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Preface

Powerful global currents are changing the economic and social systems in cities and regions around the world. In response, people in leadership positions are seeking strategies they can use to make their places competitive and, especially, to attract and retain technology-based enterprise. These places start with an inherited pattern of land use, a resource base, and a set of institutions tailored to another era. In many parts of the United Kingdom (UK), for example, this inheritance reflects an industrial base that has now declined. The challenge is to re-orientate land, resources, and institutions to accommodate the needs of the New Economy.

To meet these needs, a place has to evolve and change. This occurs through agents who mediate the decisions and responses of players from a wide variety of different organisations in the private, public, academic and independent sectors. For example, evidence that new high-tech companies emerge and grow around research centres and universities is expressed both in forms of new land use and institutional connections between these centres and companies.

Our project sought to understand how the key players, seeking to transform their place to accommodate technology-based enterprise, achieved change, and what factors influenced their relative success. The research project was undertaken as part of the Cambridge-MIT Institute (CMI) by researchers based at the University of Cambridge, Department of Land Economy, and the MIT Department of Urban Studies and Planning. Professor Peter Tyler led the UK team and the other team members were Barry Moore, Nichola Morrison, Rob McGaffin, Mónica Otero-García and Margaret Potton. Dr Christie Baxter led the United States (US) team and the other team members were Bernie Freiden, William Porter, Jean Poteete, Myuong-Gu Kang and Michael Sable. The main focus in this work was on the implications of the research findings for the UK.

The team is grateful for the support of a very large number of people from companies and organisations across the UK and the US. We would especially like to thank key people at CMI for their help and support, including Mark Giordano, James Keller, Michael Kitson, William Lucas, Scott Shurtleff and Michael Scott-Morton. We would also like to thank Karen Polenske, for giving us the opportunity to develop our ideas at MIT’s 2001 SPURS Seminar. And special thanks goes to leaders of companies, universities, research centres, government and civic organisations in each of the high-tech centres we studied, who generously gave us their time and help. Annex 3 lists them all.

The views contained in this document are those of the authors only.
Executive summary

Introduction

The transformation of the world economy and increasing global competition presents significant challenges for countries like the United Kingdom that once had a large presence in traditional manufacturing sectors. The pace of change is rapid, and the United Kingdom’s ability to compete in the New Economy depends crucially on how it develops and nurtures its technology-based enterprises.

The current global transformation is largely the result of a revolution in information and communication technology (ICT), which is driving corresponding revolutions in the organization of companies: how they value space and time when they sort production functions, and where they decide to locate operations. As high tech companies reposition themselves globally and regionally, regional leaders are re-evaluating how they can support technology-based enterprise and make their regions more competitive. Increased recognition of the importance of regions has also led to a re-examination of whether traditional institutions and policy measures will lead to optimal outcomes, as well as to the development of new policy frameworks. These new frameworks often incorporate collaborations that cross business, academic, government, and civil society sectors, and span traditional geographic units.

The research described in this report yields a series of lessons about ways to strengthen players in high tech centres from the different systems of knowledge, finance, business and the built environment and the connections among them. In short, successful enterprising places that foster the growth of technology-based activity have four things: academic excellence, flexible local institutions, adjustable infrastructure and civic leadership.

The research involved teams from the University of Cambridge and the Massachusetts Institute of Technology (MIT), funded by the Cambridge-MIT Institute (CMI). We began our work in spring 2002. We explored how key players in centres in the US and the UK enhanced the development of their high tech centres. We explored in particular the collaboration that occurred across different functional systems, the new class of civic leaders, the new vehicles of engagement they developed, and the new instruments of policy. We summarize the lessons below.

In addition to an analysis of published studies related to the development of high tech centres, the team conducted in-depth interviews with 250 high-level government, industry and academic leaders in the US and the UK, and we surveyed senior managers of technology-based companies located in these centres. The main focus in this work was on the implications of the research findings for the United Kingdom.

How can key players enable the development of enterprising places?

Global forces affect places differentially, and some centres are better positioned than others. However, this research found that key players could shape the attractiveness of their region to technology-producing companies. They did so through collaborative activities across the realms of business, academia, government, civic society and across local political units. In each of the successful places studied we found a group of players interacting to produce, disseminate, share and use leading-edge technology to create, sustain and grow the technology-based centre. Innovative behaviour was equally required to manage the negative externalities that concentrations of technology-based companies and workers inevitably created, and we found entrepreneurial and innovative behaviour present in the policy, academic and finance realms as well as the business sector of successful centres.

Crucially, enterprising places were able to create institutional vehicles that brought together the key players but which recognised the new geographies that the workings of the technology-based centres provoked and the implications for the financing and installation of new infrastructure. Broad regional intermediary partnerships enabled geographic connections to be made that were necessary to create a vision of the region and its future. Intermediaries facilitated problem-solving strategies over time, providing mechanisms for the leaders in one sector to test and build trust relationships with their peers in other sectors and they were able to form partnerships that had connection with, but separation from, government. In each place, political leadership and the political climate changed significantly over time. Some separation from government permitted organisations to maintain their operations in this climate of change.

The intermediaries facilitated connections to multiple realms. This allowed the organisation to draw resources from different sources as the capacity of these sources shifted. They also enabled entrepreneurship. That is, the organisation had both access to resources and the ability to mobilise and deliver them autonomously. They had independent credibility and could influence key decision-makers in the core sectors of government, industry, universities and in other civic enterprises.
By involving the leadership of these sectors, intermediaries were able to secure members’ resources to solve key problems, operate independently, and sustain the organization over time. Their structures as cross-sector organizations allowed them to occupy neutral territory. This enabled the participating members to stand aside from some of the inevitable complexities of initiating certain actions within their own organizations and to create alliances with other key players, and draw on their particular expertise and competences, to produce the outcomes necessary to maintain the success and momentum of the place. In these circumstances the private sector came together with the public sector because both sets of experience were required to bring about the required change at the local and regional levels.

The intermediaries were usually driven by representatives from the respective organizations that could authorize real commitment (and thus usually people at the chief executive level). Members of the intermediaries tended not to be heavily politically motivated. The intermediaries so formed had clear objectives that were deliverable and action-oriented, with actions being reviewed constantly. This heightened credibility and helped to ensure the delivery of their policies to support the growth of the technology-based areas. History matters when it comes to policy-initiated intermediaries. In the United States, the private corporation has long been a model for public action. The result is a civil institutional structure heavily weighted toward intermediaries that undertake activities in the public interest but that remain at arms length from government. In contrast, in the United Kingdom, in the post-war period public bodies have tended to take the responsibility for local action that often followed defined programmes directly accountable to central government.

Within the system of intermediaries and regional partnerships we found entrepreneurs – individual leaders thinking and acting “outside the box.” These entrepreneurs were active in each realm and their actions shaped the realms in a way to foster the growth and development of the enterprising place. Some emerged from traditional institutions, changing them from within. Others built new organizations. They were central to the development and function of the new institutions, and the institutions themselves facilitate the development of the kind of civic leadership on which successful knowledge-based centres depend. We called these “regional entrepreneurs.”

