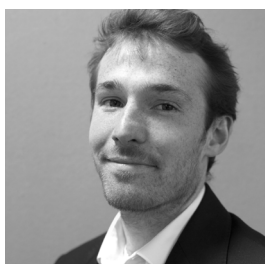


Insights into University-Industry Interactions from the Cambridge Biomedical Cluster

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Summary

This report aims to investigate university-industry interactions and mechanisms of knowledge exchange and technology transfer, taking a case study approach. The study is focused on the Cambridge cluster, particularly on the area of Life Sciences. Fifteen key interviews were conducted with serial entrepreneurs and members of local companies and institutions within the cluster. Interviewees were chosen because of their expertise and background in area of university-industry interactions (see annex material for details). Case studies and quotes have been included in the main document to illustrate some of the key findings.

Cambridge University plays a central role in the cluster. It is an important contributor to the innovation ecosystem in both overt and less explicit ways. It is clearly a source of skilled workforce, an attractor for social capital, a driver for knowledge exchange and a promoter of cross-disciplinary networks. While the University may appear to be a significant source of intellectual property and technology for startup companies in the cluster, the evidence in this study suggests that only 3.5% of the high-tech companies in Cambridge could be considered direct university spinouts. This could possibly contradict the assumption that universities are the main driver for intellectual property and technology for startup companies in clusters.

The model from lab to market is non-linear and highly complex and dynamic. The latter is illustrated by a case study example of a university spinout, Cambridge Biotechnology Limited (CBT). As shown in the illustrative figure (page 10), external events such as company buy-outs and merges are major drivers of the creation of the spinout and startup companies examined in this study. Studying the case of CBT, human capital, technology and investment appeared to flow between a total of three universities and sixteen companies (2000-2013). This demonstrates how university-industry interactions can evolve over time and how dynamic and complex the pathway from lab to market can be.

Within Cambridge University the Computer Laboratory appears to do particularly well in promoting knowledge exchange, technology transfer and entrepreneurship. A total of 205 companies were

started by the departmental staff and students since 1968. Many of the graduate-founded businesses were unrelated to the departmental research and do greatly contribute to the economic development in the cluster. A group of 68 private companies financially support research and teaching in the department. To facilitate the latter, the Computer Laboratory developed initiatives such as the “Hall of Fame” and “Industrial Supporters Club”, which, according to some, is key to their success.

Teaching and performing research are the primary academic duties. Knowledge exchange is therefore considered as a third stream activity, which is gaining in importance as funding bodies provide greater incentives for this work. However, the approach to capturing the extent of knowledge exchange within institutions is an evolving field. Some interviewees reported strong bias exists towards measuring and reporting knowledge exchange activities of financial and contractual nature in national surveys. These “commercialisation” activities appear to only represent around 10% of the total knowledge exchange engagement (source: Public & Corporate Economic Consultants and Centre for Business Research (2009): The evolution of the Infrastructure of the Knowledge Exchange system), thereby failing to capture a substantial part of the academic engagement that may or may not have a significant societal impact.

Many participants in this study reported on the challenges and misconceptions in the field of technology transfer. These included: Intrinsic difference between the drivers of academia and industry; Negotiations regarding IP ownership; Bureaucratic barriers related to the reports required by various academic funding streams; Difficulties to perform boundary-spanning activities and exchanges between universities and industry. In addition, it was mentioned that businesses are largely demand- or customer-led rather than idea- or research-led, leaving an absence of support for the research-led model often adopted when aiming to commercialise academic research. Multiple interviewees also commented on the fact that most technology transfer offices do not appear to be profitable ventures in the UK, with the exception of Cambridge Enterprise, Isis Innovation and Imperial Innovations.

1. Introduction

Universities play a key role in economic development at national and regional level. Research Councils invest over £3 billion in academic research yearly, which contribute to economic growth and society as a whole. However, now more than ever, it is essential to understand the role of Universities in the innovation ecosystem and cluster formation to maximise academic impact and contribution. In order to do so, research is needed to gain insights into the nature of the linkages between Universities and local companies.

The complexity and challenges underlying the model from lab to market need to be better understood, researched and illustrated with in depth case studies. Mechanisms of knowledge exchange and technology transfer, also referred to as translational research, need to be further explored. In order to shed light into the latter, this research project focused on the Cambridge

cluster, one of the leading high-tech clusters in the world. Since Cambridge University is known to be strong in the area of Life Sciences [1], the biomedical sector received emphasis in this report.

A literature review was followed by a series of interviews with members of the Cambridge cluster. The list of interviewees comprises of serial entrepreneurs and investors, members of companies such as Cambridge Biotechnology Limited, MedImmune, Proximagen, SQW Group and IN-PART, and members of institutions such as Cambridge Enterprise (technology transfer office); the Centre for Entrepreneurial Learning (CfEL); the Centre for Science, Technology and Innovation (CSTI) and the St John's Innovation Centre. Case studies and quotes resulting from these interviews were used to illustrate some of the key findings. A full list of interviewees is shown in the following table.

Table of Interviewees

Affiliation	Name	Job Title
Business, Innovation and Skills	Mr Peter Northover	London and East Director
Cambridge Angels	Dr David Cleavelly	Serial Entrepreneur & Angel Investor
Cambridge Angels	Dr Andy Richards	Serial Bio-Entrepreneur & Angel Investor
Cambridge Biotechnology Limited	Dr Peter Richardson	Academic Founder
Cambridge Enterprise	Dr Richard Jennings	Deputy Director
Cambridge Enterprise	Mr Boris Bouqueniaux	Head of Support Services
Centre for Entrepreneurial Learning	Dr Shailendra Vyakarnam	Director
Centre for Science, Technology and Innovation Policy	Mr Tomas Coates Ulrichsen	Research Associate
Hughes Hall, Cambridge University	Mr Stephen Allott	Quondam City Fellow
IN-PART	Dr Robin Knight	Co-founder
MedImmune (Cambridge)	Dr Paul Varley	Vice-President of Development
MedImmune (Cambridge)	Dr John Elvin	Scientific External Liaison
Proximagen	Mr Kenneth Mulvany	Chief Executive Officer
SQW Group	Mr Chris Green	Chief Executive Officer
St John's Innovation Centre	Dr Huw Edwards	Associate

2. UK Life Sciences and the Cambridge Biomedical Cluster

The UK has long been a global-leader in Life Sciences, with an industry comprising of 4,500 companies in the Life Sciences sector, which employ around 167,500 people and generates a yearly turnover of £50bn [2, 3].

