defensible to consider the cost of protecting the results of R&D as just as important as the expense of developing the IP in the first instance.

4 Interviews with University Technology Transfer Offices

4.1 This section of the report concentrates on university TTOs or the equivalent university organisation. Nine university TTOs were selected comprising:

- BRDL (Birmingham);
- Cambridge Enterprise (Cambridge University);
- Centre for Enterprise and Innovation (University of Southampton);
- Imperial Innovations (Imperial College);
- ISIS Innovation Ltd (Oxford University);
- Research and Consultancy Division (Cardiff University);
- Research and Consultancy Services (University of Strathclyde);
- SUEL (Sheffield University), and
- QUBIS Ltd (Queen's University of Belfast).

These were selected to give representation across the UK and to reflect various degrees of chemical science based spin-out activity (see Figure 2.1).

4.2 Questions to TTOs were directed to organisational infrastructure and the informal and formal processes used by each university to commercialise its research. We also looked at how these organisations interact with industry and commerce. In analysing the answers to these questions, this study highlights the factors which impede the commercialisation of academic knowledge through the creation of university spin-out companies. Data reported are therefore generally qualitative and interpretive.

4.3 What is the mission statement of your organisation?

All successful companies and organisations have a mission statement outlining what their overreaching aims and purpose are with regard to both their internal and external customers. Whilst the majority of TTOs interviewed in this study had such a statement, it was apparent that the remainder use the overall university mission statement, which in some instances makes little reference to commercialisation and almost certainly lacks specificity to guide the TTO in its endeavours, which should after all span the divide between university and industry.

4.4 When was your TTO started and what organisational structure did it replace?

The function of commercialisation of academic knowledge has existed within UK universities for many years. For example, the University of Oxford spun-out its first company, Oxford Instruments Plc. as early as 1959. Prior to the mid-1990s commercialisation activities were predominantly overseen by university administration; most universities had a research and contracts office or had developed a business liaison office to act at the interface with business.

As the depth of the relationships between universities and business has become more developed, and the importance of knowledge transfer realised, the roles of individual university business liaison offices have expanded dramatically. Functions include reach-out to local business, marketing of the research strengths of the university and advice on contract research, consultancy, collaborative research and licensing. This has been reflected in a steady increase in the number of institutions that dedicate staff towards commercialisation activities since the early 1980s[5].

It was not until the mid-nineties and, in particular, after the introduction by Government in 1999 of a third stream of funding dedicated to knowledge transfer in the university sector, that a real transition point was observed. Between 1995 and 2002 a significant period of transition occurred with the majority of institutions creating a specific team to act at the interface between the university and business[5].

However, as a result of variations in university strategies and variability in the needs of local business, no two universities have the same model for university-business liaison. Whilst some universities keep all the activities together within one department, a number of universities have established specialised units to manage knowledge transfer.

4.5 What funding is provided to you and by whom?

In the sample interviewed no two TTOs or similar university organisations were found to be funded in the

same manner. All the TTOs interviewed in this study have or have had in the past access to third stream funding.

Third stream funding is a UK-wide Government initiated funding stream that is designed specifically to support knowledge transfer and has been administered by the funding councils through many different initiatives. In England these have included, amongst others, University Challenge Funds, Higher Education Innovation Fund (HEIF), Science Enterprise Challenge and the Higher Education Reach Out to Business and the Community Fund. Equivalent schemes exist in Scotland, Wales and Northern Ireland.

The majority of respondents agreed with Lambert's assertion that the Government's investment in third stream funding had led to an increased capacity on the part of universities to engage in knowledge transfer from the science base[1] but there were grave concerns about the method of allocation of such funding and the availability of follow-on funding. Differences in approach clearly exist between funding councils and some initiatives are clearly more successful than others.

Continued Government investment in third stream funding is particularly relevant for those TTOs which depend on this source of money to fund the majority of their knowledge transfer activities and will become critical for those TTOs whose universities are stipulating that in the future they should be self funding.

The level of direct university funding varies from one TTO to the next, with some receiving substantial subsidies whilst others receive nothing at all. In general, those TTOs which have been active in this area for some time now receive an important source of revenue from licensing and consultancy activities but the returns do not enable full self-sufficiency. This is paralleled by the experience of US universities which have demonstrated that knowledge transfer is not usually a large revenue generator[1]. Some TTOs also receive a percentage of net royalties and equity benefits. However, revenues of this type will probably not be substantial in the short to medium term.

It is evident that if TTOs are to be self-funding then supplemental streams of revenue must be found. Some TTOs already receive supplemental income from corporate sponsorship, subscription clubs, conferences and events, whilst others are establishing close relationships with VCs and angel networks to reduce their dependence on public finance (see section 4.7).

4.6 If you had more funding do you believe you could achieve superior results?

TTOs strongly believe that if they had more funding they could achieve superior results. There is huge potential in UK universities to increase the flow of ideas from the science base into business and the wider community, but they are constrained by lack of resources. More could be done to encourage an entrepreneurial culture and create more spin-outs and licences if additional funding was made available.

The number of spin-outs and licences each university can handle per annum is severely constrained by the number and expertise of the people involved in the commercialisation process. A limiting factor is the difficulty in recruiting knowledge transfer executives who have substantial industrial experience and possess the following skills: awareness of commercial issues; ability to negotiate effectively; ability to raise finance; credibility with researchers and credibility with industrialists.