Building the knowledge base

A central message stood-out and this was the importance of investing in systemic academic excellence in the knowledge-based institutions that formed the heart of the enterprising place. High quality teaching and research enhances the reputation of a university and the centre. This draws the brightest students, and many of these remain into the region when they finish their studies. The flow of research funding to an area is a key factor driving academic excellence, innovation, and new enterprise development, and leaders in successful centres made concerted efforts to increase such flows. Universities and research institutions are also integral elements of a region’s “brand,” and respondents cited the importance of academic excellence and excellence in basic research to the quality of graduates and the value of the brand.

Knowledge-based institutions, including centres of corporate R&D, contributed to the dynamism of a centre by facilitating the start-up of companies, undertaking entrepreneurship education, providing facilities for the incubation of companies, investing in prime real estate and by their leaders participating in regional partnerships and related organizations created to advance the development of the centre.

In some places, universities provided the kind of charismatic leadership others defined as critical to the development and sustenance of the place. This leadership appeared to be better developed in the USA than the UK; however, for a number of reasons. One is that in US, public universities at the state level have a long tradition of academic-industry collaboration; in many cases this was part of their original missions as land-grant institutions. Another reason is that, in the hierarchy of educational institutions in the UK, top science and research institutions are seen primarily as national assets, with too much prestige for much regional or business engagement. And although this now appeared to be changing, there remains in the UK less recognition by university leaders of the mutual benefits to be derived from such engagement. US respondents connected their own actions as regional players to promoting outcomes that included increasing the flow of research funding from industry in the region and the encouragement of innovation in the region that exploited the knowledge being developed in the region’s universities. They also felt that they had a key role in increasing the presence of their own graduates in the region and thus making an impact on the regional skill base.

Although our UK respondents clearly recognized some of these benefits, UK university leaders often did not act as directly to link their interests with the fortunes of the regional economy as their American counterparts. Although they were key players in their regions, if only because of their size, their status as major employers, and their long time horizon, few in UK universities chose to engage in the kind of civic leadership commensurate to their position. In fact, compared to the American counterparts, they had fewer incentives to encourage their commitment and involvement in their local economy, and they often had limited knowledge about how to exploit local economic assets. University budgets in the UK are centrally rather than locally or regionally decided, and this was a factor. Interestingly, many UK academics made the point that their promotion and the
financial well-being of their institution depended on doing well in the Research Assessment Exercise, with rewards research published in academic journals over applied research endeavours targeted to facilitate regional economic development.

Investing in Centres

Our exploration of the relationships among finance, the stages of development of ideas and companies, and their connections to place, policy, and sources of knowledge suggests a number of lessons for sustaining enterprising places. Respondents in the US highlighted the importance of the investing in institutional assets as important investments in a centre. Respondents suggested maximizing community use of these assets. UK and US leaders were developing innovative strategies to support the development of embryonic ideas within universities and research institutions. Here, respondents in both countries cautioned that investing occur in collaboration with business. Several existing financing vehicles received high praise from companies and were heavily used, for example, technology grants such as SBIRs in the US and the SMART and SPUR awards in the UK. Respondents recommended that policy makers pay attention to this success. Leaders in most centres actively worked to maximize the use of currently available financing programmes by making sure companies were aware of and had access to them. Respondents across sectors noted the importance of financing at key junctures of a company’s development. One such juncture was when a company began pilot manufacturing, and respondents discussed the need for financing programmes appropriate to this stage.

The ability to finance new infrastructure and other public investments at least partly from local resources was central to success. There needed to be sufficient resource levers to bring about the changes required. Reduced flexibility in this respect characterised the system in the UK compared with that of the US. A lack of buoyancy in the local tax base and a heavy reliance on central government for the funding of key infrastructure had even led some areas in the UK to resist accommodating the growth of technology-based activity in their area.

Finally, in all cases, regional transformation involved changes to the built environment: re-ordering old development patterns, investment in infrastructure, reinvestment in town and city centres, and the development of premises that met the needs of emerging and growing technology-producing companies.

The spark: civic leadership

Civic leadership was crucial to success. The US has a number of development professionals and civic leaders with multiple competencies and relevant management expertise, in addition to formal network-type organisations providing them with peer-to-peer support and education. The research demonstrates clearly that to sustain the development of enterprising places, it is then necessary to bring together expertise that spans the fields of civic leadership, entrepreneurship, land use planning and finance (including local government financing issues). In the UK, there is a shortage of individuals with the diverse skill base required, and we saw an urgent need to provide educational and training support to enhance this important component of human resource base. We found examples of good practice in both the UK and the US, and we feel there is much to be learned by sharing this experience.
1. Introduction: themes and study areas

1.1 Overview

The transformation of the world economy and increasing global competition present significant challenges for countries like the UK and the US that once had a large presence in traditional manufacturing sectors. The pace of change is rapid, and the UK’s ability to compete in the New Economy depends crucially on how it develops and nurtures its technology-based enterprises.

The current global transformation is the result largely of a revolution in information and communication technology (ICT), which is driving corresponding revolutions in the organisation of enterprises; in how companies value space and time when they make locating decisions; and how they sort production functions. Most companies no longer exhibit traditional and unitary corporate structures with strong rigid organisational boundaries. Today’s enterprises are ‘networked’ with internal functions de-linked spatially, and involve external collaborations and partnerships with other companies, depending on the stage of the business process, from research to production and marketing. These networks are not simply company-to-company, but involve interactions between companies, universities and the full range of public and private service providers across nations. Corresponding with this, traditional knowledge-based institutions like universities, in both the UK and the US, are transforming their own organisations to increase their connections to, and interactions with, private enterprise.

This process is associated with strong patterns of spatial outcomes, especially for technology-based enterprise. Much research in recent years has focused on how the location decision made by companies in the New Economy differs from that made by companies in the Old. There has been strong interest in examining the role of labour; universities and research centres in the Knowledge Economy; the development of and growth of technology centres; the characteristics and patterns of such agglomerations in a Global Economy; and the role of institutions in enabling regional development and change. The new spatial needs on the part of business have led to a fundamental re-evaluation of the role of regions in industrial economics and management science, and much academic research has focused on this process (See Chapter 2).

Regional positioning has emerged as a fundamental issue for technology-based companies in the pursuit of their objectives, and it has forced regional leaders to re-evaluate how they can support technology-based enterprise. The increased recognition of the role of the region or place has also led to a re-examination of whether traditional institutions/policy measures can be relied upon to generate optimal outcomes, as well as the development of new frameworks that can be used to understand and guide the processes involved. These new frameworks often incorporate collaboration across the realms of business, academia, government and civil society.

In spring 2002 the Cambridge-MIT Institute (CMI) funded a team of researchers from the University of Cambridge and the Massachusetts Institute of Technology (MIT) to explore how key actors in high-tech centres sustained their development over time, and how policy-makers, business leaders, leaders of universities and research centres, and investors contributed to this process. The main focus in this work was on the implications of the research findings for the UK. The team adopted the following definitions: Technology-producing companies includes companies in the following industry groups: computer electronics, instruments, software, aerospace, optics, photo/cinematography, biotech, drugs, and R&D in sciences and engineering (See Annex I, Table A.4). We used the term Enterprising Places (and sometimes the more colloquial high-tech centres’) to mean centres of technology-producing companies, research universities and centres, and innovative activity. Technology-based enterprise is a general term we use to refer to the activity of an enterprising place, including the activity of technology-producing companies and related organisations.