The Cambridge cluster, which is one of the strongest hightech clusters in the world, comprises of 1,540 innovative companies, employes over 56,000 people and generates a yearly revenue of around £13bn [4]. The cluster rapidly grew around the University since the 1960s, which is referred to by some as the “Cambridge Phenomenon” [1].

“Cambridge is a world renowned bioscience hotspot that rivals the likes of San Francisco.”

Mr Pascal Soriot
CEO, AstraZeneca
(source: BBC News, March 18, 2013)

Over the years, Cambridge University developed a strong research base and was awarded 89 Nobel Prizes, many of them awarded for solving biological challenges. This demonstrates the strength of Cambridge in the area of Life Sciences, which has recently been emphasised by AstraZeneca’s decision to move its headquarters there by 2016.

3. Features of a Healthy Cluster

Before the role of Cambridge University in the formation of the Cambridge cluster can be tackled, it is essential to gain insights into the properties and characteristics of a healthy cluster.

A healthy cluster typically contains a mixture of a high social capital, sources of technology, investment, infrastructure, cross-boundary networks and an entrepreneurial culture [5, 6]. These features contribute to a highly complex and dynamic ecosystem. Furthermore, for new startup companies to emerge, some of the interviewees emphasised the importance of risk-taking behaviour by key individuals within a cluster. Such behaviour seems to promote cluster growth and development.

“A cluster is a low risk environment for individuals to take a high risk.”

Dr Andy Richards
Serial Bio-Entrepreneur and Angel Investor

4. The Role of Cambridge University in Cluster Formation

The University appears to play a central role in the Cambridge cluster. Above all, the University acts as a source of highly skilled workforce with strong technological background, which strengthen both the social capital and research base present in the region [5]. The students and researchers from the University appear to be an important source of knowledge exchange with local companies and other sectors, which is facilitated through the various networking receptions, open lectures and conferences in the cluster. In addition, Cambridge University seems to facilitate cross-disciplinary social networks and collaborations within and between departments through its college system. Finally, the University acts as the biggest employer in the region, thereby providing job stability in its surroundings, which greatly contributes to the level of risk individuals are prepared to take when considering to start new companies.

“Cambridge is a creative chaos.”

Dr Huw Edwards
Associate, St John’s Innovation Centre

There is little doubt that the University is an important contributor to the innovation ecosystem in the cluster. However, several interviewees reported that its contribution is rather indirect and in less structured and tangible ways. Although there are numerous examples of successful university spinouts, the University doesn’t appear to be the main driver for intellectual property and technology of the local startup companies. Our findings suggest that approximately 4% of the companies within the cluster can be considered direct university spinouts. Nonetheless, as previously mentioned, the University does play a central role in the cluster dynamics and did manage to spinout very successful companies. Cambridge Antibody Technology (CAT) is a well-known example of a university spinout. It commercialised the very first human antibody-blockbuster drug, Humira. Today, CAT is known under the name of MedImmune (Cambridge) and its storyline and numerous university-interactions will briefly be described in the following case study.

Box 1: University-Industry Interactions: MedImmune and Cambridge Antibody Technology

MedImmune is a Life Sciences company in Cambridge which has strong links with the University. It globally has four different sites and belongs to the pharmaceutical giant AstraZeneca. The MedImmune (Cambridge) site was previously known as Cambridge Antibody Technology (CAT). This hugely successful university spinout discovered the first human antibody blockbuster drug, Humira. In 2006, CAT was sold to AstraZeneca for £702M and subsequently merged with MedImmune in 2007. Interestingly, the original CAT employees and research activities remained fairly unchanged following the buy-out and merge.

For this study, MedImmune (Cambridge) kindly agreed to share information on their university-industry interactions. Each year, they appear to invest approximately 10% of their external funding in blue skies research. This results in 60 active university collaborations of different types, which can be broken down as follows: 12 industrial student placements, 31 life sciences PhD students, 2 engineering PhD students, 7 post-doctoral fellows, 1 clinical fellow, 2 master service agreements and 5 sponsored research agreements. Interestingly, only 8 of these are with Cambridge University, the 52 remaining collaborative projects appear to be with other universities, of which 11 are located in the UK and 7 elsewhere*. In addition to these university collaborations, MedImmune (Cambridge) seems to also engage with knowledge exchange activities in forms of workshops and informal exchanges.

**For reasons of confidentiality no further details on these collaborations could be provided in this document.*

5. From Lab to Market: A Complex, Dynamic and Non-linear Model.

When aiming to capture the impact of research funding on economic growth, there previously was a trend to describe the process of technology transfer and translational research as a static, linear and institution-based model [7]. Wider awareness is however growing that this model may be over-simplified and might not reflect the true complexity and dynamic nature of the processes involved [7]. In order to more accurately capture these dynamics, it has been suggested by some interviewees to monitor the flow, or “recycling”,

of parameters such as social capital, technology and investment between universities and local companies. This approach might result in new data on the nature of clusters and provide novel insight into the impact of universities in the innovation ecosystem. A case study example of a university spinout, Cambridge Biotechnology Limited, has been used to illustrate the latter in more detail.

“The main feature of a healthy cluster is the recycling of its technology, social capital and investment.”

Dr Andy Richards
Bio-Entrepreneur and Angel Investor

Box 2: University Spinout: Cambridge Biotechnology Limited

Cambridge Biotechnology Limited (CBT) is a Cambridge University spinout from the Pharmacology Department. It was founded in 2001 by Dr Peter Richardson, a researcher and principal investigator at the University of Cambridge. The successful biotechnology company was sold to BioVitrum for £27M in 2005. The latter story-line describes a static and linear model of how a university department develops technology and subsequently spins out a successful company. However, when going into greater depth, it appears that many other events took place. As is illustrated in figure 1, a total of three universities and sixteen companies have shown to be involved between 2000 and 2013. This suggests that key contributors and dynamics may be overlooked. By aiming to answer the following questions regarding the university spinout, we attempted to provide a broader picture:

1. Social capital: Who was involved in the spinout company?
2. External drivers: Why did the spinout take place, was it driven by external events?
3. Technology: Where did the technology come from?