Whilst it is difficult to teach such industry-learnt skills to new staff who are without industrial experience, TTOs are left with limited choices. Direct recruitment from industry is difficult, as the main barriers to the recruitment of experienced industrialists are current benchmark university salary levels coupled with the insecurity of short term contracts. It may be necessary to 'commercialise' the whole function of knowledge transfer from universities i.e. free it from university constraints e.g. salary structures.

Following publication of the Lambert Review[1], the Association for University Research and Industry Links (AURIL) and the Universities Companies Association (UNICO) have taken an active lead in trying to address the issue of recruitment and training by providing a series of workshops and providing continuing professional development for those individuals employed in university TTOs.

Similarly, with increased funding, significantly more could be done by TTOs to help early stage activities

and development funding, in particular at the proof-of-concept stage. A major hurdle in licensing and spin-out creation is the lack of funding available to demonstrate whether a new technology is commercially viable or indeed whether it is worthy of being spun out. With most universities having fully invested their University Challenge Seed Fund monies, they now have no direct mechanism of seeding new companies after the proof-of-concept stage. This is coupled with a big shortage of angel and seed investors; all of whom have been badly 'burned' in the past three years and who are reluctant to invest, and a natural difficulty to attract private investment into a venture at the proof-of-concept stage.

4.7 Have you formed any preferential relationships with venture capitalists? If so describe the nature of preference and how you believe it benefits the university. From your experience how would you modify this relationship?

The most successful university TTOs have always stressed the importance of maintaining strong links with the venture capital community as a whole. However, an increasing number of UK universities are entering into preferential partnerships with venture capital firms and angel networks to commercialise their IP (See Case Study 4.1).

The nature of the relationship varies from one university to the next. The most popular agreements involve a commitment by the venture capitalist to invest a set amount of funds in early stage technologies created within the university, whilst providing management support and expertise to facilitate the commercialisation process. In return, the venture capital firm receives equity stakes in any new ventures formed under the agreement (e.g. IP2IPO and Axiom Labs).

Case Study 4.1: IP2IPO

IP2IPO (formerly Beeston Gregory) has developed a highly innovative business model based on building long-term partnerships with universities. Although no one partnership is the same, in each case IP2IPO offers:

- Significant support for its university partner's IP commercialisation activities and in particular, expertise in the identification of novel intellectual property with commercial potential;
- Seed capital finance for spin-out companies, and
- Ongoing strategic and financial support for spin-out companies to maximise their chances of success

Its first agreement was set up with Oxford University's Department of Chemistry. In return for an investment of £20m, IP2IPO has acquired fifty per cent of the university's interest in spin-out companies and technology licences based on IP created until 2015. This was followed with agreements with Southampton University, King's College London and York. For further information visit: www.ip2ipo.co.uk

Relationships of this type provide universities with access to quality expertise, specifically in the identification and facilitation of spin-out companies. It also reduces the universities' dependence on seed finance from public funds. For universities which have a strong research base but are restricted by resources, working in close proximity with a venture capital firm is an attractive proposition and can provide additional manpower and overall credibility to their activities.

In several regions of the UK angel investor and venture capital networks either don't exist or are less well developed. In such cases, the necessity for a university to work in close collaboration with a single venture capital firm is enhanced. National networks are more important to such universities, as an alternative in establishing the links which will support spin-out activity.

There is some concern as to what happens after the unilateral deal comes to an end. Will the universities be able to successfully adapt to the do-it-yourself mode or find another collaborator or (a serious possibility) will a large void be created? There also exists an air of caution about such agreements as the executive management of some universities believe they should not be too closely linked with a specific venture capital firm in order to protect their charitable status.

4.8 How many staff do you employ? Describe categories e.g. IP Specialists, Venture Capital experienced etc.

The number of staff employed by TTOs in the UK varies significantly. This is not surprising as no one

university has the same model for university-business liaison. Some universities keep all the activities together within one department whilst others have established specialised units to manage knowledge transfer. Hence, depending on the model adopted, there is a different level of demand for knowledge transfer expertise.

The largest TTOs (Cambridge Enterprise, ISIS Innovation and Imperial Innovations) are highly skilled and commercially focussed units that employ upwards of twenty-five full-time people and cover everything in-house from technology translators to legal specialists. This avoids incurring substantial external costs. This is not reflected in the rest of the UK: university TTOs have on average less than four dedicated staff[5].

4.9 Does the university have a general policy on commercialisation e.g. licensing vs. spin-out creation?

According to the Lambert Review[1] and other commentators[2] there is a widely held view in business and universities that too many unsustainable spin-outs have been created in the last five years and this has been achieved at a cost to licensing. The Wright report[2] contends that universities are tending to focus on creating businesses rather than creating significant wealth and the proportion of university spin-out companies that really succeeds is tiny.

However, according to the TTOs we interviewed in this study, they do not believe that UK universities focus more strongly on spin-out formation than on licensing. The strategy of most TTOs is to encourage relationships with industry and the private sector as a way of developing their research base into commercially viable products or processes via appropriate business models. These may be in the form of licensing agreements, the formation of spin-out companies or through collaborative research.