The team conducted in-depth interviews with close to 250 high-level government, industry and academic leaders in the UK and the US. We also surveyed senior managers of high-technology companies located in these centres.

This research has found that key players can shape the attractiveness of their region to technology-producing companies, and they do this through a series of collaborative activities across the realms of business, academia, government, civic society and across local political units. In each of the successful centres we studied, we found a unique group of players interacting to produce, disseminate, share and use leading-edge technology to create, sustain and grow technology-based industry. We found entrepreneurial and innovative behaviour present in the policy, academic and finance realms, as well as the business sector of successful centres. Finally, we found what we termed ‘regional entrepreneurs’ helping to facilitate change and ensure that their centres remained attractive, vibrant, and successful.
1.2 The study areas

Centres in the UK included
• East of England: Cambridgeshire, Hertfordshire and Bedfordshire, and
• Scotland: the Central Belt and Dundee.

Centres in the US included
• San Diego, California,
• Research Triangle, North Carolina, and
• Massachusetts: Cambridge/Boston and Worcester.

1.2.1 East of England

In the UK, we looked at the Eastern Region of England, particularly at three of the six counties extending north of London, namely Hertfordshire, Bedfordshire and Cambridgeshire. These were predominantly rural before World War II. After the war, new towns were built in each of the three counties and, today, Hertfordshire and Bedfordshire are the most urban of the three, while Cambridgeshire remains relatively rural.

Hertfordshire, adjacent to London, developed as a post-war high-technology centre focused on defence, electronics, aerospace, pharmaceuticals and chemicals. Along with this came the growth of large companies such as Rolls Royce, British Aerospace, and Glaxo Smith Kline. Hertfordshire is also home to many of the government’s research laboratories, whose impact on the development of the area as a high-tech centre has been documented by Hall et al (1987).

Bedfordshire, to its north, also developed as an automotive and aerospace centre. The University of Cranfield, which began its life as the College of Aeronautics in 1946, is at its core, and the area currently has R&D centres for Aston Martin, Ford and Nissan’s European Centre. The end of the Cold War brought about a significant shrinkage in the defence industry. High unemployment in the area in the early 1990s prompted new initiatives that sought to encourage high-technology industries like Information and Communications Technology (ICT), media and film, and medical instruments. In the 1990s British Telecom and T-Mobile moved into properties vacated by British Aerospace and Rolls Royce.

Cambridgeshire has strengths in biotechnology, information technology, and nanotechnology. Segal Quince and Wicksteed (1985, 2001) and Keeble and Wilkinson (2000) have extensively documented the cumulative growth and development of the high-technology cluster in the Cambridge sub-region, as well as the important contribution of the University of Cambridge and other knowledge-based institutions. Technology-producing companies employed a workforce of close to 50,000 in 2001, compared with 20,000 three decades ago, mainly in small firms in the health, life sciences, ICT, and related industries, many of which are located in close proximity to the knowledge-based institutions. Cambridge, hosting the 800 year old University of Cambridge, is a major centre for world-class research in biosciences, currently the most dynamic of the local technology-producing sectors. It is underpinned by the Sanger Centre at the Genomics Campus and various departments in the University. The Human Genome Mapping Project Resource Centre provides access to leading edge tools for research in genomics and genetics as well as biological and data services for the medical research community doing work in the post genome era.

The research base in the field of biosciences at Cambridge has been greatly strengthened through international collaborative initiatives. For example, in 2002 the United States’ National Institutes of Health announced a multi-million dollar project to establish a unique data and technology base of protein molecules, combining resources from the Cambridge, Geneva, Heidelberg and Washington DC. Research institutes. This includes the Laboratory for Molecular Biology and facilities funded by Glaxo Smith Kline and the Hutchinson Whampoa Group that have co-located on the Addenbrooke’s Hospital site.

In nanotechnology Cambridge builds on strengths in photonic crystals, opto-electronics, nanolithography and molecular nanotechnology. The Interdisciplinary Research Collaboration in Nanotechnology has drawn together experts from the University of Cambridge, University College London and the University of Bristol to create a new centre located on the West Cambridge site. Important areas of research include the development of new materials to replace degenerating tissues and a nanowire research programme developing metal lines of nanometre dimensions for future integrated circuits.

Multi-national corporations have joined the research cluster in Cambridge and established ‘embedded laboratories’ linked closely to university departments. Companies include Microsoft, BP Amoco, Unilever, Toshiba, Hitachi, Glaxo Smith Kline and Rolls Royce.

1.2.2 Scotland: Central Belt and Dundee

Scotland was at the forefront of the industrial revolution with strengths in the textile, shipbuilding and iron, coal and steel industries. However, these industries and the state of the economy declined over the course of the 20th Century as a result of changing tastes and technologies; the failure of traditional industries to introduce new products and processes; the failure to attract ‘new’ consumer-based industries; the limited size of the local market; and the ‘pull’ of the Greater London sub-region (Hood et al, 2002). As a result, in the late 1950s the government offered regional incentives to induce mobile ‘sunrise’ industries to locate in assisted areas. This inward-

Embedded labs are significant research facilities established by companies within the campus of a university or research institution.
investment strategy prompted a number of large high-technology companies to establish branch plants in Scotland. Although many of these companies subsequently moved some of their operations offshore, many have retained a research and design presence in Scotland. This, together with the increasing commercialisation of the region’s technology base, has led to a restructurig of the economy based partially on indigenous, technology-based enterprises in biotechnology, ICT, opto-electronics and microelectronics. Other important sectors in the economy include food and drink, forest industries, creative industries, tourism, oil and gas, textiles and financial services.

Scotland today has thirteen universities plus a number of well-known research institutions. The major centre of high technology is the Central Belt, anchored by the University of Edinburgh, the University of Strathclyde, the University of Glasgow and Heriot Watt University. Major research institutions include Roslin and Moredun. The University of Dundee has established a world-class bioscience capability in the city of Dundee. It has successfully attracted world eminent scientists in biosciences, and a number of research laboratories including the Wellcome Trust have located there. Three of the fifteen most eminent bio-scientists in the world live in Dundee. In addition, the University has a strong medical faculty that has made major breakthroughs in keyhole surgery.

1.2.3 San Diego California

San Diego has a rapidly growing and changing economy. The fastest growing segments of the San Diego economy during the 1990s were biotechnology and ICT.

The San Diego economy has long been associated with the defence establishment. The area has always been home to major Navy bases, and most of the region’s large manufacturing firms have been major defence contractors. The downsizing of the defence budget in the 1990s, though it contributed to a substantial economic slowdown, helped lead to substantial changes in the region’s economic base. Some of the defence-related technology-producing enterprises specialised in military communications and avionics. Qualcomm, the leading manufacturer of wireless telecommunication technologies, was established in 1978 in San Diego and grew from 400 employees to approximately 10,000 before recent downsizing.

With more than 1,500 technology-producing companies, San Diego has transformed itself within two decades into one of the most innovative regions in the US. It now hosts a major research cluster including a wide variety of knowledge-based institutions, some of which were established in the 1960s and 1970s; others have located in San Diego more recently. In aggregate, San Diego receives annual research funds of $2 billion and, as of 2002, was ranked second in California in terms of federal R&D funding.