4. Investment: Where did the investment come from?
5. Time-line: How did the spinout evolve over time?
6. University contribution: What was the role of Cambridge University? Were there other universities or institutions involved?

“We need to step away from the static, linear and institution-based model.”

Dr Andy Richards
Bio-Entrepreneur and Angel Investor

1. Social capital: Who was involved in the spinout company?

CBT was co-founded by Dr Peter Richardson, a principal investigator from the Pharmacology Department at Cambridge University. Together with eleven of his industrial collaborators at the Park-Davis Neuroscience Centre (PDNC), which originally belonged to Warner-Lambert Pharmaceuticals, they launched CBT with help of the serial bio-entrepreneur and business angel investor, Dr Andy Richards. The company was firstly located in the Pharmacology Department of Cambridge University.

2. External drivers: Why did the spinout take place, was it driven by external events?

In 2000, one year prior to the spinout company, Pfizer and Warner-Lambert Pharmaceuticals merged. This was one of the largest merges experienced in the pharmaceutical sector. As often occurs after merges and buy-outs, due to subsequent restructuring and re-focus, certain product developments are abandoned and sometimes entire divisions closed down. Following this particular merge, Pfizer agreed to close down PDNC, which encouraged Dr Peter Richardson and his collaborators to spinout their promising research in 2001.

3. Technology: Where did the technology come from?

The technology originated from various sources. Dr Peter Richardson had developed two technologies at the University of Cambridge: (1) A technique that allowed the identification of gene expression patterns in single neurons and (2) a small molecule acting as an adenosine receptor agonist that could be used as a potential anti-inflammatory therapeutic. Interestingly, Aberdeen University also contributed with technology by providing a leptin mimic molecule with therapeutic potential in the area of obesity. Additional technology, know-how, equipment and industry experience was also brought in by the co-founders from PDNC.

4. Investment: Where did the investment come from?

Cambridge University offered a small amount of seed funding in exchange for an excessive amount of equity. The offer was rejected by the co-founders. Subsequently, they received angel investment from Dr Andy Richards and agreed to co-invest some of their personal funds, including some of Pfizers' redundancy fee. In a later stage, two rounds of venture capital funding were secured before it was acquired by BioVitrum for £27M. This was followed by an additional £12M over a three year period.

5. Time-line: How did the spinout company evolve?

The successful spinout was sold to BioVitrum in 2005. As a result, the laboratory and office space was transferred from the Pharmacology Department to the Brabraham Institute. As illustrated in figure 1, in 2009 CBT was transferred from BioVitrum to Proximagen, a Kings College London spinout. This transfer occurred due to refocusing of BioVitrum and didn't involve financial exchange. The latter highlights well the economical climate present during this period (2008-2009). In the same year, Proximagen also acquired Minster Pharmaceuticals, which was a spinout from GlaxoSmithKline (GSK). Several additional events also took place in 2009. The leptin mimic molecule originating from Aberdeen University was sold to AstraZeneca, but more importantly, two additional startups were formed; (1) Cambridge Biotechnology Development Limited, a company aiming to develop the adenosine receptor agonist further, and (2) GrantaBio, a Life Sciences consultancy company. In 2010,

Proximagen acquired additional assets from GSK and sold some technology to Upsher-Smith Pharmaceuticals (USP). Finally, Proximagen was bought over for £350M by USP in 2012. Interestingly, 30% of the original employees of CBT are still working with Dr Peter Richardson today at USP. Although they have been through four different buy-outs, they still work on the same technology development that was initiated 12 years earlier at CBT.

6. University contribution: What was the role of Cambridge University? Were there other universities or institutions involved?

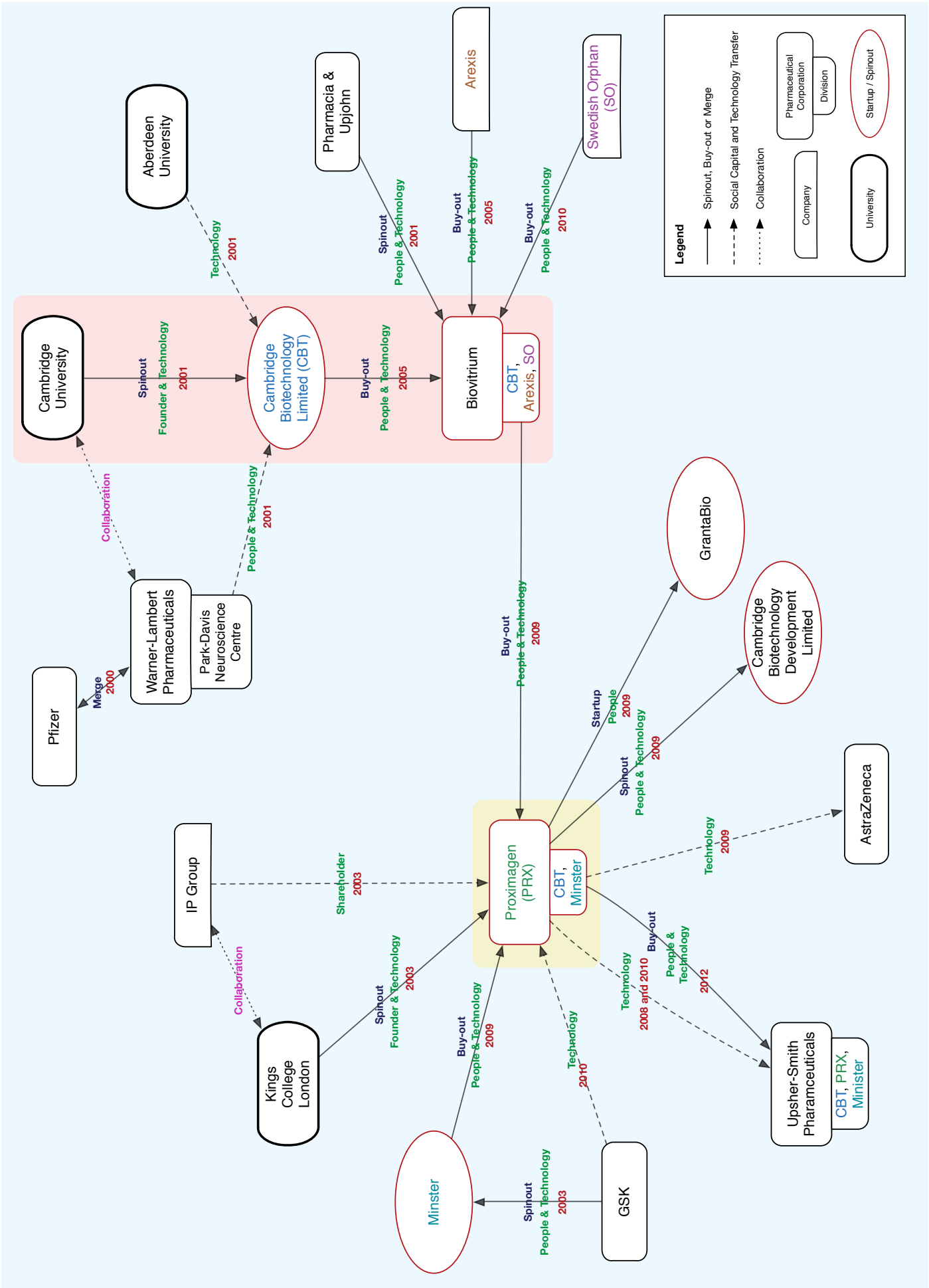
“The University offered a small amount of seed funding in exchange for an excessive amount of equity, which wasn't very encouraging. However, they were helpful by renting us laboratory and office space and by keeping my lectureship position open for 5 years.”

