The Higher Education Knowledge Exchange System in the United States

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A report to HEFCE by PACEC and the Centre for Business Research, University of Cambridge

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Foreword

It can be very hard to shake established myths, particularly if they fit into the overall national psyche. In this country, one of our big myths is that we are brilliant at research but poor at commercialising that research. Our entrepreneurial American counter-parts in contrast are outstanding at making money.

This latest research paper from PACEC/CBR - 'The Higher Education Knowledge Exchange System in the US' - goes some way towards debunking these myths. US universities play an enormously important part in American society, engaging with their local communities and helping their local areas to develop. And we are just as good at research commercialisation as US higher education, and indeed our academics may have gone further than in the US in embracing the importance of engagement with the economy and society in their core practices.

Adding value to the economy and society through knowledge exchange (KE) though is complex and hard work. There are no easy answers, and US universities are looking at good practices from this country, just as much as we are looking for answers from them. This includes the need for a professional infrastructure for KE activity. Engaged and entrepreneurial academics, as we have in the UK, are a critical component to success, but they and their institutions need professional KE people to ensure that efforts are efficient and effective – and partnerships with businesses and others are sustainable for the long-term.

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1 Introduction

1.1.1 There has been a persistent perception in the United Kingdom (UK) that US universities are performing much better when it comes to meeting the needs of businesses and the community through knowledge exchange (KE) and that this could reflect differences in institutional structures (physical infrastructure, incentives, norms and processes etc.) are more efficient and effective at supporting KE, greater professionalism and capability of KE practitioners, maturity of engagement and historical legacies of US universities. As such, they could provide models of best practice for UK universities. Direct comparisons are rare and difficult to make. A recent major survey-based comparison of several thousand UK and US business enterprises has shown that in both countries universities are relatively lowly ranked as a knowledge source for innovation compared to other businesses, customers and suppliers. However, this data shows that whilst UK and US businesses are equally likely to access the university science base those in the US are more likely to place a higher value on their university based interactions and to invest more of their own resources in supporting them[1] [2]. The role of university structures and attitudes in shaping this result is however less easily established.

1.1.2 Interpretations of the US system have often overemphasised the role of patenting and licensing compared to much more frequently used modes of interaction involving informal and people based channels, consulting and research contracting and drawn evidence of institutional design from a relatively narrow range of the KE performance of the top research universities e.g. Stanford University and MIT. In reality, the US HE sector comprises a hugely diverse set of institutions of varying size, discipline mixes, contexts etc. and with varying degrees of capability and experience with respect to KE[3]. Our research has shown that while there are examples of US initiatives and programmes and processes that the UK could usefully benefit from learning about, equally there was strong evidence from the case study interviews that US universities could potentially learn much from the experiences and practices in the UK. It is, moreover, important to emphasise that the US is itself in the middle of a major debate about the effectiveness of its innovation system in capitalising on the world leading position its holds in scientific research to rebalance the Us economy and establish a 'technology infrastructure' to meet that challenge[4] [5]

1.1.3 It is therefore, on reflection not surprising that most of the universities we interviewed in the US reported that they faced challenges similar to those being faced in the UK in

[1] Cosh A.D. and Hughes,A. (2010) ' Never mind the quality feel the width: University – industry links and government financial support for innovation in small high-technology businesses in the UK and the USA', *Journal of Technology Transfer* Special Edition, 35:66–91, March.
[2] Cosh, A.D., Hughes, A. and Lester,R.K. (2006) UK Plc:Just How Innovative Are We? Cambridge-MIT Institute, University of Cambridge and MIT
[3] Hughes, A. (2008), ' Innovation policy as cargo cult: Myth and reality in knowledge-led productivity growth', in Bessant, J. and Venables, T. (eds), Creating Wealth from Knowledge. Meeting the innovation challenge, Edward Elgar, Cheltenham. Reprinted in Augusto Lopez Claros(ed.) (2009), *The Innovation for Development Report 2009–2010: Strengthening Innovation for the Prosperity of Nations*, Palgrave Macmillan
[4] Tassey, G. (2010) "Rationales and mechanisms for revitalising US manufacturing R&D strategies", Journal of Technology Transfer, Volume 35, Number 3 / June, 2010, pp. 283 – 333
[5] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine (2007) *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, National Academies Press: Washington

terms of enhanced pressure for KE engagement and meeting the needs of businesses and the community effectively.

1.1.4 This working paper aims to explore the US KE system with a view to understanding (a) stories of success and (b) key challenges facing universities as they engage with industry, the public sector and other external organisations. It is inevitably based on a cross section view of a system in transition so that more is to be learned from individual examples of institutional design and change rather than attempts to describe the 'average ' or typical nature of the system ,

1.1.5 The Higher Education sector in the United States (US) is characterised by a hugely diverse set institutions, with approximately 4,400 degree awarding institutions in 2008/09[6]. Of these 38% were public, 37% were private not-for-profit institutions and 25% were private for-profit institutions. The Carnegie Foundation classifies universities in the United States into different types (Table 1.1). This demonstrates the great diversity of institutions, across a full spectrum from associate (typically the first two years of a bachelor's degree) private for profit institutions to specialist institutions of different types and, importantly, the research institutions split into very high activity (2.2%), high activity (2.35%) and doctoral/research institutions (1.9%).

[6] SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Directory, Colleges and Universities, 1949-50 through 1965-66; Higher Education General Information Survey (HEGIS), "Institutional Characteristics of Colleges and Universities" surveys, 1966-67 through 1985-86; and 1986-87 through 2007-08 Integrated Postsecondary Education Data System, "Institutional Characteristics Survey"(IPEDS-IC:86-99), and Fall 2000 through Fall 2008. (This table was prepared July 2009.), accessed through http://nces.ed.gov/programs/digest/d09/tables/dt09_265.asp

Table 1.1 Diverse range of institutions in the US (%)

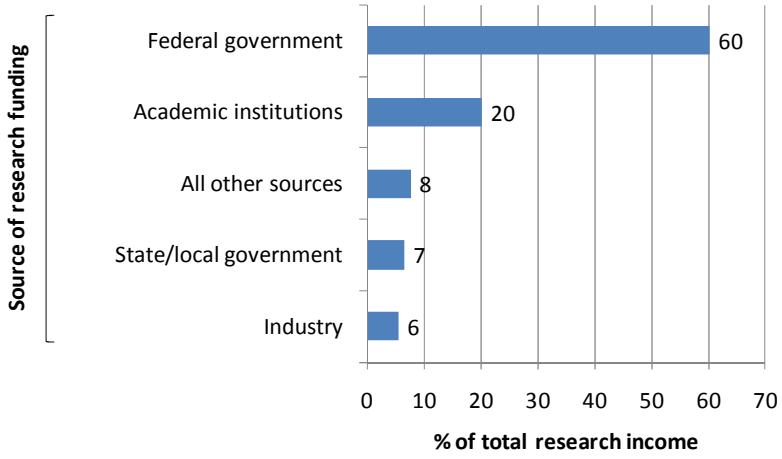
Type of institution	Proportion of institutions (%)
Associate's--Private For-profit	12.09
Baccalaureate Colleges--Diverse Fields	8.20
Master's Colleges and Universities (larger programs)	7.86
Special Focus Institutions--Theological seminaries, Bible colleges, and other faith-related institutions	7.15
Associate's--Public Rural-serving Medium	7.08
Baccalaureate Colleges--Arts & Sciences	6.54
Master's Colleges and Universities (medium programs)	4.33
Associate's--Public Urban-serving Multicampus	3.48
Associate's--Public Rural-serving Large	3.26
Associate's--Public Rural-serving Small	3.23
Special Focus Institutions--Other health professions schools	2.94
Master's Colleges and Universities (smaller programs)	2.92
Baccalaureate/Associate's Colleges	2.73
Associate's--Private Not-for-profit	2.60
Associate's--Public Suburban-serving Single Campus	2.51
Special Focus Institutions--Schools of art, music, and design	2.41
Research Universities (high research activity)	2.35
Associate's--Public Suburban-serving Multicampus	2.28
Research Universities (very high research activity)	2.19
Doctoral/Research Universities	1.91
Associate's--Private For-profit 4-year Primarily Associate's	1.62
Special Focus Institutions--Schools of business and management	1.46
Special Focus Institutions--Medical schools and medical centers	1.30
Special Focus Institutions--Other technology-related schools	1.30
Associate's--Public 2-year colleges under 4-year universities	1.25
Special Focus Institutions--Other special-focus institutions	0.89
Associate's--Public Urban-serving Single Campus	0.73
Special Focus Institutions--Schools of law	0.73
Tribal Colleges	0.73
(Not classified)	0.59
Associate's--Private Not-for-profit 4-year Primarily Associate's	0.46
Associate's--Public 4-year Primarily Associate's	0.41
Associate's--Public Special Use	0.32
Special Focus Institutions--Schools of engineering	0.18
(Not applicable)	0.00

Source: Carnegie Foundation

1.1.6 The US HE system is also highly skewed in terms of research activity, with the top 100 universities ranked by total research income generating approximately 80% of such income (Figure 1.1). This figure also shows that 60% of all R&D income secured by universities in the US comes from the federal government, while just 6% comes from industry. It is also characterised by a lack of any centralised national administrative control, although the individual States can have a powerful influence

over their own public universities and agencies such as DARPA and the National Institutes of Health can have a powerful shaping influence on research patterns within their domains of interest. There is also intense inter-university competition for resources, faculty and students in the US.