The University of California at San Diego (UCSD), established in 1960, has a developed research capacity. In 1995, the US National Research Council ranked the quality of the school’s graduate programmes, especially in engineering, tenth in the nation. The National Science Foundation funded the San Diego Supercomputer Centre as a member of one of two national consortia in 1996, and the Centre now operates as a University Department. The Centre has the most powerful vector and parallel computers available in the US, and supports research in biosciences, environmental sciences, high-speed networking and scientific visualisation. Through its Science and Technology Outreach Programme, the centre supports more than 50 government and private sector organisations.

San Diego is also a major biotechnology centre. UCSD is an important location for neuroscience in the US and a number of companies such as MitoKor have been attracted to the locality as a result of research done at UCSD and the nearby Salk and Scripps Research Institutes. San Diego State University (SDSU)\(^1\) is part of the California State University Programme for Education and Research in Biotechnology, a multi-campus interdisciplinary programme to promote research and education to support the biotechnology industry in California. The Centre for Bio/Pharmaceutical and Biodevice Development at SDSU is another initiative concerned with the growing interdisciplinary requirements in research and its application. It focuses on educating the workforce for maturing biotechnology companies.

1.2.4 Research Triangle North Carolina

North Carolina made an explicit decision over 40 years ago to use three universities: Duke University in Durham, University of North Carolina at Chapel Hill, and North Carolina State University in Raleigh, to attract research companies, building a 7,000 acre research park between the three and naming it ‘Research Triangle’. Duke University, a private institution, has a national reputation, especially in medical research. The University of North Carolina at Chapel Hill is a premier public research university. North Carolina State University, originally a land grant institution focusing on agricultural technology, has developed significant expertise in engineering. Major investments in the University system have taken place in recent times, with a wide variety of programmes customised to meet industry needs. Today, the Research Triangle Park is one of the most successful of all science parks in the US. The triangle has been successful in attracting branch operations of major multi-nationals, including IBM and Sun Microsystems.

While the universities proved to be an important marketing tool and workforce generator, research spill-overs from the universities proved to be more difficult. To re-inforce applied research activities, local leaders created the Triangle Universities Centre for Advanced Studies to bring together faculties from the

\(^1\) The largest in the California State University System.
three universities to work together and collaborate on specific research. These leaders also successfully recruited national research organisations: the Environmental Protection Agency, the National Humanities Centre, and Sigma Xi – the National Institute of Statistical Sciences. It also created the Research Triangle Institute, which has developed into an international contract research organisation, MCNC (formerly the Microelectronics Centre of NC), and the North Carolina Biotechnology Centre. Private research organisations include the Burroughs Wellcome Fund.

Using its supercomputing capacity, MCNC created the North Carolina Bioinformatics Grid to provide computing, data storage and networking capabilities to support genomics-related research across the state. Over 70 organisations – universities, biomedical, biotechnology and IT companies, non-profit organisations and foundations – have access to the Grid. It is accumulating a vast library of genomics, proteomics and related data that is being created around the world, combining it with non-proprietary data from consortium members and making it available to researchers throughout NC. The Grid is drawing on other similar projects in Europe and elsewhere.

1.2.5 Massachusetts: Cambridge/Boston and Worcester

The Boston Metropolitan Area, including Cambridge – the home of MIT and Harvard – has one of the nation’s deepest and most diverse concentrations of highly ranked research universities, affiliated institutions and non-profit research institutions. Research spending by the eight universities in the region amounted to $1.5 billion in fiscal year 2000, of which about four fifths was funded by the Federal Government. A further $383 million was spent on research by associated or affiliated research institutions in the area; and medical research at hospitals and medical schools amounted to $1.5 billion. Together, these institutions receive over $2.5 billion in annual research dollars.

Interdisciplinary collaboration is the hallmark of new and emerging areas of scientific research in Boston, such as genomics, proteomics, photonics and nanoscience. MIT alone has over 60 formal interdisciplinary labs and centres, as well as a number of project-based interdisciplinary research groups. Some of this research is highly decentralised. An example is nanotechnology research, which is undertaken at the Space Nanotechnology Laboratory, the Nanomechanical Technology Laboratory, the Institute for Soldier Nanotechnology, and the Nanostructures Laboratory; among other places at the Institute. Moreover, the convergence of technologies, the associated need for interdisciplinary research and the breadth of the science base in Boston places the region at the forefront of collaborative research globally. The region also hosts many university-industry collaborative partnerships with major companies such as Eastman Kodak, Genzyme, Intel, Raytheon, Sun Microsystems and Merck. Worcester, an hour’s drive from Boston, was the second largest city in New England in 2000. From the industrial revolution to World War II, the city’s growth was driven by a thriving metalworking and machine tool industry. By the late 1970s, however; local leaders, workers and their political representatives were becoming increasingly concerned about the economic future of the city. The industrial sector was ‘mature’, old manufacturing plants were closing throughout the northeast, and the new growth industry in Central Massachusetts – computer manufacturing companies – was bypassing the city. In the early 1980s, the city’s civic leaders decided to create opportunities for the development of biotechnology companies. Since that time, investment in biomedical infrastructure has included: the development of almost one million square feet of biotech space at the Massachusetts Biomedical Research Park; a new 300,000 square foot research building for the University of Massachusetts Medical School; a biomedical science park adjacent to the Tufts University School of Veterinary Medicine; the development of a biomedical engineering institute at the Worcester Polytechnic Institute; the development of a mixed educational, research and commercial development adjacent to WP; and the creation of Massachusetts Biomedical Initiatives, which both promotes and creates awareness for the biomedical industry in the region and operates state-of-the-art incubator facilities for start-up companies.

1.3 Organisation of this report

This report is organised around five main areas of inquiry. These are:

• What did previous research say about the location of technology-based enterprise, the patterns of agglomeration, the characteristics of high-tech centres, and the role of institutions in their development? This is the subject of Chapter 2.
• What are the connections between technology-producing companies (predominantly small- and medium-sized enterprises (SMEs) and their home regions, their suppliers and customers, companies, and people and institutions in government, universities and research centres? In other words, what do technology-producing companies need from their place? This is the focus of Chapter 3.
• What kinds of interactions occur at the boundaries of technology, finance and place, and how do policy actions in these realms meet the requirements of technology-based companies? This is the focus of Chapters 4, 5 and 6 respectively.
• What did regional entrepreneurs create vision, deliver needed resources, capture regional returns, and maintain momentum through new regional institutions? We address these issues in Chapter 7.
• What are the implications for the UK? This is the focus of Chapter 8.
2. Developing the conceptual framework

2.1 Introduction

The study required a robust conceptual framework and to establish this we did a number of things. We mapped the geographical location of technology-producing companies in both the UK and the US. The next phase of the work involved interviews with key contacts in Cambridge UK and Cambridge, Massachusetts, to get an understanding of the development of these places over time. Following this, our interdisciplinary research team brought together its expertise and experience to identify the key research questions that should form the basis of the inquiry, and we created an analytical framework to guide the research (see Section 2.3). We examined the extensive and voluminous literature on what was known about the characteristics of places where technology-based companies were located. The research team then surveyed a number of people who either ran technology-based companies or advised and dealt with them. The final phase of the work involved interviews with leaders of knowledge-based institutions, government, and others responsible for the development of enterprising places (detailed in Annex 3).