Dr Peter Richardson
Academic Founder, Cambridge Biotechnology Limited

Cambridge University played an essential role in the CBT spinout. It allowed Dr Peter Richardson to develop his academic research and start the appropriate collaborations prior to the spinout company. The University agreed to rent out laboratory and office space to host the spinout within the Pharmacology Department from 2001 to 2005. It agreed to keep Dr Peter Richardson's lectureship position open for 5 years while he was on leave at CBT. However, although the latter was encouraging and supportive, at the start, the University appeared to have requested an excessive amount of equity in exchange for a small amount of seed funding. An offer that was refused by the co-founders. It is important to note the following points:

1. The technology transfer office of Cambridge University was eventually not involved in the spinout and didn't own equity in the company;
2. The technology originally coming from the Pharmacology Department never made it to market;
3. Two additional universities contributed to the CBT story, Aberdeen University by providing a leptin mimic in 2001 and Kings College London by spinning out Proximagen in 2003, which subsequently acquired CBT in 2009;
4. The Babraham Institute played an important role at the later stage of the spinout regarding laboratory space, office space and the use of animal models for their drug development.

To conclude, the CBT case study provides insights into the complex and dynamic nature of a cluster and the role universities can play in the innovation ecosystem. This example highlights the importance of multiple partnerships between biotechnology and pharmaceuticals companies in the Life Sciences, which tend to extend outside a given cluster. This in depth analysis showed the involvement of a total of three universities: Cambridge University, Aberdeen University and Kings College London. Four company merges and buy-outs seem to have led to the launch of three Cambridge-based startups (CBT, CBDT and GrantaBio). When following the flow of technology, investment and social capital between 2000 and 2013, a total of sixteen companies appeared to have been involved: two university spinouts (CBT and Proximagen), four company spinouts (BioVitrum, Minster, GrantaBio and CBDT), six pharmaceutical companies (Warner-Lambert, Pfizer, Pharmacia & Upjohn, GSK, Upsher-Smith and AstraZeneca), two indirectly-related biotechnology companies (Arexis and Swedish Orphan) and one privately owned technology transfer office, IP Group. This case study illustrates how complex and dynamic the pathway from lab to market can be and how university-industry interactions can evolve over time.



6. Knowledge Exchange

It is believed that academic-related knowledge and skill development should benefit and impact wider society. The knowledge exchange (KE) activities between universities and other sectors are therefore critical. However, in order to assess the impact of academic activities and funding, it is essential to monitor and report these KE activities effectively. One of the challenges is that these activities can occur under many different forms. According to a study performed for the Higher Education Funding Council for England (HEFCE) [8], KE activities can be divided into four groups:

1. Public space and people-based activities (e.g. networks, courses and conferences);
2. Problem-solving activities (e.g. consultancy and advice);
3. Community-based activities (e.g. exhibitions, school projects and public lectures);
4. Commercial activities (e.g. licensing, patenting and spinouts).

One could simplify these by categorising them according to two broad criteria:

1. Contractual or non-contractual;
2. Financial or non-financial.

Although it is difficult to assess which of these have the greatest value to society, the majority of the monitored and reported KE activities appear to those of contractual and financial nature. i.e. of ‘commercialisation’ nature. Interestingly, evidence suggests that these activities represent a smaller fraction of the total academic KE activities [9], thereby failing to capture a substantial part of academic engagement, which may, or may not, significantly contribute to society. These findings suggest a potential bias towards ‘commercialisation’ activities when aiming to measure and assess the impact of academic KE.

“A narrow focus on commercialisation activities will miss large swathes of engagement which can be important for realising the full economic and societal value of public investments in the higher education base in the UK.”

Mr Tomas Coates Ulrichsen
Research Associate, Centre for Science, Technology and
Innovation Policy

Monitoring KE is not a trivial task. Incentivising academics to devote more time to monitor and report on their entire breath of KE activities seems to still be a challenge. However, when aiming to provide these incentives, one might want to acknowledge that KE is only the third stream of academic activities, the first two being research and teaching. Some of the interviewees therefore argued that it is challenging for academics to dedicate much time to the latter, making the overall assessment of academic impact a non-trivial task [10].

Schemes have been set up by HEFCE to promote and monitor third-stream academic activities. The Higher Education and Innovation Fund (HEIF) aims to promote KE by financially supporting KE initiatives, and the Higher Education-Business and Community Interaction (HE-BCI) survey aims to monitor these third stream activities at national level. Although these type of surveys generate valuable and encouraging findings, it has been reported that their format makes it challenging to perform further data analysis in greater depth, i.e. at level of detail capturing individual higher educational institutes or departments. The data-collection is usually presented in ‘bulk’ and requested in a manner that is not designed to subsequently extract detailed information by sector or geographical area. Furthermore, some of the interviewees also emphasised that KE doesn’t occur between institutions, but between individuals within institutions. It was therefore suggested that additional studies could aim to monitor information at level of individuals, which in turn could help shed further light onto the true impact of third stream academic activities.