The route to commercialisation is determined on a case-by-case basis and is driven by the inventors and the technology rather than meeting 'quotas'. The majority of TTOs contend they do have a successful track record of licensing, which remains an important source of revenue.

All TTOs have individual processes for assessing the commercial viability of ideas emerging from the research base. Some universities use a stage gate management process which takes the new venture from the initial idea to the investor-ready stage while others use innovative assessment systems and metrics to determine the commercialisation potential and route. In addition, some universities engage key individuals from their network of external partnerships in a consultation process to ensure that the best commercialisation route is adopted.

4.10 What activities & initiatives does your university have to support exploitation? Are these activities & initiatives university wide?

There has been a marked cultural change in the UK's universities with many actively seeking to engage the wider community. This has been reflected by the incorporation of commercialisation and exploitation in the majority of universities' strategic thinking. As a result, in addition to the support and services provided by the university's TTO, each university has a plethora of supplementary initiatives and schemes to encourage and foster the exploitation of their research base by business. The most common themes are discussed here.

Most of the universities interviewed currently use or are aware of a number of government initiatives which exist to encourage knowledge transfer between the research base and business (e.g. Knowledge Transfer Partnerships (see Case Study 4.2), LINK Collaborative Research Scheme and Faraday Partnerships (see Case Study 4.3)).

Case Study 4.2: Knowledge Transfer Partnerships

Knowledge Transfer Partnerships (KTP), formally known as the Teaching Company Scheme (TCS) are Government funded and enable UK businesses to benefit from the wide range of expertise available in the UK Knowledge Base - public and private sector research institutes and organisations and HEIs.

Each KTP is a relationship between a company and staff in a Knowledge Base organisation applying their expertise to a project that is central to the development of the Company partner. At the heart of each partnership is one or more KTP associates; a high calibre graduate recruited to work on the project. For further information visit: www.tcsonline.org.uk

Case Study 4.3: Faraday Partnerships

Faraday Partnerships are dedicated to improving the competitiveness of UK industry through more effective interaction between the science and technology base and industry. Effective interaction requires the identification of industry needs and the subsequent synthesis of the knowledge and experience of those who can satisfy these needs. Crucially, each Faraday Partnership employs a number of technology translators - people with broad experience of knowledge transfer who can facilitate projects between Partnership members. In total, there are twenty four Faraday Partnerships. For further information visit www.faradaypartnerships.org.uk

In addition to the formation of university spin-outs and licensing, all universities have a dedicated team in place to support exploitation via contract research, collaborative research and consultancy.

Universities are also trying hard to create an entrepreneurial culture which will result in more research being commercialised. The introduction of university driven enterprise programmes, focussed on encouraging entrepreneurship, with an aim to providing academics with the skills synonymous with commercial awareness and acting as a substitute for prior business experience, is one way of addressing this.

Schemes of this nature are run predominantly by university business schools, newly created enterprise centres or via one of the thirteen Office for Science and Technology (OST) funded Centres of Excellence (see Case Study 4.4). The programmes serve undergraduates and postgraduate students in all faculties, as well as staff and alumni. Certain university science faculties have decided to incorporate an element of enterprise teaching into their undergraduate syllabus, whilst some universities are considering enabling undergraduates to take optional business modules as part of their degree course (see Case Study 4.5).

Case Study 4.4: White Rose Centre for Excellence

The White Rose Centre for Excellence (WRCE) forms part of the Government's strategy to introduce a 'third mission' for Higher Education, alongside teaching and research, to encourage transfer of science and technology innovation to the business sector. The WRCE is one of the 13 OST funded Centres of Excellence and is a collaborative venture between the three White Rose Universities of York, Leeds and Sheffield. It is a programme to spread enterprise learning through the science and technology curriculum and to accelerate the rate of spin-out and start-up companies. For further information visit: www.wrce.org.uk

Case Study 4.5: Hunter Centre for Entrepreneurship

The Hunter Centre for Entrepreneurship is based at the University of Strathclyde and is charged with enhancing the entrepreneurial capabilities and intentions of all Strathclyde people. Its programmes serve undergraduate and postgraduate students in all faculties, as well as staff and alumni.

Students learn how to practice entrepreneurship through in-class analysis of real business situations in the presence of entrepreneurs and entrepreneurial resource providers, through in-company projects, and by developing their own entrepreneurial ventures. For further information visit: www.entrepreneur.strath.ac.uk

For new ventures, master classes in specific aspects of business e.g. writing a business plan, basic accounting, human resources and marketing have been devised and some universities also run regular surgeries where individuals are given the opportunity to have an informal one-on-one meeting with a professional (e.g. a venture capitalist or solicitor). In addition to the services provided by individual university TTOs, some regions of the UK have separate collaborative schemes dedicated to the exploitation of the research base through the creation of university spin-outs. Two examples of this are Finance Wales Spin-out Programme and Spinner (see Case Studies 4.6 & 4.7).

Case Study 4.6: Finance Wales Spin-out Programme

The Finance Wales spin-out programme was set up in response to research which highlighted the potential for the knowledge, expertise and know how within HEIs in Wales in order to contribute to the future growth of a strong, home-based economy. The scheme offers a comprehensive start-up package for people wishing to set up a business in Wales where there is a close ongoing relationship with a

Welsh Higher Education Institution (HEI). Potential benefits include: subsidised office space, advice and mentoring, an unsecured loan, effectively interest free, of up to £25,000, market research and specialist consultancy, ongoing support and staff displacement fund.