2.2 The mapping exercise

In order to identify enterprising places, we first developed a common list of technology-producing industries for the two countries. We identified industry centres using location quotients for technology-producing companies. We then identified innovative activity using concentrations of patents issued (per 100,000 population), and the public and private expenditure spent on research and development. We mapped these results by metropolitan area in the US and by district and unitary authority in the UK (See Maps in Annex 2). We checked our results against other studies of high-tech centres, to ensure that we had identified places commonly understood by other researchers to be high-tech centres. Within these regions, we then selected smaller areas for study, choosing them to represent enterprising places in various stages of development (e.g. embryonic centres, mature centres), and different economic and policy contexts.

Our purpose was to select study areas, not to undertake research on national industry agglomerations. However, one of our team members, Myounggu Kang, went on to do such an analysis of enterprising places in the US as part of his doctoral dissertation at MIT. We note his findings in Section 2.4.
2.3 Analytical framework

Our team sought to understand the relative competitive success of different places (which were explicitly seeking to transform themselves to accommodate technology-producing companies), by focusing on how the key players in the place came together to effect the required change. As a framework for the analysis, we defined four broad systems in which change agents were based:

- Knowledge System: institutions, networks, and agents through which ideas (that can form the basis for new inventions and sustained development), develop and traverse, and through which workers gain access to technological expertise.
- Finance System: institutions and agents that provide capital for investment in business operations, facilities, and community infrastructure.
- Built Environmental System: agents and organisations, who produce housing, infrastructure, schools, parks, commercial centres and cultural facilities.
- Business System: agents, institutions, and formal and informal networks that facilitate the commercialisation of ideas and the development of globally competitive businesses, including business decision-makers, skilled labour, as well as accountants and lawyers.

We looked for entrepreneurial activity within each of these systems, activity that attempted to shape that system to the purposes of enterprise growth and development. We looked at the ways players in these systems came together across systems and worked in concert to create the most positive conditions for enterprise growth and development. We also tried to identify multi-system networks or “webs” of institutions and people committed to a coordinated approach. We proposed that it was at the intersection of these systems that the competitive place arose.

And the role of geography in all this? ‘Places’ exist in a physical space, the boundaries of which may reflect particular physical attributes, economic areas, or political jurisdictions. We assumed that these were the result of its historical legacy with respect to its traditional industries and the effect that these have had in shaping the nature of its labour force, the form of its infrastructure (most critically that relating to transport), and the pattern of its land use. The nature of the resulting settlement pattern and the access provided by the place’s infrastructure determine the connectivity of the place to other places and the ease with which flows of goods/services (trade) and people (as in commuting) may occur to enhance its economic competitiveness. A place’s resources - land, capital, and labour - govern its ability to meet the needs of both its population and the business that resides within its boundaries.

The revolution in Information and Communication Technology and the globalisation of national economies are generating important changes in the spatial distribution of regional and local activity. Thus the agents of change identified in the above framework face ongoing challenges to enable their place to be competitive in meeting the needs of technology-based enterprise. In so doing, they need to overcome the legacy of the past: to transform transport systems, housing systems, public realms etc. that were adequate to meet the needs of 19th and 20th Century manufacturing, but which may not support new technology-based activity. This legacy does not just reside in physical space but also in the institutions, structures and forms of working and doing business that exist in the place. The challenge for agents of change is to transform these multiple systems from the old to the new.

To understand how key players in enterprising places did this, we explored the ways agents of change in our study areas came together through innovative institutional formats and modes of working. We also identified the importance of intermediaries in this process; the key policy instruments that assisted in bringing about change; and the importance of specific individuals.

2.4 Evidence from the literature

We faced multiple challenges in our analysis of the literature. In our analytical framework we defined four broad systems: knowledge, business, the built environment and finance. Our intent was not to explore deeply into each of these (which would have been a very significant research endeavour beyond our resources), but rather to explore their intersections. We faced our own boundary problem: how to define the boundaries of different disciplines, and how to transverse them. We especially wanted to explore how these systems came together in a particular place. This necessitated a clear examination of business location theory both in its traditional dimensions, which have been well studied, and in new dimensions associated with recent changes in ICT, globalisation, and other dynamics of the New Economy, which are not nearly so well studied.

2.4.1 Global currents

Recent changes in technology, especially ICT, are producing a restructuring of global economic activity, dispersing some activities and re-agglomerating others. An important consequence is that very high-speed communications enables firms to create functional units in different places and facilitates the outsourcing of manufacturing and back office operations, accelerating trends that began well before the era of the internet. Firms today can send separate sub-units to the most desirable location globally and collaborate with other business...
entities regardless of distance (Sommers and Carlson 2003). Company fragmentation is accompanied by the development of new kinds of intermediate organisations (Lamoreaux, Raff and Temin 2002).

In her introduction to Global Networks, Linked Cities, Saskia Sassen (2002) described the impacts these trends have created for global financial networks. These firms are more widely dispersed with functional units distributed to serve global markets, increasingly concentrated in certain cities. At the same time, Sassen found that the massive demand for central management and control functions (financial, legal, accounting, managerial, executive, planning), has given rise to new concentrations of producer services in particular cities.

Sassen (2002) saw the current global landscape as a network of places. Core (global) cities anchor multiple cross-border functions in a network of places. Cities in the global networks reflect divisions of labour and do not compete directly. These new functions are in contrast to the historic roles primary cities used to play as national gateways. New trans-territorial centres are constituted via telematics and intense economic transactions, and consist of multiple and diversifying inter-city links. Regions, which used to be organised with hinterlands around a central city, are reconstituting themselves as grids of nodes, a pattern that may underlie today’s interest, especially in the UK, in regional city systems. On the other hand, cities that are strategic sites in the global economy tend, in part, to disconnect from their region through disproportionate concentration of strategic resources and activities.

2.4.2 Firm decisions: Traditional location theory and its limits

Early economists and geographers were very interested in understanding how firms and businesses decided where to locate and the spatial patterns that resulted. von Thünen (1826) created a model for agricultural location choice; Weber (1929) and Hoover (1948) developed models explaining manufacturing choice; and Christaller’s (1993) model explained the location of service firms. These models, coupled with Losch’s (1944) general location theory explained why firms, under traditional assumptions, located where they did.

These traditional location theorists assumed that an individual firm’s location strategy was determined by the location of its input and output markets in a region or country. The models assumed that a firm sought to find the lowest cost location and the theories explained the comparative advantage of different locations based on whether areas were endowed with the classical factors of production – raw materials, labour and markets, and given substantial transportation costs in moving inputs and products. Individual firms and the whole aggregation of individual decisions that formed an industry were conceived as making successive adjustments to find the lowest cost location and minimise their transport costs. Ultimately, a spatial equilibrium was assumed. These models centred on a point of time whereby location advantages and the efficiency basis of competitive advantage among firms were assumed to be static.

The situation facing technology-producing companies today is quite different. Transportation costs have become relatively cheap (Glaeser and Kohlhase 2003) and have diminished in importance to companies (Hall et al 1987, Polenske 2003). Changes in ICT have redefined the economic meaning of distance and proximity, with one result being that firms can effectively locate different functions in different places, even in different organisations (Sassen 2002). The dis-aggregation of firm functions in the New Economy violates assumptions of decision-making by a unitary firm. For technology-producing companies, knowledge is embedded in their labour; thus companies need high-quality skilled labour and not cheap labour. Finally, technology is changing much more rapidly than it was when traditional locational theorists were studying the behaviour of companies. Decisions are made in a more dynamic framework, whereby firms are continually preserving and enhancing their positions in the face of competitive pressures (Massey 1999).