“Our understanding of university-industry engagement would benefit greatly from the ability to disaggregate longitudinal knowledge exchange datasets by target sector and by disciplines involved. This is an important limitation of our existing national datasets of knowledge exchange activity.”

Mr Tomas Coates Ulrichsen
Research Associate, Centre for Science, Technology and
Innovation Policy

Box 3: Initiative-Promoting University-Industry Interactions: IN-PART

IN-PART is a novel startup company aiming to promote university-industry interactions and partnerships. By means of a dynamic online platform, IN-PART actively promotes innovative university concepts, projects and technologies that could benefit from an industry partner. By working hand in hand with technology transfer offices and university business teams, IN-PART is trying to promote university innovation by acting as a matchmaking service to link academics with their ideal industry partner. Companies who wish to find an academic collaborator can also use the platform to browse for relevant university technology and expertise. Following successful pilot studies with six universities in the UK, involving industry partners such as Procter & Gamble, GSK and Rolls-Royce, the full IN-PART platform was launched in January 2014.

7. Technology Transfer: Challenges and Misconceptions

Technology transfer or translational research is referred to as the process of commercialising academic research. The technology transfer offices (TTOs), which are often embedded within the university, aim to facilitate patent filing, licensing and university spinouts from academic research. This often involves helping academics to develop a proof of concept with their technology, which increases their chances in a later stage to engage successfully with commercial partners.

Each year, the HE-BCI survey aims to examine KE activities between universities and the wider world. Within this context, the TTO of Cambridge University, Cambridge Enterprise (CE), provides information on their technology transfer activities, which they kindly agreed to share for this particular study. As mentioned previously, the nature of the data requested for submission by HE-BCI makes it challenging to extract information per sector or geographical area, but is nevertheless valuable. According to the shared information by CE, on average, per year (2009-2012), they facilitate around 300 disclosures and patent filings, have around 665 active licensing agreements, which generate approximately £6M of revenue. They are aware of 94 active firms, which could be considered as university related startups, i.e. containing either intellectual property technology or founding members from the University. These 94 firms employ around 830 people, have a yearly turnover of approximately £42M and have attracted a total of around £142M external funding. These figures¹ are encouraging and demonstrate the potential of Cambridge University in the translation of their academic research. Based on the spinout sample of CE, it is however important to observe two things:

1. Around half of these companies are in the area of Life Sciences, suggesting that Cambridge is strong in this particular field and that technology transfer is perhaps more likely to occur in the Life Sciences sector;
2. Few software companies seem to be included in this list. The latter is particularly intriguing because the Computer Laboratory in Cambridge is the department with the highest number of startup companies.

The Computer Laboratory is, according to some, the Department of Cambridge University with the strongest knowledge exchange, technology transfer and entrepreneurial activities. A total of 205 companies were launched by students and members of staff since 1968, which are all listed on the departmental website [11]. It is therefore interesting to note that the majority of these ventures do not appear on the register of the TTO. One of the reasons may relate to the fact that many of the graduate-founded businesses are unrelated to the departmental research. Some equally suggest that The Computer Laboratory operates reasonably independently from the TTO and has a different attitude towards intellectual property and spinout companies, leaning slightly towards a more liberal model. However, one could also argue that software development companies experience fewer intellectual property roadblocks than other sectors and that the lower product development costs facilitate startups and spinout companies and therefore need less support from the TTO. Nevertheless, this particular department not only appears to have a big economic impact on the cluster, but also seems to be quite successful at promoting knowledge exchange, technology transfer and entrepreneurship. The key resulting question would be the following: Are there potential mechanisms that might contribute to the Computer Laboratory's success? According to some, it could be attributed to three initiatives [12]:

¹ The data reported in the HE-BCI survey is dependent on the reliability of the spinout and startup companies to complete and return the questionnaires to CE, which can vary considerably from year to year.

1. The Computer Lab Ring;
2. The Hall of Fame;
3. The Computer Laboratory Supporters Club.

Each of the above have slightly different purposes. The Computer Lab Ring aims to provide a life long service to its graduates and aims to maintain an active network between alumni and the department, thereby promoting knowledge exchange [12]. The latter appears to be achieved by means of social events and career-fair opportunities. The Hall of Fame has a similar purpose and falls within The Computer Lab Ring, but focuses specifically on the company co-founders from the department [12]. It lists all the startup companies from The Computer Laboratory in the department and on their website, organises an annual dinner attended by the co-founding alumni and celebrates these successes by providing annual awards for best company, product and publication of the year. In addition, it seems to encourage students to become entrepreneurs by creating entrepreneurial role models in the department. Finally, The Computer Laboratory Supporters Club is a group of 68 companies which financially support teaching and research in the department [12, 13]. In exchange for their support, they receive exclusive recruitment opportunities for summer internships, placements, joint research projects and job vacancies within their companies. They also seem to benefit from open access to departmental seminars and events, enabling them to build personal relationships with the departmental staff and students. The type of activities described above has been reported as activities that strongly promote the impact and knowledge exchange of university departments. Interestingly, some of the interviewees suggested that the knowledge exchange and skill transfer by means of departmental students and staff may have a bigger impact on innovation than the actual research or technology developed within university departments. This reinforces the idea that universities might want to consider recruiting a fraction of entrepreneurial students within departments, in order to promote spinout and startup companies [12].

“In selected high potential subjects such as Computer Science, universities should consider reserving a few places for students showing entrepreneurial potential to increase the chances of successful startups being founded.”

Mr Stephen Allott
Quandom City Fellow, Hughes Hall,
Cambridge University

7.1 Challenges of Technology Transfer

The challenges of technology transfer are extensively

studied and interviewees confirmed many of the challenges and misconceptions identified in other reports.