It has supported 65 businesses over the first 3.5 years, helping to draw a further £3.3M in grant funding, private sector funding and owners' contributions, helping to create over 200 jobs. For further information visit: www.spinoutwales.com

Case Study 4.7: Spinner

Spinner has primarily been designed to provide comprehensive support to the exploitation of research from all eight of the Spinner universities. The project has been put into place to explore and protect their ideas, then develop them into fully viable commercial opportunities. The main objective of Mercia Spinner is to create 40 spin-off companies by 2010, generated and shared between all eight universities (University of Warwick, Birmingham, Keele, Staffordshire, UCE, Coventry, Aston and Wolverhampton). For further information visit: www.spinner.org.uk

The Lambert Review[1] concluded that the best form of knowledge transfer involves human interaction. It is, therefore, not surprising that most universities now have either an entrepreneurial club, or an innovation society or some form of knowledge transfer network to support exploitation (see Case Studies 4.8 & 4.9).

Case Study 4.8: Oxford Innovation Society

Established by Isis in 1990, the Oxford Innovation Society allows companies to have a 'window' on Oxford science and fosters links between business and the academic community. In the past 12 years, over 90 companies have taken advantage of this opportunity, helping to shape one of the most successful technology transfer networks. For further information visit www.isis-innovation.com/about/ois

Case Study 4.9: ISIS Angels Network

Established in 1990, the Isis Angels Network (IAN) is a not-for-profit company limited by guarantee that provides a vehicle for the introduction of private individuals and companies with potential interest in investing in spin-out companies from the University of Oxford. For further information visit www.isis-innovation.com/about/ian

A small number of universities also offer incubator facilities on a fully commercial basis. New ventures are usually offered space for up to a maximum of one year, on short term contracts. SETsquared is one such initiative (see Case Study 4.10). However, few universities interviewed offer 'wet chemistry' space.

Case Study 4.10: SETsquared

SETsquared is a collaborative partnership between the universities of Southampton, Bristol, Bath and Surrey which is used to support nascent entrepreneurs from within the universities and across the entire local region. Companies are provided with incubation space and a range of business support services. It opened in the summer of 2004 and is filled with a range of high-tech companies. For further information visit www.setsquared.co.uk

Other initiatives include the introduction of 'enterprise champions' within individual schools and faculties to drive the universities' enterprise agenda at a local level, networking events, business plan competitions and a series of lectures, seminars and conferences. Whilst these activities and initiatives are primarily adopted by the science based sectors they are available to all sectors of academia and are university-wide schemes.

4.11 What factors influence the number of spin-outs? (positively and negatively)

Availability of early stage funding is a significant impediment to the creation of spin-out companies. Most University Challenge Seed Funds have been fully invested and a funding gap seems to be emerging. Some universities have found that a positive relationship with venture capital firm or angel network can help overcome this problem, as it removes the dependency of the university on public funding (see Section 4.7 and Case Study 4.1).

The nature and clarity of a university's commercialisation policy continues to influence spin-out activity. A lack of clarity in the ownership of IP in research collaborations increases the time and cost involved in doing a deal with the university, deterring some organisations, especially SMEs, from trying to collaborate with universities in research[1]. Impediments also arise from protracted negotiations on the distribution of equity in the spin-out company and unrealistic demands from the university and founders. For example, even when the venture does get funding there exists a reluctance to accept dilution of the university shareholding in order to attract new funding to allow the venture to grow quickly.

The quality and breadth of the science base is crucial. If a university has a strong research base it is likely to provide a sufficient number of ideas to ensure a good stream of exploitation opportunities and in so doing attract a 'cluster' of companies 'feeding' from this reservoir of ideas and qualified individuals.

The expertise, resources and reputation of the TTO are fundamental to the number and quality of university spin-outs. The interface between universities and industry would be significantly enhanced if there were more competent knowledge transfer executives who have a wide breadth of experience, and are trusted by both academia and industry. There is a distinct need for good intermediaries who understand both academia and industry, and can respond to the gap between 'push' and 'pull'. It is important to get it right as it is unlikely that academics will try the commercialisation pathway twice. The ethos of the TTO (i.e., proactive as opposed to reactive) could also influence the propensity for a university to nurture successful spin-out activity.

A lack of good business management skills significantly undermines spin-out activity. It is important that good business management is brought in at an earlier stage in the development of spin-outs. Inventors are not always equipped enough to deal with the more 'savvy' venture capital companies and frequently lack the experience to grow with the company, often holding back its progress until (usually) the venture capitalist investor makes the move to resolve the 'road block'.

The introduction of naïve government legislation, in the form of Part 7, Income Tax Earnings and Pensions Act 2003 (Schedule 22), has impacted significantly on spin-out creation in 2004. It adversely changed the taxation position relating to academics' shares in a spin-out; founders are liable for tax on the value of their shares even before the company has begun trading. Due to concerns over Schedule 22, spin-out activity has ceased in many universities.