Figure 1.1 Share of research income secured by the top 100 universities ranked by research income, by income source (%)



	Value ($millions)	Share from top 100 (%)
Federal government	31,231	79.8
Academic institutions	10,435	78.3
All other sources	3,954	84.0
State/local government	3,418	73.3
Industry	2,870	82.1
Research income from all sources	51,909	79.5

Note: R&D expenditures from academic institutions refers to the use of internal funds for R&D. 78% of this type of research funding is captured by the top 100 institutions.
Source: US National Science Foundation: Top 100 academic institutions in R&D expenditures, by source of funds, 2008

1.1.7 The source of revenues in US universities also differs substantially according to whether the university is public or private (Table 1.2). Federal funding accounts for approximately 12.1% of revenue for all US degree awarding institutions small variations across public and private not-for-profit institutions. State and local funding, however, which accounts for 21.3% of revenue for all US institutions is concentrated primarily in the public universities, who realise 36.0% of their revenue from such sources while private no-for-profit universities realise just 1.2% from state and local sources. Private gifts and contracts are a much larger component of private not-for-profit universities compared with public universities as are investment returns.

Table 1.2 University revenues by source for degree-awarding institutions in the United States in 2006/07

2006/07	Share of revenue by source for degree-awarding institutions (%)			
	All	Public	Private - not-for-profit	Private - for-profit
Student tuition and fees (net of allowances)	22.5	16.7	26.0	88.2
Federal appropriations, grants, and contracts	12.1	13.2	11.1	5.2
State and local appropriations, grants, and contracts	21.3	36.0	1.2	0.5
Private gifts grants, and contracts	6.3	3.4	11.1	0.0
Investment return (gain or loss)	15.4	5.8	30.7	0.3
Auxiliary enterprises	7.2	7.9	6.7	2.2
Hospitals	7.6	8.4	6.9	n/a
Other	7.6	8.7	6.3	3.5
Total revenues (%)	100	100	100	100
Total revenues ($millions, current prices)	465	269	182	14
Number of institutions	4314	1688	1640	986

Source: US Department of Education, Institute of Education Sciences, National Centre for Education Statistics (2009) *Digest of Education Statistics 2009*

1.1.8 The geographic context in which HEIs are located can also have a large bearing on the type of activities they perform. Again, the US exhibits a diverse set of institutions with 22% of universities located in large cities, 18% on the urban fringe of a large city, 24% in mid-size cities, 14% in small towns, and 7% in rural areas[7]. Variations exist by the type of institution (Table 1.3)

Table 1.3 Distribution of US universities across different geographical contexts (%)

	All institutions	Very High Research	High Research	Doctoral/ Research	Non-Research
Large city	22	33.3	33.0	35.7	21.1
Mid-size city	24	44.8	31.1	20.2	23.0
Urban fringe of large city	18	10.4	11.7	21.4	17.7
Urban fringe of mid-size city	6	3.1	4.9	3.6	6.0
Large town	3	4.2	8.7	4.8	2.9
Small town	14	3.1	6.8	8.3	14.3
Rural	5	1.0	1.9	1.2	5.3
Not assigned	2	0.0	1.9	2.4	2.3
Missing	7	0.0	0.0	2.4	7.4

Source: Carnegie Foundation

1.1.9 Given the huge diversity of HEIs in the US, and the limited nature of the time frame and budget for the research we chose to carry out a a set of case studies covering a selected range of institutional types. We identified the cases on the basis of scoping interviews with UK and US academics practitioners and policy makers interested in KE. This enabled us to identify cases where there was a perception that the KE system was functioning well or in an innovative way where improvements could be made and where important challenges remained. The report reflects this approach.

[7] Based on an analysis of statistics collected on universities by the Carnegie Foundation.

Case Study Universities

1.1.10 The research involved in-depth case studies with seventeen universities across the US. The case studies were selected to highlight how different types of universities organised and operated their knowledge exchange systems rather than to try and cover a representative sample of US universities. Of the seventeen case studies, eight were publicly funded state universities while nine were private. Six of the eight public university case studies were land grant institutions, designated by its state to receive the benefits of the Morrill Acts of 1862 and 1890[8].

Table 1.4 Case study universities

University name	State	Ownership	University Type
Pennsylvania State University	PA	Public	Land grant
University of California, Berkeley	CA	Public	Land grant
University of California System (Office of the President)	CA	Public	Land grant
Ohio State University	OH	Public	Land grant, sea grant
North Carolina State University	NC	Public	Land grant, sea grant, space grant
University of Texas at Austin	TX	Public	Land grant, sea grant, space grant
University of California, San Diego	CA	Public	Sea grant, space grant
University of Utah	UT	Public	
MIT	MA	Private	Land grant, sea grant, space grant
Brigham Young University	UT	Private	
Stanford University	CA	Private	
Nationwide Children's Hospital	OH	Private	
Partner's Healthcare (Harvard University Medical School)	MA	Private	
Boston University	MA	Private	
New York University	NY	Private	
University of North Carolina at Chapel Hill	NC	Private	
Rice University	TX	Private	

1.1.11 The case study universities were predominantly very large institutions involved in both research and teaching, with many receiving significant amounts of research income. As such it is likely that the findings of this study apply more to the larger, more research intensive HEIs in the UK such as those in the top 6 and high research intensive clusters[9] or the Russell Group universities. That said, there are likely lessons that will be applicable across the UK HE sector.

[8] These acts allowed states to create higher education institutions through the granting of federally controlled land, with a focus on the teaching and research in areas related to of agriculture, science and engineering.
[9] PACEC and Centre for Business Research (2009) *Evaluation of the Effectiveness and Role of HEFCE/OSI Third Stream Funding*, a report to HEFCE, report 2009/15

2 The Strategic Leadership of Knowledge Exchange

2.1.1 The strategic leadership of the knowledge exchange system can have profound impacts on the performance of the system in generating economic and social benefits for the users of university knowledge outputs. The nature and structure of the leadership, the values they extol and the strategies they implement will provide the framework within which academics and other university staff operate and will influence the nature and scale of activities that thrive within the institution.

2.1.2 Many case study universities in the US – possibly with the exceptions of Stanford University and MIT – suffer from a culture which embraces and rewards traditional teaching and research activities to a much greater extent than KE engagement and academic enterprise. This was highlighted in a recent article for the Kauffman Foundation on the future of American Universities by Michael Crow, President of Arizona State University, who noted that:

> *"Institutional inertia is nowhere more evident than in the academic valorisation of increasingly specialised knowledge. In our effort to produce abstract knowledge without regard for its impact, many universities have lost sight of the fact that they are also institutions with the capacity to create products and processes and ideas with entrepreneurial potential. … Through some elitist logic, the concept of entrepreneurship has been eradicated from institutions of higher education in [*the United States]. *… Our universities must recover an entrepreneurial edge if they are to be relevant and useful on a global scale".*[10]

2.1.3 However, as in the UK, the US case study universities reveal that US KE system has experienced significant cultural changes over the past decade, with positive changes in culture towards KE, and increased acceptance of KE related activities as a valued part of an academic's role. Left to themselves, many academics would be pre-occupied with teaching and research, the activities upon which most are assessed. As North Carolina State University (NC State) noted, leadership is crucially important for reforming this mind-set and planned, purposeful effort, initiated by the senior management of universities was seen as essential for transforming academic attitudes and creating an engagement agenda that embraces academic enterprise and engagement with external organisations.

2.1.4 These changes typically coincided with the arrival of new leaders with strong, visible commitment to KE. For example, the arrival of Paul Horn at New York University (NYU), who was tasked with their KE mission, was instrumental in providing a strategic framework to organise and restructure their KE system from a bottom up, fragmented and ad-hoc engagement process to a much more integrated, coherent system that allows them to address key strategic priorities while still allowing the bottom-up activity to flourish. He is a distinguished researcher who, for many years, was head of research at IBM and who had, as part of this role, initiated interactions

[10] Crow, M. (2008) "Building an Entrepreneurial University", in Kauffman Foundation *The Future of the Research University: Meeting the Global Challenges of the 21st Century*

with universities such as MIT and Stanford. This background and experience outside, but still close to, the academic environment, was seen as critically important to the success of the current strategy towards KE engagement at NYU.