Firstly, the drivers between academia and industry appear to be intrinsically different [14]. Academia lies within the public sector and aims to provide public goods in the form of teaching and peer-reviewed academic publications. Conversely, the private sector aims to develop and sell products or services to customers and become profitable ventures. Therefore, within the technology transfer space, it has been reported that it can be challenging to find the right equilibrium between teaching, publications, filing patents and generating profit. In order to align the drivers and aims between both sectors, skilled negotiators and boundary-spanners seem to be required on both sides. In addition, it is not uncommon to encounter academics with a strong sense of academic freedom and purity, which can make them reluctant to engage with the private sector [10].

Secondly, next to drivers, intellectual property ownership seems to be one of the main challenges of technology transfer, which appears to be a big barrier for university-industry collaborations [15, 16]. Within a University environment, it is often complex to assign to whom the intellectual property belongs, since academics are funded through multiple independent funding streams, who are often providing financial support to the same piece of research. Each of these funding sources have their individual policy towards intellectual property ownership, which can add to the complexity of commercialising academic research. Furthermore, it has been reported that some TTOs have a quite monopolistic attitude towards intellectual property, spinout equity and revenue ownership. This attitude may not fully encourage entrepreneurial students and researchers to take the risks involved with the commercialisation of their findings [16].

Thirdly, because of the complex funding streams observed in academia, the bureaucratic requirements when aiming to commercialise academic research seems to add to the overall challenge. Even within the stream of Governmental funding, various Research Councils and Higher Education Councils will expect different reports and updates from the academic researchers and TTOs.

Finally, it has been reported that it currently still is challenging for people to take a semi- or full-sabbatical in a different sector. Schemes that allow and reward these type of boundary-spanning activities could promote university-industry collaborations and potential technology transfer.

7.2 Misconceptions around Technology Transfer

“Technology transfer is a collective delusion.”

Dr David Cleevely
Serial Entrepreneur and Angel Investor

Given the current economical climate, it seems appealing to view universities as a source of intellectual property and technology for startup companies in order to promote economic growth. The model “from lab to market” does appear to be an attractive model, which is actively promoted by Government Departments, Research Councils and Higher Education Councils. However, some of the interviewees expressed their concerns regarding this model. Which resulted in exploring the following questions:

1. How frequently does successful technology transfer occur?
2. Are TTOs usually profitable ventures and does the Cambridge model apply to other universities?
3. Should academics be encouraged to become more commercially active and commercialise their research?

The question on how frequently successful technology transfer occurs is reasonably straightforward to answer in Cambridge. There are around 1,540 high-tech companies in the Cambridge cluster [17]. Of the 94 active Cambridge University related startups, approximately 53 appear to have IP or technology developed within the University [18]; therefore, they represent around 3.5 % of the high-tech companies in the cluster. This estimate is based on the HE-BCI survey dataset provided by CE.

The following question is whether the Cambridge model of technology transfer could and should be applied to all universities and whether TTOs are usually profitable entities. According to several interviewees in this study, only a limited number of universities worldwide manage to generate revenue and profit from their licensing and spinout activities. Within the UK, Cambridge University, Oxford University and Imperial College seem to be the exceptions. It was reported that many TTOs aspire to generate profit, but are often a cost to universities [19, 1].

“Technology transfer as a revenue stream is often aspirational for Universities. Cambridge, Oxford and Imperial are the exceptions in the UK.”

Dr Huw Edwards
Associate, St John's Innovation Centre

Finally, since successful technology transfer might rather be the exception than the rule, some participants query the role of universities in the innovation ecosystem. Some questioned whether academics should be encouraged to become more commercially active and translate their academic research. It was suggested by most, that academics should not aim to become more commercially active, but rather more commercially aware and try to increase their knowledge exchange activities (including those of non-financial and non-commercial nature).

“Academics should not become more commercially active, they should become more commercially aware.”

Dr Richard Jennings
Deputy Director, Cambridge Enterprise

Although academics are usually good at identifying and solving complex problems, it was mentioned that very few seem equally skilled at innovation and entrepreneurship. In addition, evidence suggests that most companies are customer and demand led, resulting in only a minority of companies to be purely research and discovery led [20]. The latter reasons made some of the interviewees question the importance of the model “from lab to market” for the innovation ecosystem. Although most seem to agree that universities are essential to the UK economy and do contribute greatly to scientific discoveries, many were questioning whether they are a significant source of IP and technology for startup companies. Their contributions are suggested to be rather indirect by providing skilled workforce and allowing knowledge exchange through their efficient networks and wealth of social capital [5].

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Annex Material - Interviewees



Dr Andy Richards

Serial Bio-Entrepreneur and Angel Investor

Dr Richards is a serial bio-entrepreneur and angel investor from the Cambridge cluster. He is a director or chairman of numerous companies, including Altacor, Novacta Abcodia, Arecor, Summit Corp plc, PsychologyOn-line, Cancer Research Technology and Babraham Bioscience Technology. He is a founding member of the Cambridge Angels. Dr Richards is also a council member of the Biotechnology and Biological Sciences Research Council (BBSRC). He obtained his PhD in Chemistry from the University of Cambridge and spent his early career with ICI (now AstraZeneca) and PA Technology.

Key topics addressed during the interview:

- Role of Cambridge University in the Cambridge cluster;
- Model from lab to market;
- Case study example of a Cambridge University spinout, Cambridge Biotechnology Limited;
- Flow of social capital, technology and investment within a cluster;
- Models for university-industry interactions;
- Impact of research funding on economic growth.



Mr Boris Bouqueniaux

Head of Support Services, Cambridge Enterprise

Mr Bouqueniaux is responsible for the IT and Business Support teams at Cambridge Enterprise, the technology transfer office of Cambridge University. He oversees the development of Cambridge Enterprise's case portfolio management system, related processes, administration and reporting facilities. Prior to his current role, he was a Senior Technology Associate in the Life Sciences team at Cambridge Enterprise. He has an MSc in Biology from the University of Montpellier (France). Before joining Cambridge Enterprise, Mr Bouqueniaux worked as a Research Associate for an international executive search consultancy providing top senior manager and executive recruitment services to the Life Sciences and Healthcare industries.

Key topics addressed during the interview:

- Activities of Cambridge Enterprise;
- Interpretation of the data submitted by Cambridge Enterprise for the HE-BCI survey.