ISIS Innovation Ltd is the knowledge transfer company of the University of Oxford and has, in the past, spun out on average, one company every two months. However, with the introduction of Schedule 22 this figure has fallen to two for the whole of 2004. Similarly, according to UNICO the number of spin-out companies created by universities nationwide dropped significantly after these changes to tax laws. In 2002-03 universities spun off an estimated 172 companies, but this fell to 89 in 2003-04[6,7].

Following a lengthy consultation process between government offices, AURIL and UNICO it seems that a resolution has been found; the chancellor announced the abolition of the tax liabilities on academics shares in high-technology university spin-outs in his pre-Budget report[12].

One clear factor which contributes to the success of a spin-out company is the commitment of the founding academic to commercialising the technology. In some instances the individual academic is not sufficiently emotionally or financially committed to championing the commercialisation of the scientific discovery[2].

This can be due to a multitude of different reasons but is fuelled by the existence in universities of a mismatch between academic and commercial cultures. Universities must therefore attempt to create a more accommodating culture for those academics which wish to participate in commercialisation activities. In agreement with the Wright report[2], universities should provide greater career support and entrepreneurial training to those academics who wish to participate in the commercialisation of their research in order to gain their commitment to the process. One such mechanism would be to offer academics a sabbatical to enable them to develop a spin-out company free from teaching and research commitments.

The lack of suitable and cost effective space on a science park is the most important infrastructure related impediment and is particularly important for chemical science based spin-outs which require 'wet chemistry' space and specialised equipment. This was also cited by the spin-out companies themselves (see Section 3.13) and supports the Wright report[2].

4.12 How many (if any) spin-outs have failed, and in your view what are the main reasons for failure?
The TTOs interviewed for this study cited that only a small number of spin-outs had been outright failures; the general consensus was that they are more likely to show limited growth and hence, become the 'living dead' rather than disappear completely. This is to some extent reflected in the data collated by us from the chemical science sector (see Section 2.13 and Figure 2.4).

The Wright report[2] asserts that the proportion of university spin-out companies that truly succeed is tiny because universities are tending to focus on creating businesses rather than creating significant wealth, and unless universities are prepared to back their spin-outs with appropriate resources, most will continue to fail. This report supports this conclusion.

Similarly, the lack of required commercial expertise on the part of the universities and academic founders often manifests itself in bad management. As a result, there is often an inability to conceptualise how a technological discovery can be best developed to satisfy a market need[2]. Thus, there may be no credible or established market for the technology or product, or the direction in which it must be developed to create such a market is not correctly assessed (and then acted upon). In addition, there is also an unrealistic expectation of what technology development costs compared to the revenues it may generate. This is manifested by unrealistic revenue projections, undisciplined cost control and failure to meet technology milestones.

Failure to raise finance is also a factor explaining the failure of spin-outs to grow. Companies find it extremely difficult to raise follow-on funding. This is predominantly true in the development phase. Lack of credibility with potential investors, resulting predominantly from the weak commercial track record of the founding academics together with the perceived effect of academic culture and values is the main reason, with overvaluation by the university of its IP as an important secondary reason.

Lack of commitment by the academic founder can also result in failure for early stage companies. This report agrees with Wright's assertion that in some instances, the founder and/or surrogate entrepreneurs do not become sufficiently emotionally and financially committed to championing the commercialisation of their scientific discoveries[2].

In some instances, there is a 'soft underbelly' of spin-outs which seem to be more vehicles to continue further research rather than genuine attempts to set up spin-out companies.

4.13 What else would help the formation of spin-outs that is not within university control? Do you have any other views on spin-outs?
It seems apparent that the main challenge for the UK is how to raise the overall level of demand by business for research from universities. Hence, Government needs to work on the 'pull' side (demand by business). The 'push' side (supply of commercial ideas from universities into business) appears to be progressing well.

In general, the creation of university spin-outs is seen as beneficial to the regional economies. However, the view from the university community is more often than not that universities are here predominantly to do research and teach. This is indeed their core business and it should remain so. It would be, frankly, difficult to engender the massive cultural change required in which UK universities become substantially more commercial and entrepreneurial such as has happened in some non-UK universities, for example Massachusetts Institute of Technology (MIT).

Many academics have made a decision to eschew rewards of the material world. Yet, there is a general perception that universities are an untapped resource containing hoards of budding entrepreneurs. Some entrepreneurs do exist within the confines of universities but the majority of academics are not entrepreneurs and it is unfair to assume they are and put pressure on them to become so. Yet those who

are must be encouraged by creating a unique environment in which they can flourish.

For many universities the development of a virtuous circle of support would be beneficial. Lambert[1] made an important point when referring to knowledge transfer centres: these are crucial for universities which have not yet developed 'the Cambridge phenomenon' of self-sustaining critical mass of innovative companies around the university. Billions are spent on research in the UK per annum. This amount of spending necessitates a cadre of industrially-experienced people to work with the academics to tap into the commercial potential of the UK research base. This can only be achieved if the universities open their arms to the experience of the commercial world.

The majority of universities have accepted that they will not make huge returns through the creation of new ventures. Nonetheless, spin-out formation is now an important element in the majority of university strategies. Most universities are now committed to local development and regeneration. Spin-outs provide a home market for graduates and often lead to further funding and collaborative work for the university. If the university makes money it is a bonus. The acceptance of this 'bargain' by most universities is a huge step forward.