2.1.5 However, while strong, active leadership is required in most cases to create an academic institution that embraces enterprise and external KE engagement, for universities in which the academic cohort is already entrepreneurially minded, and where the local and regional context in which this cohort is located is sufficiently geared towards such activities (e.g. Stanford University in Silicon Valley and MIT in Boston), a much looser strategic framework can be beneficial. This allows for a much more organic growth of activity and support infrastructure around a common set of existing values.

2.1.6 There has also been a distinct change in the approach of a number of the case study universities away from the assumption that KE engagement is a uni-directional flow knowledge from the university towards the user, towards a view that the university stands to benefit from such engagement as well. This two-way flow of knowledge has resulted in the shift from a highly transactional approach to KE towards a partnership, collaborative approach in which the user is seen as a partner to the university rather than simply a customer. This emphasis on relationship and partnership building has allowed some universities to greatly improve access to knowledge captured within the institution as well as improve the quality and scale of KE activity.

2.1.7 The leadership of selected case studies also recognised the broadening of knowledge exchange away from technology transfer to a wide ranging engagement process with *industry*[11]. This breadth of approach reinforces the need to go beyond narrow conceptions of KE and its success based on patenting licensing and spin outs. For example, the University of California Berkeley restructured its technology transfer operations in 2004 incorporating the Office of Technology Licensing (OTL) and the Industry Alliances Office (IAO) to create the Intellectual Property and Industry Research Alliances office (IPIRA) in recognition of the many different ways in which external organisations can engage with the university beyond the narrow confines of technology commercialisation. This holistic view was also echoed by the University of California Office of the President, whose office in support of commercialisation recently restructured from the Office of Technology Transfer to the Innovation Alliances and Services office, recognising the broader mandate of the university system to support the spectrum of university-industry interactions. The emergence of the new strategic direction of New York University under Paul Horn has also seen a broadening of the concept of engagement. Crow (2008) notes that Arizona State University is very careful to ensure that academic enterprise stretches across *all* disciplines and covers the full breadth of engagement, recognising the important contributions that all areas of the university can make to economic and societal development.

[11] Public and community outreach is typically seen as a very important activity of US universities although it typically separated from industrial engagement.

2.1.8 Despite these developments in some of the case study universities, others conceived of knowledge exchange as the narrower activities of technology commercialisation and technology transfer and still view these types of activities as the central role of knowledge exchange. That is not to say that they do not engage in the wider activities, particularly in skills development and in public outreach, but they consider them as separate entities with few strategic or operational links to the commercialisation of research.

2.1.9 The responsibility of knowledge exchange mission at the senior management level varies by institution. In most of the case study universities, much of the industrially focused KE activity, such as technology transfer and collaborative and contract research, fell within the remit of the Vice President of Research[12]. Specific areas of commercialisation then report to this VP.

2.1.10 The University of Utah has recently separated out the remit for technology transfer and commercialisation from the Vice President of Research, creating what was thought by the University to be a unique new management position in the US – a Vice President for Tech Venture Development. This position covers all activities relating to the commercialisation of research including technology transfer, commercially sponsored research and entrepreneurship education to targeting young entrepreneurs. Despite this split, there is very close interactions between the VP for Tech Development and the VP for Research recognising that the burdens placed on academics arising from research commercialisation as well as the potential conflicts of interest that may arise need to be taken into account at the strategic level.

2.1.11 There is typically a member of the leadership board dedicated to outreach – including public engagement and extension (continuing education) activities – emphasizing its prominence in many US universities. This position is also typically responsible for implementing the university's state-wide economic development mission. For example, at Penn State University, the VP for Outreach reports directly to the President and is responsible for academic outreach, cooperative extension, justice and safety institute, public engagement and state-wide workforce and economic development. Similarly, at NC State, the Vice-Chancellor for Extension, Engagement and Economic Development is responsible for economic development partnerships, extension and continuing education, the small business and technology development centre and other public outreach activities. In 2008, Ohio State University (OSU), created a new Senior Vice President role focusing on outreach and engagement recognising these "activities … have long built meaningful and mutually beneficial collaborations with partners outside the academic community." The new senior vice president position will provide leadership and oversight for a broad array of areas, including community outreach, service learning, health and safety outreach and continuing education. It will also have a prominent role in the university's economic development efforts.

[12] Vice Presidents are equivalent to Pro-Vice-Chancellors in the UK

2.1.12 The level of formal and informal interaction between the different parts of the leadership, and the coherence between the different strategies of each varied significantly. Even some of the universities considered to be exemplars in this area cited difficulties in creating a coherent approach across the *full* spectrum of activities.

3 Universities and State Economic and Community Development

3.1.1 The global intensification of competition and the demise of manufacturing in many of the US States is placing immense pressure to restructure their economies towards high value added, knowledge based firms. In turn, State economic development boards are enormous pressure on universities to play a central, more active role in the restructuring of the local economy towards supporting innovation and human capital upgrading in the pursuit of a high value, knowledge based economy. The response to this trend of global intensification of competition seen predominantly as a State issue compared with the UK where the national importance takes centre stage. As such, the demands being placed on universities inevitably vary from State to State as they address their specific economic development needs.

3.1.2 In addition, the increasing impetus for the incorporation of a community development element alongside the traditional teaching and research roles of university missions comes from a number of changing socioeconomic circumstances[13]. The rapid expansion of higher education has increased interactions between ever-larger and more diverse student bodies and their surrounding communities. This has coincided with a flight of capital from urban areas, as firms relocate and outsource internationally to cut costs. As the latter is not an option for largely immobile universities, such institutions are now some of the few remaining large institutions in close proximity to poor urban neighbourhoods, and universities or university-affiliated hospitals are presently the largest employers in around a third of US urban areas. The local importance of HEIs is clearly evident.

3.1.3 In this context, it is also in universities' own interests to play a supportive role in the local community. The high level of competition between a fast-growing number of institutions means that universities in unsafe or depressed areas struggle to attract the talented academics and students that are central to their success. This is a particularly pertinent issue for a number of leading research universities who sit in close proximity to poor urban areas, such as Columbia, Yale, Pennsylvania and Chicago. Consequently, many of these institutions have invested heavily in local development.

3.1.4 In response to these trends, most, if not all, of the case study universities, both public and private, now recognise a critical role for the university in supporting state-wide economic and community development. This support can come in a number of different guises including support for small business start-ups and growth including venture funds, business advisory services, and entrepreneurship education; extension and continuing education services that attempt to reach far and wide in the state; and public engagement activities that are typically, but not exclusively, localised around the university.

[13] Maurrasse, D.J. (2001). *Beyond the Campus: How Colleges and Universities Form Partnerships with their Communities* (New York: Routledge).

3.1.5 Reflecting the importance attached to state-wide economic and community development many universities have leadership positions dedicated to developing and implement this mission e.g. the Vice Chancellor for Extension, Engagement and Economic Development at NC State. In addition, this position is typically backed up by resources and infrastructural developments to help the university support state-wide economic and social development.

3.1.6 The strong emphasis on local and state-wide economic and community development reflects a number of different underlying factors not least is the important role of the State in the strategic direction of the university. A number of states operate a university 'system' (e.g. California, North Carolina, and Texas) which provides in part a coordination function for the types of universities in the State. Others, such as Ohio, have a dedicated board within the State legislature (in this case the Ohio Board of Regents) that helps to coordinate its public universities. One of the key roles of the Ohio State Board is to make universities relevant to issues that are important to the State. The local and state governments also invest significant resources in their universities in areas where they can best support economic and community development.

3.1.7 There are also incentives, in some States, for companies to engage with their state's universities. For example, the State of California provides companies with R&D tax credits when they sponsor research at one of the University of California campuses. At North Carolina State University, companies from the State of North Carolina receive preferential royalty rates on licenses from the State's universities.

Support for local economic development front and centre in a university strategy: New York University

3.1.8 The role in local and state-wide economic and community development is typically strongly reflected in the university strategy of the US universities studied. For example, a central thrust of the strategic mission for external engagement at NYU is to emphasise sensitive and productive engagement with the local community as it looks forward to a substantial expansion on its way to its 200th anniversary in 2031. To this end NYU is playing a key role in New York's urban and community planning and urban economic development.

> *"The future of the city and NYU are one and the same. Just as New York City's long-term plan realises that one of the city's prime strategic advantages is found in its intellectual, cultural, and educational strengths, NYU knows that its energy, innovation and vibrancy mirrors its city's. Now through a planning process unprecedented in its history, NYU sets out to help sustain its city's intellectual, economic and artistic life"*[14]

3.1.9 A key element in the strategy is support for local and regional entrepreneurship, encouraging students and academic staff to establish new companies. The aim is to build clusters of innovative firms based in the city, firms which students can be

[14] New York University Strategy

employed during and after their academic study. NYU is perceived to act as the anchor and to create the culture for this spawning and clustering of new start-ups. As part of this strategy to promote entrepreneurship, a New Ventures Fund has been established to support the Centre for Entrepreneurship in the NYU Business School and their Business Plan Competition. A business incubator has been built next door to the Medical School. It is hoped that these initiatives will attract more entrepreneurial students and generate more opportunities for medical and science students.