Mr Chris Green

Chief Executive Officer, SQW Group

Mr Green has been Chief Executive Officer of SQW Group since 2006, and was previously managing director of subsidiary company, SQW. He led a management buy-out of SQW in 2004 and negotiated a merger with Oxford Innovation in 2006, which brought OI into the SQW Group. Mr Green has 33 years experience of economic development and planning work in the public and private sectors, including 23 years consultancy experience with SQW. He has directed a range of projects throughout the UK and internationally on technology-based development, urban and regional regeneration, education/industry links, business growth, tourism and institutional development.

Key topics addressed during the interview:

- Role of universities in cluster formation;
- Linkages between local universities and businesses;
- The Cambridge Phenomenon;
- Impact of research funding on biomedical clusters.



Dr David Cleavelly, CBE

Serial Entrepreneur and Angel Investor

David Cleavelly CBE, FREng, FIET was appointed the Founding Director and Executive Committee Member of the Centre for Science and Policy, University of Cambridge in 2009. He is the Chairman of CRFS, which he co-founded in July 2007, and the founder and former Chairman of telecoms consultancy Analysys (acquired by Datatec International in 2004). In 1998, he co-founded the web based antibody company Abcam (ABC.L) with Jonathan Milner and was Chairman until November 2009.

In late 2004 he co-founded the 3G femto base station company, 3WayNetworks, which was sold to Airvana in April 2007. He has invested in over 35 companies and is Chairman of four of them, including the award winning restaurant “Bocca di Lupo”. He has been a prime mover behind Cambridge Network, co-founder of Cambridge Wireless, co-founder and Chairman of Cambridge Angels and is a member of the IET Communications Policy Panel. For 8 years until March 2009 he was a member of the Ofcom Spectrum Advisory Board. From 2001 to 2008 he was a member of the Ministry of Defence Board overseeing information systems and services (DES-ISS, formerly the Defence Communications Services Agency).

After being sponsored to study Cybernetics at Reading by Post Office Telecommunications, he joined their Long Range Studies Division. A PhD at Cambridge was then followed by the Economist Intelligence Unit in London. He is a Fellow of the Royal Academy of Engineering and the IET.

Key topics addressed during the interview:

- Role of Cambridge University in the Cambridge cluster;
- Promoting startups and entrepreneurship;
- Challenges and misconceptions around technology transfer;
- Role of individual university departments in technology transfer;
- Models for university-industry interactions;
- Role of Government in supporting startups.



Dr Huw Edwards

Associate, St John's Innovation Centre

Dr Edwards is part of Oxford Innovation's team of innovation advisors. His experience spans strategic and tactical aspects of knowledge transfer for the businesses, industries, public bodies and academic institutions, underpinning the international knowledge based economy. He has been involved in a comprehensive portfolio of strategy projects conducted in the UK and abroad, a wide selection of high technology development projects for individual academic institutions and industry, backed up with many years experience in project management and project evaluation. For the past 15 years Dr Edwards has been an expert advisor to the European Commission. He assisted the European Commission in drafting parts of the FP7 programme. He continues to help the EC with grant reviews in Micro and Nano technology and the IT for Health programme. Dr Edwards advises Life Sciences companies on venture capital and business angel funding and is a regular panellist on the European Biotech Finance Forum.

Key topics addressed during the interview:

- Role of Cambridge University in the Cambridge cluster;
- Features of a healthy cluster;
- Model from lab to market;
- Role of technology transfer offices;
- Challenges and misconceptions around technology transfer;
- Future impact of AstraZeneca on the Cambridge Biomedical Cluster.



Dr John Elvin

Scientific External Liaison, MedImmune (Cambridge)

Dr Elvin the scientific external liaison at MedImmune (Cambridge). This involves interacting with external scientific contacts within universities and government funded institutions with a view to exploring potential collaborations and mutually beneficial interactions. Prior to his current role, Dr Elvin worked for many years at Cambridge Antibody Technology and obtained his PhD from Oxford University.

Key topics addressed during the interview:

- Linkages between MedImmune and various universities;
- Measuring university-industry interactions;
- New models for university-industry interactions.



Mr Kenneth Mulvany

Chief Executive Officer, Proximagen

Mr. Mulvany has been the Chief Executive Officer of Proximagen Group (also known as Proximagen Neuroscience) since March 2004. He acts to focus Proximagen Neuroscience's commitment to deliver novel drugs and innovative new treatments for neurodegenerative disease, and has new hope to patients and value to shareholders. Mr. Mulvany began his career at Scripps Research Institute Department of Immunology before joining the division for autoimmune diseases at Merck Research Laboratories. Prior to joining Proximagen, Mr. Mulvany spent five years as managing partner for the Strategum Group. He has 12 years of biotech and IPO experience. He has been an Executive Director of Proximagen Neuroscience since 2005. He serves as a Director of Proximagen Limited. He serves as a Member of the Advisory Board for Swarraton Partners Limited. He served as a Director of Minster Pharmaceuticals since February 2010.

Key topics addressed during the interview:

- Case study example of Cambridge Biotechnology Limited and Proximagen;
- Flow of social capital, technology and investment within a cluster.



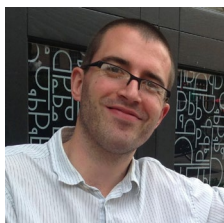
Dr Paul Varley

Vice-President of Development, MedImmune (Cambridge)

Dr Varley is the Vice-President of Development at MedImmune (Cambridge). He has been in this role for 15 years. Prior to MedImmune he was the Head of Protein Sciences at British Biotech. Dr Varley obtained his PhD from Newcastle University.

Key topics addressed during the interview:

- Linkages between MedImmune and Cambridge University;
- Measuring university-industry interactions;
- New models for university-industry interactions;
- Role of Cambridge University in the Cambridge cluster;
- Challenges of technology transfer and translational research.



Mr Peter Northover

London and East Assistant Director, Department for Business, Innovation and Skills

Mr Northover is the Assistant Director of London and East at the Department for Business, Innovation and Skills (BIS). Prior to BIS, he was the Head of the Regional Parliamentary and Private Office for the East of England. He was also the Deputy Head of the Regional Governance Team at the Government Office Regional Co-ordination Unit. Mr Northover also worked at the Department for Environment, Food and Rural Affairs. He obtained his Master from Nottingham University.

Key topics addressed during the interview:

- Local enterprise partnerships and city deals;
- Role of Government in promoting knowledge exchange and university-industry interactions.