2.4.3 Markets in the New Economy

Traditional theory assumes that firms face one of a few markets and non-trivial transportation costs in getting products to market. In the New Economy, markets are often organised differently to when traditional economists were studying firms, further changing the location equation. As Baptista (1998) noted, changes in customer preferences usually evolve at national and even international level (versus local and regional levels). At the same time, firms are more likely to be serving global markets. Kang (2006) found that the spreading out of markets around the world influenced highly market-oriented firms, such as high tech service firms, to disperse, and for production firms to disperse their market-related operations, including market-related research and development.

On the other hand, when the bulk of demand is located in one place, then a strong concentration of suppliers exists in that location and the local market becomes a key influence on a firm’s location decision (Kang 2006). Being close to one’s market is crucial when there is a high variability in demand and rapid changes in the characteristics of the products. Being located near the market enables an ease of gathering information from customers and rivals (for example, in the printing and fashion industries). Companies choosing to disperse functions to different locations often locate market operations near customers. Kang (2006) found a similar phenomenon with respect to certain R&D activities. He explored outsourcing of R&D...
to South Korea by multi-national firms, and he found that while multinationals did pure or basic research in advanced countries, in Korea the purpose of R&D was to customize products and services and support sales and services in the Korean market.

2.4.4 Labour in the New Economy

A number of studies have focused on how labour availability influences the location decisions of firms in the New Economy (Keeble and Wilkinson 1999; Castells and Hall 1994; Sternberg and Tamasy 1999; Hall et al 1987). These studies made distinctions with respect to the types of labour required by companies: administrative staff and managers; professional and scientific staff; clerical staff; skilled and supervisory workers; and semi- and unskilled workers. They also assessed the importance of the cost of labour and whether it was easy to recruit and attract labour in each of these categories.

Technology-based companies tend to draw from segmented labour markets, but with characteristics that differed from those described by earlier labour economists. Hall et al (1987) found high tech industry to be split between the research and development and routine manufacturing processes, requiring a small number of highly skilled professionals, who tended also to be highly mobile, and low-paid mostly process assembly workers, who were primarily located in low wage, weakly unionised rural locations. Levy and Murnane (2004) studied the effect of ICT on the job market in the New Economy. They found that computer use resulted in job bifurcation: computers substituted for mid-level administrative and clerical jobs, leaving a market of high-skill and low-skill jobs with not much in the middle.

The pool of professional and skilled labour is a major attraction for firms dependent on such a workforce to locate in an area. In turn, skilled employees are said to be attracted to an area by good working and living conditions, good housing, environment, cultural and education facilities, night life, and diversity (Hall et al 1987, Gareau 1991, Florida 2002). Recent researchers suggest that firms follow these skilled workers. Keeble and Wilkinson (1999) study of Cambridge noted that the availability and quality of the local research staff was a major reason for businesses locating there. They also noted that an attractive local living environment for staff and directors, as well as the credibility, reputation and prestige of the Cambridge address, were seen as specific advantages of the region over others. Hall et al’s study noted that labour shortages and problems in getting skilled production workers into an area was more of a hindrance on expansion plans than the actual cost of the labour.

2.4.5 Agglomerations – Marshall’s Districts

Early urban theorists also studied how firms benefited from close proximity to one another (Marshall 1890, Weber 1929). In Marshall’s Principles of Economics, 8th ed. London: Macmillan (1890), we find the classic discussion of the concept of industrial districts.

“When an industry has chosen a locality for itself, it is likely to stay there long; so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries. Good work is rightly appreciated; inventions and improvements in machinery, in processes and the general organisation of the business have their merits promptly discussed. If one man takes up a new idea, it is taken up by others and combined with suggestions of their own; and thus becomes the source of further new ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with instruments and materials, organising its traffic, and in many ways conducing to the economy of its material.” (Marshall 1890:225)

According to Marshall, firms in an industrial district benefited from three positive externalities. Localisation allowed firms to increase subdivisions of functions, namely differentiation and division of labour so that companies could develop specialised skills and technology. At the same time, this increased specialisation of skills could be diffused through a community to create an abundant supply of qualified labour; subsidiary trades and specialised services that were beyond the scope of any one firm to develop independently. In this environment, knowledge spill-overs and enhanced communication among workers and firms accelerated the adoption of innovations.

The intricate network of informal contacts among local actors and information flows constituted an industrial atmosphere, and once in an area, skilled workers stayed because job prospects were better and the complex growth and linkages between firms provided subassemblies and specialised processes for other firms. Once the pool of skilled labour grew up, this added to the inertia of location. Also, once the process of industrial localisation was underway, it was essentially cumulative and dependent upon extensive co-operation with competitors in technology creation and innovation.
2.4.6 Revisiting Marshall’s theory

Marshallian theory on the process of industrial localisation has re-emerged as a theme among academics to explain the geography of firm clusters today and the factors that contribute to their development (Baptista 1998, Keeble and Wilkinson 1999). In Marshall’s day, agglomeration economies usually operated near the city centre at the prime heart of the city (i.e. London and New York) (Hall et al 1987). Jacobs (1969) suggested that cities themselves provided an urbanisation externality, that companies in one industry benefited from the diversity of multiple co-located industries. Yet today, the technology-based industry tends to prefer greenfield site locations that have not been previously industrialised. Massey (1984) notes that this may be because members of the crucial innovative group, having acquired mobility through car ownership, moved their homes out of the city and into high amenity housing. He argues that the prime differentiators between regions are no longer based on industrial structure, but on occupational structure, both within and between industries. Small companies that have growth potential and enterprise tend to be highly concentrated in one particular region due to the sector that they are concerned with, access to capital, skilled population, education, R&D facilities, and access to the market.

Recent authors have provided examples of the ways in which this complex network of producers bound them together in a web of relationships. Saxenian (1985) for example, demonstrates in the case of Silicon Valley how one firm – Fairchild – spawned 50 companies, and how the majority of skilled workers, particularly the engineers, were recruited locally. She later described how the history of industrial relations and structure affected the characteristics of the local networks in Silicon Valley, California and on Route 128 in Massachusetts (Saxenian 1994). Porter’s study of industrial clusters, decades later (1990), added concrete detail about firm inter-relationships in over 100 industry clusters in ten nations.

2.4.7 Porter’s Clusters

Possibly one of the most influential theories of the past decade has been that of Michael Porter’s ‘cluster theory’, now being used as a tool for promoting national, regional and local competitiveness, innovation and growth (Martin and Sunley 2001). Baptista (1998) remarks that he is probably the first modern economist to regard geography as a central issue in analysing markets and competition:

“...in a global economy – which boasts rapid transportation, high speed communications and accessible markets – one would expect location to diminish in importance. But the opposite is true. The enduring competitive advantages in a global economy are often heavily localised, arising from concentrations of highly specialised skills and technology, institutions, rivalry, related businesses and sophisticated customers.” (Porter 1990)

Porter goes on to describe the competitive importance of “clusters consisting of industries related by links of various kinds” (p.131). Industries in clusters are linked both horizontally (complementary products and services, the use of similar specialised inputs, technologies or institutions), and vertically (buying and selling chains), including input-output trading linkages. Interaction occurs between four sets of factors that make up a ‘competitive diamond’. These drive cluster development and, the more developed and intense the interaction, the greater the productivity of an area. The four factors are:

- firm strategy – structure and rivalry
- factor input conditions
- demand conditions
- related and supported industries.