3.1.10 Given the University's location in the heart of a historic area of New York, the leadership had to recognise the University was part of a special neighbourhood to which they owe an obligation and care. Their new strategy to 2031 was created as a result of an intensive and inclusive process between NYU and its community neighbours and is based on an understanding of the mutual and reciprocal benefits between New York City and the University.

A comprehensive infrastructure to support economic and community development: North Carolina State University

3.1.11 A number of the case study universities have built up a comprehensive set of infrastructure to support local and state economic and community development. For example, NC State has long track record of involvement in and commitment to supporting local and state-wide economic development reflecting its land grant heritage. The history of engagement goes back over 100 years:

- 1899 Summer courses first offered for public school teachers
- 1906 First NC Cooperative Extension Service county agent
- 1907 First Southern state to hold institutes for women
- 1924 Continuing Education began for non-matriculated students
- !955 Industrial Extension Service established
- Jane S McKimmon Center for Extension and Continuing Education opened
- Small Business Technology & Development Center opened
- Today More than 80 Programs

3.1.12 Its strategic mission reflects the longstanding emphasis of the university on supporting local and state-wide economic development manifest in recent decades in its important contribution to the growth and development of the Research Triangle and NC State's innovative Centennial Campus. The university has created a comprehensive set of infrastructure under the umbrella of an Office of Extension, Engagement and Economic Development, to support this engagement process including:

- NC Cooperative Extension: provides more than 2.2 million citizens in each of the state's 100 counties with educational programs, publications and events on topics ranging from enhancing agricultural, forest and food systems to developing responsible youth and strengthening families.
- Economic Development Partnerships: connect NC State faculty and the business community to attract business and investment, to support

entrepreneurship, to integrate workforce training, to apply precision marketing models and to organise and lead industrial clusters. The motivation for these EDPs is that "funded research combined with teaching and extension produces innovations, which when transferred and commercialized, results in knowledge and wealth creation. Results include more competitive manufacturers, expanded resident corporate R&D, more local high-growth companies, increased technology commercialization and empowered communities throughout North Carolina."[15]

- Gen. H. Hugh Shelton Leadership Center: As an extension of NC State, the Center seeks to assist individuals across the life-span opportunities to develop and enhance leadership skills and practices emphasizing the importance of honesty, integrity, social responsibility, diversity, and compassion as a leader
- Industrial Extension Service: Established in 1955 to help North Carolina industries grow and prosper, it seeks to help companies stay abreast of the latest technologies and best practices in both engineering and business management. An independent survey showed that their services have been worth more than $500 million to North Carolina.[16]
- McKimmon Centre for Extension and Continuing Education: serves as a gateway to the vast intellectual and technical resources at NC State University. It was established in 1924 as the College Extension Division and has continually evolved to meet the educational needs of individuals, organizations, governmental agencies, and corporations in North Carolina. It addition to the educational activities of the Centre, it also provides research expertise.[17]
- Small Business and Technology Development Centre: Established in 1984 to help North Carolina businesses grow and create new jobs. The Centre provides provide management counselling and educational services to small and mid-sized businesses throughout North Carolina, and most services are free of charge. Particular areas of expertise include Technology Development and Commercialization; Government Procurement; Export Financing Services; Boating Industry Services; and Marketing & Research Services.[18]
- 80 formally established Service Centre, Institute and Outreach Programs in Colleges and Divisions.

3.1.13 The university has also ensured that its institutional structures and policies are also geared to supporting state economic development. This is no more evident than in variable royalty policy from the licensing of technology which favours businesses from North Carolina and the inclusion of such activities in the academic promotions and assessments procedures.

State funding programmes supporting local capacity and capability building in universities: the cases of Ohio and Utah

3.1.14 The States of the United States provide significant investment for technology development and commercialisation. A 2006 audit of these programmes by the National Centres of Excellence[19] shows that the US States had allocated

[15] http://www.ncsu.edu/econdev/acheivingresults.html
[16] http://www.ies.ncsu.edu/aboutus/
[17] http://www.mckimmon.ncsu.edu/
[18] http://www.sbtdc.org/
[19] Alder, G. M. (2006) *State Technology Development and Commercialisation Programs: A survey of the States*, a report for WestCAMP, Inc.

approximately $2.9 billion to technology development and commercialisation, with approximately $0.93 billion allocated to state research investments, $0.46 billion to technology maturation and seed funding, and $1.47 billion to venture capital investments.

3.1.15 Two interesting examples of State programmes designed, in part, to help universities contribute more to state-wide economic development are Ohio's Third Frontier programme and Utah's USTAR programme.

Ohio's Third Frontier Programme

3.1.16 In 2002, the State of Ohio introduced a $1.6 billion, 10 year commitment to support technology-based economic development, known as the 'Third Frontier Program'[20]. It has thus far provided assistance over the period 2002-2008 targeting five key technology platforms[21] across a wide variety of areas including[22]:

- Research and commercialisation collaboration: $684 million
- Entrepreneurial support: $120 million
- Product development assistance: $89 million
- Cluster development: $57 million
- Workforce development: $1.5 million
- Technology centres and incubators: $17 million
- Capital funds and venture capital funds: $99 million of $150 million allocated
- Tax credits: $29 million of $45 million set aside

3.1.17 The research and commercialisation collaboration programmes included creating 26 endowed chairs at Ohio universities ($146.5 million), supporting university based centres of excellence in target technology platforms ($295 million), funding applied research ($190.1 million) and providing grants for capital equipment purchases ($52.2 million).

3.1.18 A recent evaluation of the Third Frontier programme estimated that for every dollar invested by the State, it generated approximately $10 in return. One factor cited by the report as key in the success of the programme was getting industry, universities and other research institutions aligned in their interests and collaborating in their actions. As seen by the allocations above, a central part of the programme was to support research in industrially relevant areas as well as building and supporting a variety of "bridging" organisations that build effective collaborations between companies, universities, Federal laboratories and other research institutions.

[20] SRI International (2009) *Making and Impact: Assessing the Benefits of Ohio's Investment in Technology-Based Economic Development Programs*
[21] The five technology platforms include biosciences; advanced materials; advanced energy; instruments, controls and electronics (ICE); and power and propulsion
[22] Information on the Third Frontier Programme obtained from a recent evaluation of progress by SRI International: SRI (2009) *Making an Impact: Assessing the Benefits of Ohio's Investment in Technology-Based Economic Development Programmes*

Utah's USTAR Programme

3.1.19 The State of Utah has more recently set up a suite of programmes to support its policy of 'innovation-based economic development'. The initiative, known as USTAR – Utah Science, Technology, and Research – was allocated $179 million in total, with $15 million going to the support research teams at the University of Utah and Utah State University to create world-class research teams in strategic innovation development areas, $4 million to support economic outreach programmes around the State designed to support access to the technologies and resources located within the State's universities, and $160 million toward the construction of new research facilities at the University of Utah and Utah State University.

3.1.20 USTAR focuses on four key areas of innovation-based economic development:

- Diversity Utah's economy with high quality jobs
- Build Utah's innovation infrastructure
- Recruit and grow world-class research talent
- Commercialise technology and promote innovative entrepreneurship state-wide.

3.1.21 The programme is currently constructing a 200,000 square foot research unit on the University of Utah campus. The facility will be staffed by faculty hired directly supported by USTAR funding and will focus on research in the priority innovation areas (biodevice and biopharma, energy, medical imaging and brain medicine, imaging technologies and digital media, and nanotechnology) and[23]:

- Are based on existing University strengths
- Have vast commercialization opportunities
- Address large and strategic global markets
- Leverage Utah industry strengths

Public Engagement and community development

3.1.22 The public and community engagement mission typically closely aligns with a university's mission to support local and state-wide economic development, with much of the activity focused on disadvantaged groups and the regeneration of disadvantaged areas.