It is also worth noting that a number of UK spin-out companies have shown great promise but have not reached their full potential; they have been acquired before generating any real size. All of the Oxford spin-outs that have succeeded are now foreign-owned. This is partly because thinking in the UK financial community is 'short-termist', lacking real long term resolve. Investors are happy to sell a company at a good profit for £100 million, but are not prepared to make the further investment to turn it into one worth £1 billion.

4.14 What mechanisms does your university use to co-operate with industry?
In addition to the support and services provided by TTOs each university has a variety of supplementary initiatives and schemes to encourage cooperation with industry. These range from formal consultancy and collaborative research to the facilitation of technology showcasing events, expertise directories, company visits, networking events, business clubs and industrial liaison.

Some universities are also establishing centres of excellence which provide a direct link between academia and business, along with a mechanism to access key academic expertise and facilities that many companies do not have in-house (see Case Study 4.11).

Case Study 4.11: Sheffield Polymer Innovations and Enterprise (SPIE)

A project to develop the first of a series of Sheffield Centres for Innovation and Enterprise, piloted in the University's new Polymer Centre with the establishment of the SPIE. SPIE will establish an industrially orientated delivery-focused infrastructure for polymers related research. www.polymercentre.org.uk

Most universities are also active participants in a number of Government initiatives which aim to promote knowledge transfer between universities and business. CASE studentships and the KTP scheme (see Case Study 4.2) are two popular examples.

4.15 Approximately how many patents does your office support and at what rate are they being filed (per year)?
All universities continue to protect their innovations by taking out patents. As one would expect the number of patents supported and the rate at which they are filed varies between universities.
Initial patent filing is pretty routine in all universities but evidence of substantial progress needs to be shown for the international phase to be undertaken. This continues to be severely restricted by individual university budgets. Questions arise as to whether any university or university spin-out would be able to protect a patent should it be attacked and indeed maintain a growing patent portfolio over many years.

4.16 Do you agree with the Lambert Report conclusion that universities should focus on the overall public good and less on making money from the spinning out of IP, focusing on licensing and less on spin-outs?
This particular conclusion has provoked a mixed response from TTOs. Only one university completely

agreed with this statement and believed that universities should focus solely on the public good.

Most agree that public funded research is intended to benefit the economy and they should never end up in a situation where technology does not get exploited because commercial terms could not be agreed. However, universities increasingly need to have independent sources of funding and it is therefore appropriate for universities to get a return from the IP they generate when a successful outcome is reached.

As to there being too much emphasis on developing university spin-outs and not enough on licensing technology to industry, universities feel that rather than addressing the balance, it is essential for the right approach to be taken, the one that will ensure success. Whilst universities realise a spin-out company can be a vehicle for developing and exploiting technology, licensing technology to an existing company is regarded as an equally valid route to exploitation.

Both routes have their strengths and weaknesses. The fact that some licences may go to a non-UK resident companies is not a reason to prefer spin-outs to licensing, as wherever the IP ends up, licensing will improve universities links with business[1]. However, the contribution spin-outs and SMEs make to local economies in terms of employment and local regeneration should not be underestimated.

If handled correctly, it is generally agreed that the commercialisation process can be done for the overall public good and provide a modest financial return for universities. In order for this to be done efficiently three parameters need to change and must be driven by the universities themselves:

- Development of an entrepreneurial culture;
- Increase in university TTO resources, and
- Development of a network of good local professionals and experienced entrepreneurs.

If more emphasis is placed at the interface between universities and business, ergo on the TTOs, more ideas will be brought to commercial fruition, thus resulting in an enhancement of the overall public good and in the generation of greater levels of revenue which can be fed back into knowledge transfer. The key focus in the immediate future must, therefore, be concluded to be a strengthening of the capabilities, resources and dynamism of the TTOs. The ideas are there in the universities and the British venture capital community is second only to one other nation. Therefore the bridge between the two must be the focus of attention.

PART II

5 THE ROLE OF VENTURE CAPITAL IN PROMOTING CHEMISTRY – RELATED TECHNOLOGY SPIN-OUTS AND START-UPS

5.1 This section of the report captures comments made by those interviewed which pertain to the general venture capital (VC) environment in the UK. Before starting on this part of the report some definitions are appropriate for those readers not generally familiar with the subject.

Types of Venture Capital

5.2 **Angel Investors** – investors, generally private individuals, but including friends of the founders and small investor groups who invest at the earliest stages of a venture, often while the business model is still being formed and potential market explored.

In the USA this is a very vibrant investor group, made up of individuals with not only high net worth but often with experience of building businesses themselves and who help guide the venture through the frequently encountered pitfalls. This group of investors have suffered badly in the collapse of the technology bubble in 2001/02 and the fact that many of them have been 'burned' will slow down venture investing for some time to come; until the 'pain' fades and (see later) they again believe that follow-on VCs will treat them fairly and not simply and cynically 'wash them out' in subsequent funding rounds.

It has now reached the point where each successive round of investment may take preferential liquidation rights over the investors of the previous rounds. This is counter to the intuitive assessment that the later the investment, the lower the risk that the money will be lost. It does speak to a scarcity of investment funding or else these later stage investors would not be able to demand such onerous terms. It is said that the funds are available but that investment managers are ultra-cautious about making investments: scarcity by another definition.