Domestic rivalry among the firms provides the necessary incentive for investment, and the geographical industrial concentration increases the intensity of these interactions. Together these produced a dynamic system. The co-location of related firms encourages the formation of, and enhances the value-creating benefits arising from networks of interaction between firms. Firms are endowed with skilled human resources, market-specific technology and specialised infrastructure that give them a competitive advantage over other areas. The intense rivalry and geographical concentration of firms has a favourable effect on the development of related and supported industries, such as specialised suppliers and users. As the cluster of firms draws on these common specialised inputs and infrastructure, this means that they are constantly upgraded and increased in supply.

Parallel to Porter’s work, which emerged from business strategy, economic geographers have undertaken research on the nature and form of local business concentrations. Geographers variously term these concentrations: the ‘new industrial spaces’; ‘territorial production complexes’; ‘regional innovation milieux’; ‘network regions’; and ‘learning regions’ (Pinch and Henry 1999; Keeble and Wilkinson 2000; Amin and Thrift 1992). Yet, as Martin and Sunley (2001) have noticed, many of these geographers have adopted Porter’s cluster terminology in preference to their own. Martin and Sunley (2001) point out that this wide use makes the clusters ‘a chaotic concept’, conflating and equating quite different types, processes and spatial scales of economic localisation under a single universalistic notion. The multidimensionality and vague character of the cluster concept poses problems of definition and of investigation. Porter made no reference to a cluster’s...
Martin and Sunley (2001) also remarked that despite the vast and still expanding literature on clusters, there was little detailed work based on in-depth comparative analyses of cluster profiles and processes. This classification, like the type carried out by Markusen et al (1999) when creating a typology of industrial districts, was argued to be an important stage of theorising and processes. This classification, like the type carried out by Keeble and Wilkinson (2000) is a particularly useful collection of advantages among areas (Allen 1999; Massey, 1999). The work by Keeble and Wilkinson (2000) is a particularly useful collection of papers based on original research into the recent evolution and dynamic processes underpinning the growth of key European regional clusters of technology-based small and medium-sized firms.

But how do industry concentrations arise? Marshall said little about how the process of industrial localisation started and why it started in certain places and not others (Martin and Sunley 2001). Hall and Breheny et al (1987) noted that hardly any literature focused on how enterprising places came into being and what started them. Instead, like Marshall, they focused on how success breeds success. Porter’s study suggested that economically specialised entities in the Marshallian sense. Nor does he discuss at what spatial scale and over what geographical range clustering processes operate. He also admitted that cluster boundaries rarely conform to standard industrial classification systems. Instead, Porter argues that “drawing cluster boundaries is often a matter of degree, and involves a creative process informed by understanding the most important linkages and complementarities across industries and institutions to competition” (Porter 1990, pg 202). Martin and Sunley (2001) raise their concerns over the fact that this vague interpretation can create confusions:

“The obvious problem raised by these cluster definitions is the lack of clear boundaries, both industrial and geographical. At what level of industrial aggregation should a cluster be defined, and what range of related or associated industries and activities should be included? How strong do the linkages between have to be? How economically specialised does a local concentration of firms have to be to constitute a cluster?” (Martin and Sunley 2001:14)

With respect to the progress of clusters, Kang (2006) separately tracked jobs in what he termed “high knowledge-generating industries”, approximately the same ones we focused on in this research. Kang found that firms engaged in production, for example, producers of computer equipment, became further concentrated during the 1990s than they had been at the beginning of the decade. These increasing agglomerations did not constitute concentrations of increasingly large firms; rather they were increasing agglomerations of smaller firms. Over the decade, the number of firms with more than 500 employees declined, as did the average number of employees per establishment. In some cases, the agglomeration took the form of “winner-take-all.” Kang attributed this pattern to the importance of tacit knowledge in these industries, generated by interactions among collaborating producers and thus their desire for physical proximity.

During the same period, Kang found that service jobs in these industry groups in the US dispersed. He attributed this to the importance of tacit knowledge and the mutual learning generated through interactions between firms and customers, and the desire for companies to be close to their markets.
2.4.9 Industry concentrations and knowledge

Researchers going back to Marshall (1890) stressed the importance of locally rooted labour – or local human capital resources – in the collective learning process. Hall et al (1987) noted that local entrepreneurs were likely to start new firms in their local areas, as they had access to capital, previous management experience, education and were knowledgeable about the local markets. Capello (1999) argued that a stable local labour market can create the industrial atmosphere that Marshall discussed, as cumulative technology is embedded in this local labour force. This in turn can help reduce transaction costs for companies. A concentration of a large number of firms belonging to one industry in the same place means that similar skills are pooled. This pooled market benefits both workers and firms, enabling them to cope with uncertainty in relation to business cycles. Mobility and flexibility is also necessary within the local labour market, as this allows for lower redundancy costs and easier adaptation to changes in products and processes.

Although local labour was important, other authors stressed that movement of skilled and professional labour into an area was also crucial. This immigrant workforce could bring ideas with them into the area (Keeble and Wilkinson 2000). Hence, labour markets’ connections to wider national and global networks helped to transfer know-how and learning from outside the local area. It also helped to develop external linkages that are seen as critical to firm growth (Bresnahan et al 2001).

Another strand of the literature on the significance of labour in company decision-making stressed the specific role of university-related labour. The presence of a local university’s research and development (R&D) operation was critical as it provided an important source of new graduates who could establish innovative firms; continue to draw on the stream of university research; and provide a supply of new scientists and technologists. As Keeble and Wilkinson (1999) noted, this flow of highly skilled workers within this scientific research and professional labour market could create localised processes of new firm spin-offs. Their study of Cambridge focused in particular on the way that firms interact and continue personal contacts with the university, parent or incubating company. This interaction could range from swapping ideas through to formal sub-contracting, share holding and joint venture arrangements.

Modern economic geographers who focus on the dynamics of spatial production systems have developed the concept ‘regional collective learning’ to explain how knowledge develops in these systems. Keeble and Wilkinson (2000) defined regional collective learning as the creation and further development of a base of common or shared knowledge among individuals making up a productive system which allows them to co-ordinate their actions in the resolution of technological and organisational problems they confront. Collective learning is centred on three mechanisms:

- the degree of local movement and spin-off of technological/managerial expertise in the form of entrepreneurs (with embodied expertise),
- the extent and frequency of inter-firm technical networking and interaction,
- the importance of flows of key research and professional staff between local firms.

Within this broad concept, the literature particularly stressed the importance of localised processes of knowledge creation – how firms learned about new technology, trusted and shared information. Formal and informal business networking among local firms is a necessary ingredient in the process of innovation (Yeung 1994). Inter-firm relations allow effective transfer of knowledge and other organisational capabilities. Close user-producer collaboration allows for greater production flexibility and joint development. Hence, by risk sharing, it is argued that uncertainty is reduced. Camagni (1991) stressed that a close presence of other innovators sharing similar experiences, as well as the presence of suppliers and end-users of products and processes, creates an important source of knowledge and ideas. Direct co-operation and exchange meant that suppliers could gather feedback for further innovation and users simultaneously could learn about new products and processes. In effect, this exchange was highly dependent on geographical proximity and enhanced the competitiveness of an area. This networking – sharing and collaboration of information flows – created the necessary synergy that builds up the collective learning region. In turn, it reduced uncertainty and created a common cultural background within which to operate.