3.1.23 A report by the US Department of Housing and Urban Development in 1999 showed that US universities are "redirecting their economic and intellectual resources, facilities, and other assets to benefit their communities in many innovative ways. They are working to facilitate economic development, provide much-needed social services, support public schools, offer technical assistance to community-based organizations, target research that provides guidance for community problem solving, and create opportunities for faculty, students, and community residents to learn from

[23] http://www.innovationutah.com/innovation.html

one another". The report divides university activity in this area into seven categories[24]:

- Service Learning: University programs in which students engage in service activities for credit as part of their coursework. Activities may consist of actual coursework or the provision of a community service that is related to a specific course of study.
- Service Provision: Noncredit student and faculty initiatives in the form of coordinated, sustained, long-term projects targeted to a specific community.
- Faculty Involvement: Faculty members who embody the driving force behind activities within the community.
- Student Volunteerism: Activities driven primarily by students. These activities provide students with worthwhile positive experiences while allowing them to fulfill noncredit graduation requirements of volunteerism in community development.
- Community in the Classroom: Specific nondegree, noncredit courses for local residents designed to enhance community building and community capacity.
- Applied Research: Research activities that define needs, guide program planning, assess outcomes, or otherwise contribute to efforts to improve conditions within the community.
- Major Institutional Change: Initiatives that change the mission, promotion and tenure criteria, awards, and course offerings of colleges and universities.

3.1.24 Many universities have dedicated infrastructure supporting their public engagement mission, for example:

- Cal Corps (UC Berkeley):
  - Founded in 1967 by students, Cal Corps is the University's Public Service Center. The Center partners with the community, student leaders and faculty to engage over 6,500 students each year as volunteers, and through jobs, internships, and courses.
  - Its Mission is to engage the University and the community in reciprocal partnerships to create educational programs for students, to promote leadership through service, and to foster social justice and civic engagement.
  - Importantly, they offer services to students, staff, alumni and the community.
  - In 2008/09, they worked with 270 community organisations. Students provided approximately 320,500 hours of service with an approximate economic impact of $6.2 million.
- Haas Center for Public Service (Stanford University)[25]
  - It provided services in areas such as:
    a Community based programmes (e.g. tutoring and mentoring in schools)
    b Courses (e.g. faculty members creating service-learning courses that involve students providing direct service to local schools, non-profit organizations and government agencies)
    c Research (e.g. community based research that address specific community-related issues)
    d Fellowships for student internships with non-profits, government agencies or foundations in the US or abroad
    e Personal leadership development

[24] Department of Housing and Urban Development (1999) *University-Community Partnerships in America: Current Practices, Volume III* (http://www2.huduser.org/portal/publications/commdevl/partner.html)
[25] Haas Center for Public Service (2007) *20th Anniversary Report 2003-2006*, Stanford University

- Support for faculty engagement

- It spent $2.1 million on programmes in 2005/06, with its funding coming from a variety of sources including endowments, gifts and general university funds.
- It targets all potential partners including students, staff, alumni and the community.

4 Infrastructure of the Knowledge Exchange System

4.1.1 Previous reports on the English HE sector KE system in this working paper series[26] highlighted the breadth of infrastructure that has been built up over the past decade to support the knowledge exchange process between universities and external organisations in the public, private and third sectors. This is no less true of US universities, which have developed support infrastructure in each of the five key areas identified by PACEC/CBR (2009b):

- Facilitating the research exploitation process
- Skills and human capital development
- Stimulating interactions
- Exploiting physical assets of the university
- Civic / community engagement

Diversity of infrastructure

4.1.2 As in the UK, there was evidence of a wide variety of infrastructure being put into place to support the knowledge exchange process in the US case study universities across each of the five categories above. While each university builds a system of infrastructure that meets its specific needs, and increasingly the needs of the local community and state-wide economy, there are nonetheless some common types of units that exist across different institutions. These include (but are not limited to):

- Research exploitation:
  - Technology transfer offices / intellectual property offices
  - Industrial research offices / industrial liaison offices
  - Proof of concept centres
  - Research contracts offices (offices of sponsored programmes)
  - Open innovation research centres and research 'clubs'
- Skills development
  - Continuing education offices
  - Extension offices that provide educational programmes, events, technology updates and access to the university around the state
  - Entrepreneurship education including involvement in 'live' spin-out and technology commercialisation projects
- Stimulating interactions
  - Visiting fellowships
  - Lab-lets bringing together industrial researchers and academic researchers
  - Research clubs
- Exploiting physical assets
  - Innovation parks
  - Incubators
  - Co-location of industrial and academic research labs
- Civic and community engagement

[26] E.g. PACEC and Centre for Business Research (2009) *Evolution of the Infrastructure of the Knowledge Exchange System*, a report to HEFCE

- Science outreach offices
- Public engagement offices
- Community-focused research centres
- Community regeneration
- Community-based or non-profit internship support

The evolution of the knowledge exchange system

4.1.3 The specific components of the each university's system of support infrastructure built up to support the knowledge exchange process necessarily differs, accounting for the specific internal and external contexts within which they are located, their existing capabilities and capacities, their strategies and, importantly, the legacies that influence their evolution.

4.1.4 The way in which the different universities systems have evolved also differs. At one end of the spectrum, the knowledge exchange system has evolved organically from the 'bottom-up', with little strategic direction and influence. Infrastructure emerges, for example, as academic and / or external needs arise or as a result of funding opportunities or as a result of academics in pursuing particular types of external engagement. This results in a very ad-hoc development of the knowledge exchange system. At the other end of the spectrum is a much more top-down, controlled development of the organisational structure of the knowledge exchange system. Under this model, the support infrastructure and institutional practices and policies are the direct restructured or introduced as a direct result of a wider strategic plan driving the university's knowledge exchange mission. There are, of course examples between these two poles of the spectrum where a top-down plan provides a structured framework that guides the bottom-up activity and infrastructure of the institution. It was evident from the case study universities that the purely bottom-up, organic evolution of the system with minimal strategic direction works best where a culture has historically existed that embraced academic enterprise and entrepreneurship within the institution and where the university is located within a geographical location which fosters enterprise and entrepreneurial activity rather than hinders it. Universities that lack either of these criteria appear to benefit more from stronger leadership and the existence of a top-down framework that does not stifle the activity occurring at the level of the academic, but rather nurtures it and provides it with direction.

4.1.5 Arizona State University provides a good example of the creation of a system of infrastructure based on a very strong direction by the leadership of the university. Michael Crow, President of Arizona State University, inherited a university that, like many in the US and globally, was heavily geared both operationally and culturally towards teaching and research. Achieving his vision of an institution where academic enterprise and entrepreneurship was the driver of local and national innovation required strong leadership and a suite of integrated and networked infrastructure to be installed at all levels. In his article on building an entrepreneurial university (Crow, 2008), he suggests that the innovation infrastructure of a university can be divided into five key levels:

Level 1: Disciplines: The academic disciplines are at the foundation, producing knowledge. Innovative KE is viewed as being able to occur across *all* disciplines, not limited to STEM subjects

Level 2: Initiatives: These initiatives are created to assist entrepreneurial ventures that come out of the work of the disciplines. Crow (2008) favours fostering a large number of initiatives because "inevitably, some will fail". Natural selection provides the best way of ensuring that the most efficient and productive initiatives are sustained. Initiatives at Arizona State University include: innovation space, entrepreneurship and innovation research, angel funding, technology venture clinics, the Arizona technology investment forum and the ASU Technopolis which brings together entrepreneurs, venture capitalists, and creative thinkers in the Phoenix region.

Level 3: Skysong: conceptualised as a hub for knowledge driven industries, technology innovation and commercial activity, it is a $500 million, world class assembly point for knowledge, technology research and commerce. It consists of large global and foreign based companies (such as Canon and Ticketmaster) that could engage in beneficial exchange with the university and its start-ups as well as small and medium sized technology firms that are critical in driving innovation. The clusters of entrepreneurial firms are supported by business support professionals including venture capitalists, angel investors and other financial service professionals, as well as business service providers such as law firms, accounting firms and management organizations

Level 4: Policies: Institutional policies that promote entrepreneurship and facilitate the flow of ideas into actionable, commercialisable outputs. Minimising or eliminating policies that inhibit decision making, deaden creative thinking and increase bureaucracy. This level also includes reforming faculty level incentives to encourage greater academic enterprise and entrepreneurship.

Level 5: Networks: High levels of internal and external connectivity at all geographic levels and functional levels helps to maximise the number of pathways for an idea to move from conception to reality. Networks include linkages with other academics, entrepreneurs, industries and many other types of actors who are central to the innovation process.

The scale of the knowledge exchange infrastructure system

4.1.6 While it was not possible to estimate the average scale of the overall knowledge exchange system in each university, attempts were made to understand the number and types of staff in different KE infrastructural units. Much of the evidence gathered here originates from the websites of the individual units and focuses on the specialist staff rather than general clerical or administrative staff. In addition, it was not possible to determine the full time equivalent number of staff.

4.1.7 Table 4.1 shows that the size of the different units varies considerably reflecting the demand for services (e.g. the technology transfer offices at Stanford and MIT are large, serving a large entrepreneurial academic community that produce significant amounts of commercialisable research output, while that at Brigham Young University is small reflecting the demands placed on it by the amount of research it undertakes). Community outreach units can be sizeable, for example the Haas Centre for Public Services at Stanford University has 24 staff listed on their website and 61 student staff, while the Office for Diversity and Community Engagement at the University of Texas at Austin has 16 key staff listed. It should be noted that Table 4.1 illustrates

the size of different KE units within different universities, but these are not complete for any institution (so for any university mentioned there will be other KE units not covered in the Table). Hence the total number of KE staff in any university, employed in all KE units, will be higher than the numbers illustrated in Table 4.1.