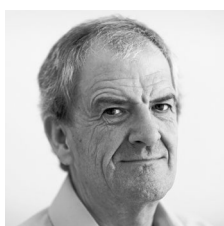
Dr Peter Richardson,

Academic Founder, Cambridge Biotechnology Limited

Dr Richardson is the academic founder of Cambridge Biotechnology Limited and a founding partner of GrantaBio LLP. He served as CSO and Executive Director of Cambridge Biotechnology Limited from 2001 to 2005. Between 2005 and 2009, he served as Managing Director and Chief Scientific Officer of this company, while also serving as Executive Vice President and Head of Discovery in Biovitrum AB. Between 1989 and 2006 he served as a Lecturer and Senior Lecturer in the Department of Pharmacology, University of Cambridge where he pioneered research into drug discovery for Parkinson's disease and inflammation, as well as new gene expression technologies. Between 1994 and 2001 he was an adviser to Kyowa Hakko, Park-Davis and Pfizer. He is the author of over 70 peer-reviewed scientific papers and remains an Associate Lecturer at the University of Cambridge. Dr Richardson studied Biochemistry at the University of Oxford, and was awarded a doctorate in Clinical Biochemistry from the University of Cambridge.

Key topics addressed during the interview:

- Case study example of Cambridge Biotechnology Limited;
- Role of technology transfer offices;
- Model from lab to market;
- Flow of social capital, technology and investment in a cluster.



Dr Richard Jennings

Deputy Director, Cambridge Enterprise

Dr Jennings is Deputy Director of Cambridge Enterprise and a board member of both Cambridge Enterprise and its wholly owned consultancy company, Cambridge University Technical Services (CUTS). He is also a non-executive director of IfM Education and Consultancy Services Ltd, the Institute for Manufacturing's knowledge transfer company. Dr Jennings has a very extensive track record of establishing mutually beneficial university-industry collaborations and commercialising university-derived intellectual property through consultancy, licensing and spin-off companies. He has a D. Phil in Chemistry from the University of Sussex, is a non-executive director of Granta Design Ltd and a Fellow of St Edmund's College.

Key topics addressed during the interview:

- Role of Cambridge University in the Cambridge cluster;
- Features of a healthy cluster;
- Role of technology transfer offices;
- Challenges and misconceptions around technology transfer;
- New models for university-industry interactions.



Dr Robin Knight

Co-Founder IN-PART

Dr Knight is the co-founder and director of IN-PART, a startup that aims to actively promote university technology and early-stage research to a wide range of companies and industry sectors. Prior to IN-PART, he was a research associate and PhD student at King's College London.

Key topics addressed during the interview:

- IN-PART case study;
- Challenges around technology transfer and knowledge exchange;
- Barriers to university-industry interactions.



Dr Shailendra Vyakarnam

Director, Centre for Entrepreneurial Learning

Dr Vyakarnam is the Director of the Centre for Entrepreneurial Learning at the University of Cambridge. He worked in industry for several years before completing his MBA and PhD. He has combined academic, practitioner and policy interests to provide advice to government agencies and UN agencies in several countries, on the development of entrepreneurial ecosystems, technology commercialisation and entrepreneurship education. He has mentored entrepreneurs and held non-executive directorships of small firms in addition to developing growth programmes for SMEs over several years. His main contribution over the past 10 years has been to develop practitioner-led education for entrepreneurship at the University of Cambridge Judge Business School, Centre for Entrepreneurial Learning. He has been assisting universities in several countries to better understand how to integrate this novel curriculum into their programmes. Dr Vyakarnam is presently Co-Founder and Director of AcceleratorIndia. He is on the editorial board of the International Small Business Journal and Strategic Change: Briefings in Entrepreneurial Finance.

Key topics addressed during the interview:

- Role of Cambridge University in the Cambridge cluster;
- Importance of social capital in the clusters;
- Linkages between local universities and businesses;
- The impact of research funding on biomedical clusters.



Mr Stephen Allott

Quondam City Fellow, Hughes Hall, Cambridge University

Mr Allott is a quondam City Fellow of Hughes Hall, Cambridge University and gave the 2006 Hughes Hall City Lecture "From Science to Growth – what exactly is the mechanism by which university research turns into economic growth? [12]" He is also the Crown Representative for Small and Medium Enterprises working in the Cabinet Office. Mr Allott is the founder and a Governing Council Member of the Cambridge Computer Lab Ring, a graduate association for Cambridge University computer science graduates. He also works as an adviser to growing technology companies. He has served as chairman of the board of 7 SMEs and as a non-executive director on 2 further SMEs. He has founded and built his own startup. Prior to that he was President, CFO and a main board director of Micromuse (NASDAQ: Muse), a London origin software company that grew from 50 to 800 people. He has also worked for McKinsey, Sun Microsystems and Xerox and is a graduate of Trinity College, Cambridge University.

Key topics addressed during the interview:

- Approaches to technology transfer and knowledge exchange by the The Computer Laboratory at Cambridge University;
- Challenges and misconceptions of technology transfer;
- Models for university-industry interactions.



Mr Tomas Coates Ulrichsen

Research Associate, Centre for Science, Technology and Innovation Policy

Mr Coates Ulrichsen is a Research Associate at the Centre for Science, Technology and Innovation Policy (CSTI) at the University of Cambridge. His academic interests lie in the role and dynamics of the university research base in the innovation system, with a particular emphasis on processes of technology emergence, technology transitions, and industrial transformation. Prior to joining CSTI, he was an Assistant Director of a leading UK economic development consultancy, Public and Corporate Economic Consultants (PACEC). Much of his work at PACEC involved research into the role of universities in the innovation system and analysing the knowledge exchange process. Much of this work was undertaken in collaboration with colleagues at the Centre for Business Research, University of Cambridge. Mr Coates Ulrichsen has an M.Phil in Economics from the Faculty of Economics, University of Cambridge and a M.Eng in Aeronautical Engineering from Imperial College London, where his dissertation focused on turbulent boundary layers under varying shear conditions.

Key topics addressed during the interview:

- Role of Cambridge University in the Cambridge cluster;
- Measuring knowledge exchange between universities and businesses;
- Models for university-industry interactions;
- Challenges of technology transfer;
- Role of Government to promote startup companies.