5.3 **University Investors** – this is an important category of investor for spin-out ventures (i.e. where IP is conveyed from a university to a privately funded, and held, venture). Universities may also earn equity through contributions in-kind, such as laboratory facilities, access to expensive instruments and occasionally cash, although universities are not high-risk investors by nature.

The equity of the university is, like that of the angel investor, vulnerable to follow-on investments made with little regard to those who took the earliest and highest risks. As a result, they have suffered massive dilutions in the past few years. University TTOs need to consider more sophisticated equity models whereby this dilution can be limited or else there is little incentive for them to take equity rather than simply licence out technology and charge commercial rates for services, which would hinder early development of a spin-out.

5.4 **Start up Venture Capitalists** - generally these are small VC funds operating locally and investing hundreds of thousands of pounds. They form the base of future venture investing and do a very important job of sorting out those ventures which have a chance of success from those which should not be funded. This category of investor takes high risks, yet they have been savagely mauled since the technology bubble burst. In the Cambridge area there were nine such funds in 2000, of which only two now survive. This will leave a hole in the chain of investors for some time to come. Start-up VCs have realised they are vulnerable to predatory follow-on investors; another risk factor on top of the normal risks of technology failure and that they, therefore, have to be able to follow-on with investment in subsequent funding rounds. This will require larger funds to be raised by this class of investor.

5.5 In describing these three classes of investor, overt criticism has been made of the behaviour of some of the mainstream VCs since the technology bubble burst. Some of these VCs shrug and invoke the laws of the financial jungle. However, there are others who defend themselves by pointing to the greed of founders and early investors in pushing valuations up too quickly, before the fundamental strength of

the business is really established. In such cases, they have the choice of either rejecting the investment or diluting the early investors down by investing new money at a more realistic valuation; wherever the allocation of blame, 'washout' of early stage investors is, according to one VC, 'the worst for 20 years' and cannot be good for the future availability of funding for early stage ventures.

5.6 **Mainstream Venture Fund**s - these funds are the engine of growth for spin-outs and start-ups, investing anything from low single digit millions of pounds to tens of millions. As the fund which they have raised increases in size, the minimum investment tends also to rise as the work to evaluate a company/investment and to document a deal varies little by size. This trend may be leaving a gap at the lower end of the funding range, especially with the reduction in start-up venture capital availability. Government seems to have recognised this gap with the creation of the Enterprise Capital Fund but will this be enough?

A worrying report that we have heard during this investigation, is that UK Pension Funds have turned away from early-stage technology investing vehicles, in favour of private equity funds investing in established businesses, most in non-technology based businesses. The reason is, apparently, that over the past 20 years average returns to UK investors in technology have been single-digit percentage internal-rate-of-return (IRR) compared to average returns in excess of 20% in non-technology, established businesses. Since return on investment is supposed to correlate to risk when averaged over sufficient time, and early stage ventures are undeniably higher risk, something is wrong with this picture. Something is especially wrong when the above rule is, anecdotally, followed in US investing. This subject needs further investigation to determine why returns in UK technology investing have been, on average, so low. Some suggest that it is the lack of in-depth knowledge by many investors of the technology field in which they are investing that is the root cause. Government may also consider whether the favoured tax position of pension funds may demand that there be some minimum level of higher risk investing.

One clue may be that three of the VC funds interviewed made a plea to attract successful British entrepreneurs back to the UK (usually from tax exile in the US) suggesting that lack of high quality technology entrepreneurs is one major reason for the lack of success in technology venturing (the author's own experience however suggests that the Inland Revenue would need 'to get with the programme' for this to be successful, as expatriates returning to the UK would be unwilling to expose their non-UK earnings to UK taxation; US tax law is especially 'friendly' to entrepreneurial investment. Another reason suggested in the VC interviews is that UK government purchasing policy is less small company 'friendly' than that of the US for example. However, one VC interviewed put it down simply to lack of expertise in technology on the part of too many investors. The reality is probably that all three potential deficiencies need to be addressed.

Methodology

5.7 A sample of eleven organisations was selected to represent the general VC environment in the UK and examples of corporate venturing:

- 3i;
- Abingworth;
- Amadeus Venture Partners;
- BASF Ventures;
- British Venture Capital Association;
- Doughty Hanson Ventures;
- Dupont (US);
- North Star Ventures;
- Quester;
- Scottish Equity Partners, and
- TTP Ventures.

Answers to the questions featured in the interview are reported below and are therefore generally qualitative in interpretation.

Main Messages Gathered from Investors

5.8 Chemistry related start-ups are not favoured by the VC community. Likewise, 'Materials' are viewed as too remote from the end-market to generally allow strong control by the venture over its destiny. The exception is bio-related chemistry; although the climate for even this segment has soured more recently, as the very long gestation times (10 years) for more fundamental developments are realised as being out of the time frame attractive to the vast majority of VCs to exit their investments.

Another reason given for this relative lack of interest is that there is a lack of trade buyers willing to pay attractive multiples of investment. Public market chemical companies generally do not enjoy high price-to-earnings multiples and, therefore, high P/E multiple acquisitions are very dilutive to earnings per share. Comparing the FTSE listing of quoted chemical companies 15 years ago with that today, one sees the demise of the segment in terms of numbers and market capitalisation. Small wonder there is not much corporate spin-out activity or that the segment is not viewed as fertile ground into which to sell promising start-up ventures.