Table 4.1 Staff numbers (headcount) in selected KE units

University name	KE Unit	Staff headcount
Pennsylvania State University	Industrial Research Office	10
University of California, Berkeley	Office of Intellectual Property and Industry Research Alliances (IPIRA)	11 in Office of Technology Licensing; 5 in Industrial Alliances Office
Ohio State University	Industrial Liaison Office	2 (recently formed in 2008)
North Carolina State University	Office of Technology Transfer	14 listed
University of Texas at Austin	Office of Technology Commercialisation	9 full-time positions (21 In total)
University of Texas at Austin	Office for Diversity and Community Engagement	16 key staff listed
University of Utah	Technology Commercialisation Office	29
UC San Diego	Technology Transfer Office	31
	Moores Cancer Centre Industry Relations Office	1
MIT	The Deshpande Center	3-7
MIT	Technology Licensing Office	31
Brigham Young University	Technology Transfer Office	4
Stanford University	Office of Technology Licensing	41
Stanford University	Haas Centre for Public Services	24 staff; 61 student staff; 3 visiting practitioners/scholars
Stanford University	Office of Science Outreach	2
Nationwide Children's Hospital	Technology Commercialisation	5

Note: Number of staff reflects the headcount of those staff identified through the website, focusing on the key staff rather than clerical and administrative staff. It was not possible to identify the number of full time equivalent staff.
Source: University websites

The coordination of the knowledge exchange system

4.1.8 In most cases, there was evidence of coordination failure of the knowledge exchange system as a whole, although component parts may be functioning well. For example at one top research university, the research commercialisation infrastructure (which included a technology transfer office, industrial research office, business support and incubator space etc.) was functioning well and providing a high level of support and access to the university for firms. However, it was remarked in the interview that there was little coordination of their activities with the other knowledge exchange functions of the university such as the teaching, continuing education and extension

activities. Few links either at the strategic level or the operation level existed between these silos of activity.

4.1.9 In other cases, there was evidence of coordination failure even within different component parts of the knowledge exchange system. In one case, there were a relatively large number of units providing services to support the commercialisation of research, with each providing support to a seemingly separate part of the commercialisation value chain. However, the linkages between these different units were very weak and there was little coordination of the activities. This has inevitably reduced the efficiency of the commercialisation process. The lack of a coordinated approach has resulted in frustrations amongst academics who find it more difficult to commercialise their research. It was evident that strong leadership was necessary to precisely define the roles of the different infrastructure along the commercialisation value chain and build the interfaces between these points.

4.1.10 In one of the case study universities – North Carolina State University – strong levels of coordination were evident, with much of the knowledge exchange infrastructure coming under the responsibility of a single Vice Chancellor (PVC equivalent) who was very active at ensuring a coherent organisational structure for their entire knowledge exchange mission.

4.1.11 In the universities such as Stanford and MIT, where a very organic knowledge exchange system has emerged as a result of their very specific contexts, it was claimed that the coordination of infrastructure occurs as a result of the strong networks between units. This ensures that duplication of support services are minimised and that each unit is aware of their defined role along the knowledge exchange engagement role, with clearly defined interfaces between units.

4.1.12 Coordination through better definitions and mutual understanding of the roles of units has been helped in a number of units by secondments of new staff between units. These secondments help the new staff of one unit understand the processes required of other parts of the engagement value chain to help increase the efficiency of the process.

Building open innovation platforms for engagement

4.1.13 A number of universities have recognised the emergence and importance of the open innovation model of innovation[27] and taken steps to facilitate this process by improving access to university research and knowledge. One method that is increasingly evident is the creation of university-industry-government (state) research centres that bring together in partnership these different actors into the research and innovation process. In some cases this may be a highly collaborative process where the industrial researchers physically co-locate with academic researchers and share knowledge and outputs.

[27] See, for example, Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology,* Massachusetts: Harvard University Press

4.1.14 In other forms, the research centres are more 'clubs' centred around different technological or sectoral themes, with members contributing a fee which goes to funding research in the interests of all members. Research outputs are then disseminated to all members. Mimura (2010)[28] claims that companies benefit from this type of engagement by receiving valuable information about the latest technological developments, becoming informed on where the academic expertise lies, access to talented students who could be prospective employees, and through giving them the chance to influence the direction of world-class research in their chosen sector/technology.

4.1.15 A critical benefit of these types of organisations is the networking of academics and members of external organisations to foster the exchange of ideas and knowledge.

The emergence of an 'integrated' commercialisation office

4.1.16 Traditional technology transfer offices (TTO) exist in many universities in the United States focusing on the commercialisation of research through IP out-licensing and in some cases, the formation of firm spin-outs. However, it was remarked in the case study interviews that the majority of these are not functioning efficiently, with many unable to cover their costs. One potential argument has been that many universities simply do not have the volume of commercialisable research outputs that justify having a traditional TTO. The inability to raise sufficient revenues from the commercialisation of research outputs results in insufficient resources to attract and retain staff unless covered by cross-subsidisation from other university activities. That is not to say that these universities do not generate important research outputs that can be of benefit to the economy and society, rather that the knowledge exchange efforts may be inappropriate for the institution.

4.1.17 The University of California, Berkeley, however, reformed its commercialisation infrastructure involved with industry contracting in 2004 to adopt a much more holistic approach to research commercialisation (Mimura, 2010). It recognised that industry could approach the university from many different directions, some of which would require contracts while other channels did not. By merging the activities of the traditional Office of Technology Licensing and Industry Alliances Office into the Intellectual Property and Industry Research Alliances (IPIRA) office, they were able to streamline industry transactions and increase corporate sponsored research. Under the old system projects were often regarded as in competition with each other, or at the expense of one another. Bringing the functions under a single operation has helped remove these constraints by eliminating silos and reconciling the objectives of each office. The office has also dispensed with the traditional view of Technology Transfer, focusing on ongoing relationships rather than single transactions, that results from many points of contact and many methods of engagement. It has identified the following programmes:

- Philanthropy (no strings attached to the gifts)

[28] Mimura, C. (2010) "Nuanced Management of IP Rights: Shaping Industry-University Relationships to Promote Social Impact" in Dreyfuss, R., First, H. and Zimmerman, D. (2010) *Working Within the Boundaries of Intellectual Property*, Oxford: Oxford University Press

- Open collaboration model where firms undertake research alongside academics and students with an open dissemination framework
- Industry Affiliates Programme where firms pool resources to fund common research around particular expertise
- Corporate sponsored research (large and small) including the establishment of large scale cross-disciplinary university-industry research institutes where the results are taken up and commercialised by industry, including through start-ups
- Socially responsible IP rights management to promote the widespread availability of technology and healthcare in developing countries

4.1.18 Mimura (2010) argues that, critical to its success, are the staff and networks established that allow them to "expedite translational research and bridge funding gaps through creative partnering and flexible contracting" (p. 21). There has been a recognition that IP does not always need to be the main focus of a contract and, indeed, in many cases, there is no need for a discussion over IP. The office has seen cultural and negotiation biases being reduced, industry and foundation funding increasing well above expectations, collaboration types and numbers increased, barriers to gifting into the university have been reduced and greater numbers and types of contracts and strategic alliances have been formed.

4.1.19 While other universities have not gone as far as integrating these different functions into one office, those considered to be exemplars of university-industry commercialisation have recognised the important synergies between the traditional technology transfer role, industrially sponsored research projects, university development and company formation, and created strong links and interfaces between the different infrastructural units.

Experimentation in the interface between universities and industry

4.1.20 The case studies revealed a great deal of experimentation in the knowledge exchange system in the United States over the last decade. While good practice has emerged on how to organise different parts of the KE system, there is little consensus on best practice, and there was ample evidence of universities struggling to restructure their KE systems to help improve their KE performance. There was little convergence in the structure of KE systems across the universities studied reflecting a number of different factors including highly different internal and external contexts, legacies, as well as a lack of knowledge on what really works. It was unsurprising, therefore, that many of the universities interviewed were as interested learning about the developments in the UK KE system as we were in finding out what was going on in the United States.

Attracting and retaining knowledge exchange staff

4.1.21 The quality of knowledge exchange staff was viewed as extremely important for providing an efficient knowledge exchange support service to academics. However, there was little consensus amongst research commercialisation units on the qualities required by their staff. However, it was evident that those technology transfer

operations that were highly successful had recruited senior staff with significant experience in industry, and where possible in starting up and growing technological firms. Most viewed a technological background and some form of industrial experience as necessary.

4.1.22 Some case study universities, particularly smaller universities hampered by location (e.g. remote to large markets) or global reputation viewed sales and marketing skills as paramount to raising awareness of the research outputs of the university amongst potential buyers of the technology. An interesting example of innovation in this sphere was the use of alumni networks (including through online social networking sites) to promote technologies.

4.1.23 Attracting and retaining good quality KE staff to support the commercialisation process was viewed as one of the critical constraints facing the infrastructure of the KE system. One large research institution with an enviable record at commercialisation noted that technology commercialisation is not really a career option and people use it as a stepping stone to other careers. They have therefore tended to hire people with proven track records who have had success in industry and who are not searching for a further step in their career progression.

4.1.24 That said, the technology transfer operation at another large research university noted that staff sometimes viewed moving into university commercialisation from industry as an improvement in their quality of life. This may have impacts on the level of service provided to the academics given the demands of technology commercialisation.

Academic tensions towards knowledge exchange engagement and the incentive structures in universities

4.1.25 The institutional legacy of academia has resulted, amongst research universities worldwide (including both the US and UK), in a promotions and rewards system based largely on the publication of research in peer reviewed journals. Universities tend to set promotions and tenure criteria based on the system-wide norms, which do not normally accept other forms of research outputs. At the same time, academics are being asked to perform more tasks including teaching and administration which places large pressures on their time to undertake research and publish. Combined, these factors have resulted in tensions amongst academics that reduce their willingness to undertake activities that do not contribute to their research publications – the primary method for their assessment and reward.

4.1.26 A number of case study universities have looked at addressing this problem by reforming their promotions and tenure criteria. For example, the University of Utah Engineering department now includes patents in their promotions criteria. North Carolina State University has reformed its promotion and tenure system to included knowledge exchange outputs. However, universities cited a core difficulty of unilateral promotions and tenure policy reform. A number of universities argued that if each, alone, moved away from a promotions and tenure system based on research

publications, this could substantially reduce the mobility of academics between institutions. Should an academic want to switch institutions, they would find it harder to satisfy the criteria on the new institution that still emphasized publications as the primary assessment criteria. This would reduce their attractiveness to potential recruits and hence their competitiveness in the higher education sector.

4.1.27 However, the reforms implemented at Arizona State University by its President, Michael Crow (Crow, 2008), include reform to faculty incentives and a change in the culture emphasizing academic enterprise and engagement with external organisations. He argues that academics that they will attract those academics that fit with their values while those that want to remain in ivory towers would naturally move elsewhere.

4.1.28 Academics in the UK also suffer from cultural difficulties in moving between academia and industry and back again[29]. These difficulties were also clearly evident amongst the case study universities in the United States. Time spent in industry ***had*** to involve advancing the academic's research agenda (and by implications contribute to their publications) or they would be penalised in terms of career progression upon their return. This difficulty is likely closely related to that of the institutional failure associated with promotions and tenure criteria outlined above.

Challenges in restructuring and launching infrastructure

4.1.29 Another challenge universities have faced surround the introduction of new infrastructure into a system suffering from historical tensions and negative perceptions of related KE infrastructure by academics (e.g. due to the historical lack of professionalism, quality and capability of the infrastructure). The design and role-out of new infrastructure has to take this into account and confront the legacy effects of related infrastructure. If it does not (for example through active marketing, networking and relationship building) it risks being tainted with the same negative assumptions that constrained the previous infrastructure.

4.1.30 A number of KE units have undergone significant reform over the past decade to improve performance and the quality of the support they provide to academics. One important facets of reform has included the realisation that many units are primarily a service function in support of the academic's knowledge exchange activity. In parallel, efforts moved towards building relationships between KE staff and academics to help overcome the negative perceptions of KE support by academics.

[29] PACEC and Centre for Business Research (2009) *Evaluation of the Effectiveness and Role of HEFCE/OSI Third Stream Funding*, a report to HEFCE, report 2009/15

5 Commercialisation and the Intellectual Property Debate in the United States

5.1.1 In recent decades almost all research universities in the US, as in the UK, have established Technology Transfer Offices (TTO) designed to support the commercialisation of their intellectual property (IP) and manage the university's IP portfolio. In part this activity is driven by the promise of additional revenues from commercialisation (Columbia University earned $178 million in licensing revenue in 2003 and annual licensing income generated by US universities increased from about $160m in 1991 to $1.4billion in 2005) and partly from a recognition of the value of intellectual property rights as a policy tool with the potential to encourage increased innovation. Critical to the latter point is the view that IPRs give people and incentive to produce socially beneficial innovations. Without some guarantee of a private return, inventors might not undertake innovative activity the fruits of which cannot be defended against imitators.

5.1.2 In the US policy developments have generally resulted in a strengthening of patent-holder rights with a consequential growth in the number and complexity of patents. In the context of university IPR in the US the position is complicated by the existence of private as well as public universities. The latter are accountable to a wider range of stakeholders and are typically less flexible in their IP activities than private universities. For example they may be more concerned with encouraging local economic development through their IP regime (local licensing arrangements than with commercialisation per se.

5.1.3 The Bayh-Doyle Act (1980) (BDA) has been seen a the key legislation establishing the framework for the commercialisation of federally funded research. It should be noted however that there is considerable debate as to whether it played the central role attributed to it in the changing pattern of patenting in the US subsequent to the passage of the Act[30]. The act replaced differentiated individual contracting arrangements (Institutional Patent Agreements) with a uniform policy. Hitherto every government agency and university had their own unique arrangements regarding ownership of their IP. Under the BDA government funded organisations such as universities have the right to retain IP rights to inventions derived from publicly funded research. It requires that academics who are being funded by a Federal research grant disclose their inventions to the university TTO. BDA provided a framework for making new discoveries generated in government funded research more accessible. .Importantly, the BDA was preceded by the Stevenson-Wydler Act which had made technology transfer a mission of government owned labs requiring them to establish technology transfer offices to support commercialisation of publicly funded research. The prize was improved efficiency in commercialisation and new sources of funding. At the same time the hope was for greater involvement of small business in federally supported R&D efforts.

[30] see for example Mowery, D. C. (2007) "University-Industry Research Collaborations and Technology Transfer in the United States since 1980", in Yusuf, S. and Nabeshima, K. (eds) (2007) *How Universities Promote Economic Growth*, World Bank: Washington

5.1.4 In the UK, academic researchers are employees of the university and patent rights stemming from their research belong to the university[31]. Most universities have agreements with students that stipulate ownership of IP to be held by the university with negotiated shares of any royalties for the students. However, as in the US there remains considerable diversity among UK universities in their handling of IPR.

5.1.5 The last decade has witnessed an expansion of equity investments in licenses in the US and the integration of patenting and licensing into broader programmes of university industry links. Also it is increasingly recognised that there is a need for different relationships according to the sector or type of business

Case study experience under the BDA framework

5.1.6 The case studies reveal a generally positive stance by Technology Licensing Offices to the management of university IP under the broad framework provided by BDA although there is some evidence of emerging tensions.

5.1.7 The Technology Transfer Office at Stanford University, for example, believes that the BDA is a good thing as it is has clarified and made very transparent who owns what. The Bayh Dole Act has also had an effect on professionalising the process of commercialisation within institutions and allowed for development of offices that hold large amounts of vital specialist knowledge on issues regarding technology transfer. The TTO believed that not all universities need their own TTO and that perhaps offices that lack a critical mass of commercialisable research outputs could share resources or use an external office.

5.1.8 The BDA permits a high degree of flexibility of IP management strategies by university TLOs. Berkeley's Intellectual Property and Research Alliances (IPIRA) recognises that transactions with industry must be varied and flexible to achieve a variety of outcomes that meet the mutual goals of industry and the university. Where contracting is the most appropriate form of knowledge transfer, Berkeley implements a wide spectrum of IP management strategies to accommodate the many different ways in which Berkeley interacts with industry. The spectrum recognises that in some engagements IP protection is required while in others, it is of little or no importance. Open collaborative research agreements require relatively little by way contractual IP arrangements. The Intel Berkeley research laboratory (lablet) provides university researchers with access to company proprietary resources and research outputs are disseminated widely. Each party funds its own research IP rights may be filed either by Berkeley or Intel (or jointly). If either party elects to obtain patent rights the other party receives a non-exclusive licence. Industry affiliate programmes involve companies joining a research programmes in specialised areas through payment of a membership fee and receive information on the latest developments, research of interest and how and where academics may be of help. At the other end of the spectrum is corporate sponsored research where agreements on IP ownership are defined in great detail and where the corporate sponsor typically receives first

[31] Siepmann, T. J. "The global exportation of the Bayh-Dole Act"

sight of the research outputs and usually has first right to exclusive licenses. Where university resources are used the university owns the IP rights.