5.9 R&D budgets in the chemical industry have been 'clobbered' as the industry has struggled with declining margins and poor profitability. Most R&D in chemical companies is relatively short-term focussed. Long-term research has been abandoned by all but the largest global chemical majors and spin-outs from the industry itself are few and far between. Some chemistry related IP is spun out by the large pharmaceutical companies as they focus R&D on areas capable of generating substantial revenues.

5.10 Increasingly, chemistry is just one discipline in a number required to deliver a commercial technology business. This requirement for cross functionality is confusing to some VCs. It is seen by leading chemical companies to be a key to their regeneration and increasingly they are redefining themselves as 'materials' companies.

5.11 British VCs tend to focus on the following technology segments for investment:

I. IT – generally software. This is not capital intensive, highly user focused and therefore close to the consumer. Ventures in this area are readily saleable and assimilated by established software houses as 'bolt-on' products.

II. Semiconductors – technology here is evolving so quickly that commercialisation is quick, success/failure is quickly determined and exit via IPO or trade sale relatively quickly attained. Markets for products are attractively large.

III. Biotechnology – this has been the 'sexy' investment area of chemistry since Monsanto set up Advent Partners in the early 70s to invest in this exciting new area of technology and made enormous returns with investments in start-ups such as Genentech. The success of the global pharmaceutical industry has provided the exit vehicle for VCs investing in this area, a sine qua non for attractiveness of investment.

The size of the potential markets for the products arising from biotech innovations satisfy yet another sine qua non for investors and the existence of successful role models, such as Amgen and Genentech, where the exit for the investors has been the public markets, has also been important.

However, it is increasingly recognised that biotech ventures can take many years to get to the point where they stop consuming cash, let alone generate a profit. Many venture funds have a limited life span (so-called closed ended funds which have to liquidate their holdings at the end of, typically, ten years and cannot invest further funds in ventures at, again typically, six years) and therefore reach a point where they need to exit these biotech ventures earlier than might be ideal from the point of view of realising a return on investment. The long gestation period for development of the technology also means that the period of profitable, patent protected, commercial exploitation of the technology is relatively short.

5.12 In addition to the established private sector venture funds there are now a number of sources of funding which have obtained monies through the public purse; some of these are more sophisticated investors than others. The North East, North West and Scotland seem to have taken an aggressive approach in this regard with funds such as North Star in the North East realising that the key to new business creation is a combination of money and expertise.

On the other hand, the RDAs are generally held to be unsophisticated investors (with the notable exception of Scotland) and there is much nervousness about the level of investing expertise within the RDAs to effectively invest the funds they have at their disposal. Some of the people we talked to, point to the success of Singapore in investing government monies through a dedicated VC entity 'Tamasek' to foster government technology development objectives. It is said that Belgium has established a similar vehicle 'GIMV' although this has not been investigated. This model is worthy of further investigation as it would complement the private sector venture funds. In similar vein, the role that DARPA (Defence Advanced Research Projects Agency) plays in the US in promoting technology developments in selected fields is pointed up as a model for government financial support of strategically focussed technologies. DARPA had a budget of 2.7 billion dollars in 2003.

5.13 It is felt by a number of the interviewees that the angel investor needs to be better encouraged to invest in early stage ventures. The environment in the US is felt to be superior in this regard. For example, in the US individual investors can self-certify that they are 'accredited investors' whereas the FSA in the UK demands that this be done through accountants. It is felt that there should be more encouragement for the individual, higher net worth investor in addition to the current focus through Venture Capital Trusts.

5.14 There has been a shift away from early stage investment in the past five years. One VC interviewed said that the very early stage investment market really was the living dead, with only the very exceptional technology venture getting funding. At the other end of the investment spectrum it is widely acknowledged that the appetite on the part of the UK VC community for the very big investments needed to retain control over a company to create an entity worth $1 billion is lacking and that we will continue to see promising ventures sold to overseas investors (mainly US funds as well as companies) at an earlier stage in their development. Cambridge Display Technology is an outstanding example; fundamental British invention coupled with an area of technology with huge market potential. Sold in 1999 by the original British VCs for $125 million after VC investment of less than $10 million to American private equity funds who have since invested a further $100 million to promote the development of the technology. The company has just listed on the NASDAQ exchange at a capitalisation of $235 million.

5.15 Just as there are those who would challenge the charitable status of British pension funds who eschew any investment in early stage technology, there are those to whom we have talked who say that the Treasury should place tighter requirements on VC funds for their investors to qualify for taper relief on their investments. Investing which contributes to the future global competitiveness of the UK should rank above that which simply makes an established business more profitable. Food for thought.

5.16 In the context of spin-outs from UK universities, from these discussions with British VCs it is apparent that there are a number of issues to be addressed. The universities need to make themselves easier to deal with: 'we prefer to deal with company spin-outs. University spin-outs are just too much hard work'. The universities are seen as too focussed on making a 'profit' from spin out activity. MIT is held up as a model of a university whose prime focus is to facilitate IP spin-out rather than make a profit from research which has been funded by the public purse. However, if government continues to 'squeeze' the universities' sources of funds then one can understand if the university tries to relieve that pressure by capitalising on one of the few money generating assets that it does have.

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