5.1.9 On the question of which organization should be responsible for the commercialisation of IP-the university TTO, the academic inventor or a third party (public sector or private sector body), the University of California Office of the President was concerned that allowing private companies to manage University IP exploitation, runs the risk of focusing on internal revenue generation rather than maximizing IP flows. Similar views were expressed at Arizona State where they have moved from a revenue maximizing model to a model that rewards deal flow density to ensure that University IP flows, not just to those that guarantee the greatest revenue streams are diffused into the economy and society (Crow, 2008). Many TTOs were also adamant that they cannot be run as a typical business although it was recognized that it must be run in same way as any service industry with maximum exposure across the university and with swift response rates to queries and an emphasis on building relationships. Importantly, if one accepts that it is not possible to accurately cherry pick which IP will be successful, then the question arises as to what happens to the bulk of knowledge that is passed over and not placed in the public domain. University TTOs have to work with the IP they are given by the academics and try and get it out after due diligence.

5.1.10 The Kauffman Foundation (Litan and Mitchell, 2009; Schramm, Litan and Stangler, 2009) has been critical of the current arrangements under the BDA and have proposed an amendment to the BDA, suggesting that underperforming Technology Licensing Office (TLO) with monopoly power over an institution's (university's) IP be forced to compete with one another by assigning the initial rights to individual faculty inventors rather than to the university. Inventors could then choose how to commercialise their research, be it through the TLO of their own institution, another TLO or some other independent licensing agent. This proposal is based upon the premise that inefficient and understaffed TLOs are serving as a bottleneck to the commercialisation of research. Exposing TLOs to competition should lead them to increase efficiency, specialise in certain areas, draw on outside expertise and generally improve performance. The crux of the issue is the question of whether or not TLOs are presently managing technology transfer efficiently.

5.1.11 The Kauffman proposal for amending the BDA found little support from the case study TTOs. Without exception the case study universities were of the view that the current assignment of IP to the university has been a positive development and that assigning rights to individual academic inventors would reduce rather than increase the efficiency of the commercialisation process. The complex IP management process that individual academics would then have to negotiate is succinctly summarised by Mimura (2010) at Berkeley:

> *IP rights management in the academic sector is multifaceted because scrupulous drafting and unambiguous definitions are required to preserve options for future funding for the laboratory; protect students; preserve the university's tax-exempt status; fulfil our obligations to other sponsors; inform affected researchers of the terms and conditions of the award;*

> *address public benefit concerns, such as providing access to results created by a public institution; and administer the award effectively and efficiently. Complexities also arise from the need to consider export control issues and such other aspects of research administration as conflict-of-interest management, animal care and use, human subjects protection, and environmental, health and safety concerns. These issues must be addressed before a contract can be signed.*

5.1.12 Overall, university TTOs believe that the BDA framework for commercialisation has a lot of value, they do accept that the current commercialisation process can be improved, although they are adamant of the need for internal capability to govern this process. However, the Government University-Industry Roundtable by the National Academy of Sciences in 2003[32] found that

> *'The universities' approach of securing iron-clad protection for intellectual property seems to be yielding diminishing returns, even within the narrow confines of the licensing activity itself… The requisite legal negotiations for IP-that-will-ultimately-prove-to-be-useless are laborious, individualised, and negotiated between universities and companies on a case by case basis. The upfront legal negotiations can easily cost more than the total cost of the research project being conducted and/or extend past the time when the company has interest in the technology path being pursued… In summary, the uncertainty of the true value of university-generated intellectual property, combined with a litigious culture, have made the university-industry working relationship… unaffordable and nearly unsustainable within the US.'*

5.1.13 There is clear evidence, however, that some of the more enterprising universities have taken these, and other criticisms, on board and are creating more innovative, flexible ways of engagement. For example, University of North Carolina at Chapel Hill identified a number of factors hindering the start-up of new firms, including excessive demands for equity in IP (often exceeding 15%), royalties being required to exceed cash flows, the expectation of external financing and unpredictable or unreasonable licensing terms. There were concerns that the process of launching a company involved competitive, rather than collaborative, negotiations between faculty and the university. In response to these problems, the Carolina Express License Agreement were designed to reduce barriers to firm formation, addressing the issues of universities taking substantial equity positions in start-ups and unhelpful royalty structures.

[32] Quoted in Mowery (2007) "University-industry research collaboration and technology transfer in the United States since 1980", in Yusuf and Nabeshima (2007) *How Universities Promote Economic Growth*, the World Bank: Washington

6 Conclusions

6.1.1 The aim of the research in this working paper was to explore the knowledge exchange system in the United States and compare the situation to that in the United Kingdom. Given the huge diversity of institutions in the US, we naturally had to focus the research on selected institutions. The research focused on understanding stories of successful university engagement with external organisations and on understanding some of the key challenges facing the system.

6.1.2 Despite the large differences between the US and UK HE systems, they both face similar challenges to improving knowledge exchange:

- Despite many years of experimentation in the US, as in the UK, there appears to be no convergence on the most efficient organisational models for the knowledge exchange system. This is likely a result of the very large internal and external contextual factors that influence the development of an efficient system as well as the very important role of legacies in influencing the nature of infrastructure required and the institutional structures necessary to guide the system.
- A key source of inefficiency in the system was a lack of streamlining of different infrastructure that support the same commercialisation or knowledge exchange value chain. The duplication of services and poor interfaces between different infrastructural units providing support to the knowledge exchange process of the academic can create tensions, frustration and even result in the abandonment of the interaction by academics and firms.
- Attracting and retaining KE staff with right qualities is very challenging given the resources available in many universities to fund the knowledge exchange system. This results in a vicious circle with poorer quality staff leading to a reduced ability to raise funding which then prevents the university from investing further in raising its engagement capability.
- There was a distinct need for flexibility in contracting process. External organisations have very different requirements and can engage with universities on a commercial basis in many different ways to exploit the knowledge located within the institution. A flexible and innovative contracting process allows for these organisations to engage in the most efficient manner given their situation and objectives, and maximises the potential for a mutually beneficial relationship being built.
- IP can act as a significant barrier to engagement if the commercialisation infrastructure does not recognise the cases where protection is required and where it is much less important. A failure to recognise this can create large difficulties between the university and external organisation and reduce the efficiency and effectiveness of the engagement process, as well as harming the reputation of the institution as an engaged university focused on diffusing its knowledge for economic and social benefit.
- Commercialisation infrastructure has improved, but problems still remain. Many are not profitable and many US universities, like many in the UK, lack the scale of research outputs to justify the costly investments in such infrastructure.
- The problem of time is the greatest constraint in both countries preventing further engagement with industry and other external organisations. Overcoming this constraint appears to be critical for enhancing the role that universities can play in supporting local, regional and national economic and social development.

- Universities, both in the US and the UK need to facilitate access to the knowledge that is located within their walls. Creating a porous institution – an 'open university' – in which external organisations can easily access the knowledge through the most appropriate mechanism (whether it is contract based or much less formal), while rewarding the knowledge and expertise received, would seem to be an imperative for universities. Economic benefits could derive from facilitating the open innovation model being increasingly adopted by external organisations, and minimise the barriers to the access of knowledge and expertise. The inappropriate protection of IP, and inflexibility of many university contracts can, for example, create insurmountable barriers that external organisations are unwilling to confront, thus preventing knowledge from flowing into the economy and society.

6.1.3 Despite these similarities, some key differences do exist:

- Community engagement currently has a much higher status in US universities and is recognised and resourced to a much greater extent. In many US universities, there is a senior management position with the dedicated mission to supporting state economic and community development. Support for community development transcends the public and private university divide and who typically take active roles in their communities.
- The role of US universities in local and regional economic development appears to be much greater compared with the UK. This is partly a result of their heritage, with many of the top public universities arising out of the land grant acts, and the powerful influences and resources of State government in the US compared to regional governments in the UK.
- Universities in the UK appear to have gone much further in introducing KE as a part of the promotions and assessments criteria.
- The US system suffers from a lack of national coordination as a result of the structure of the system. This makes it difficult for a university to unilaterally reform to address system-wide failures exist such as promotions incentives towards KE. The coordination of universities occurs primarily at the State level with powerful influences on the direction of universities. However, there are signs of change in the US with the development of a National Innovation Strategy to provide a framework and coherence to the US innovation system, and presumably, the role of its universities in supporting it.

6.1.4 In conclusion, the research has found that the US knowledge exchange system in the higher education sector, like the UK system, is continually experimenting to meet the challenges of effectively diffusing the knowledge from the university base into the economy and society. The US system suffers from many similar problems to the UK and while important lessons can be learned from the US, it is important to recognise the advances in the UK that can yield important lessons abroad. In most of the interviews in the US case study universities, there was considerable interest in the activities and organisational models for KE being tried in UK universities and a desire to learn from these experience, in recognition that there is unlikely to be a model of best practice, but rather, the evolution of the system requires a process of learning from the experiences of others in similar circumstances in overcoming critical challenges.