Central to the question of how knowledge spreads within industry clusters are the concepts of tacit and codified knowledge. Polanyi (1962) described tacit knowledge as the kind of information that is carried by individuals, passed from master to apprentice, diffused by people not by prescription. Marshall (1890) described the diffusion of knowledge within industrial districts as occurring in this way. Codified knowledge, on the other hand, can be written and thus diffused with ease, and in the era of the internet, this diffusion can be almost instantaneous. The transfer of tacit knowledge requires proximity. The diffusion of codified knowledge does not. Sassen (2002) identified a parallel phenomenon in her discussion of global cities. She identified as “datum” bits of information that are easily transmitted but that mean little on their own. Interpretation, evaluation, and judgment about data can produce higher order information, which is useful to companies. This occurs through the “specialised social connectivity” to which global cities offer access. Clustering of companies is most important at early stages of industrial life cycles when the exchange of tacit knowledge is vital, whereas less is known about the maturity stage of the cycle (Audretsch and Feldman 1996).
Other authors have questioned whether relative decline is an inherent systematic feature of cluster dynamics (Baptista 1998). Pouder and St John (1996) argued that agglomeration economies that initially draw firms together and act as a source of strength could eventually erode and become a source of inertia and inflexibility. This could occur if learning occurs only through internal networks within an area at the expense of wider external networks. The concern is that a continued accumulation of knowledge can lock firms into an obsolete and increasingly non-competitive technological trajectory that creates barriers to exit for insiders. Keeble and Wilkinson (2000) stressed that whilst internal networks are important, learning from knowledge externally is essential as markets are worldwide and firms need to develop external links. Porter (1990) stressed access to markets and firm rivalry as sources of external information critical to competitiveness.

Martin and Sunley (2001), on the other hand, are skeptical about whether the evidence confirms that firms in localized concentrations adopt new technologies more quickly than their geographically dispersed or isolated counterparts. They suggest that the role of tacit knowledge is over-emphasized, that the idea of strength could eventually erode and become a source of competitive advantage for particular areas is unclear.

“More detailed comparative research needs to be carried out to determine the precise extent to which, and the precise conditions under which, clustering does raise firm performance and innovativeness.” (Martin and Sunley 2001:36).

Other authors have suggested that much of the evidence to support claims about the importance of industry concentrations to firm growth and innovation is anecdotal and based on success stories about particular locations (Swann et al 2000; Harrison and Malmberg 1996). What is clear from these observations is that focusing on a successful economic region should not be in isolation from wider inter-regional systems. Wider inter-firm networks, access to information, changing global technologies, and market opportunities are all essential for long-term regional growth.

2.4.10 The role of institutions

Perhaps one of the most significant developments in research in recent years has been to recognise the role and importance of other economic agents and institutions besides the companies themselves in enhancing the competitive advantage of locations. Unlike Marshall (1890) who did not acknowledge the role of institutions and public intervention in agglomeration economies, modern authors now place greater emphasis on this aspect (Amin & Thrift 1992, Keeble and Wilkinson 1999, Cooke and Morgan 1998). For example, Porter, writing in 1998, expanded his definition of clusters to include “associated institutions (for example, universities, standards agencies, and trade associations) (Porter 1998:117).

Such writers suggested that collectivist and institutional involvement is the basis for successful co-ordination of organisations within an area. Social relations and rules of behaviour are embedded in formal institutional relationships, and these engender trust and co-operation that strengthen inter-firm networks. In effect, institutions establish a framework of standards that underpin co-operation. Amin and Thrift (1992) termed this collaboration as ‘institutional thickness’ or capacity, and cite four factors relating to ‘institutional thickness’:

- a strong institutional presence
- high levels of interaction between networks
- defined structures of domination and/or patterns of coalition resulting from both the collective representation of sectional and individual interests
- the development among participants of a mutual awareness that they are involved in a common enterprise.

Keeble and Wilkinson (1999), Cooke and Morgan (1998) and Simmie (1997) as well as others equally place considerable emphasis in their work on the role of institutions in shaping regional innovative capacity, which, they contend, may be more important than the networking and intensity of interaction between individual firms. These institutions in the UK include non-firm institutions such as central and local government, Regional Development Agencies (RDAs), trade associations, universities, and business support agencies as well as venture capital funds. As Lorenz pointed out, each of these institutions, or as he termed them, ‘local collective agents’, enhanced the collective learning processes. Knowledge was transmitted through these organisations and networks. At the same time, dependencies were created that were fostered by the cultural, institutional and geographical proximity. Boschma (2005) in particular looked at the role of institutional proximity. This knowledge is not traded or even tradable, but it significantly affected the competitive performance of an area. Storper (1995) called this process ‘untraded interdependencies’, which extend beyond traditional customer-supplier and servicing relationships to embrace formal and informal collaboration and information networks. This interaction entailed non-firm institutions as well as firms that share conventions and rules for the development of communication and interpreting technology.

Other authors have labelled this collective process an ‘innovative milieu’, a term adopted by Aydalot (1986) and Camagni (1991) in their research at the European School of Regional Economic research (GREMI). This too focused on the interrelationship between the suppliers and customers, (i.e. the makers and users of products and processes). Their work focused on the formal and informal collaboration of companies and the inter-firm
mobility of workers in localised markets that create spin-offs of new firms from existing private sector companies, as well as institutions such as universities and public sector research laboratories. These spin-offs transferred knowledge across the different actors and kept the links between the public and private sectors on-going. Capello (1999) particularly documented a schema of the emergence of innovative milieux and the preconditions for the various stages of development. One of the necessary ingredients is the social interaction and supportive institutional framework that generates trust and encourages informal and tacit knowledge transfers. These lead to external economies and savings in transaction costs as noted by theorists such as Marshall and Porter. However, the difference with this perspective is the importance given to non-business institutions in not only supporting but also enhancing these agglomeration tendencies.

Different public institutions have particular roles in this collective learning process or innovative milieux. Specialised business services, for example, are part of the knowledge infrastructure and form a crucial role acting as a source of expertise on government regulations, standards, product testing, market research and financial services. Training agencies similarly provide advice to local knowledge-based firms, particularly new start-up companies, and provide necessary skills training courses. Being able to share a knowledge base with respect to technical, marketing and managerial skills is all seen as part of the collective learning process. Hence, a highly developed and effective supportive infrastructure made up of these services is a critical layer in this process. The Keeble and Wilkinson (1999) study noted that overcoming constraints and exchanging tacit knowledge was particularly critical for specialised small and medium-sized enterprises (SMEs) in growing clusters. They often exhibited high levels of inter-firm networking and use of local business support and institutional resources.

Universities as key local collective agents and their role in enhancing the collective learning process or innovative milieux have, in turn, been the focus of attention for a number of academics both in US and across Europe. Academia plays a central role in regional knowledge-based development strategies. The literature suggests that the location of national research centres has been a major factor driving activity in certain high tech places (Hall et al 1987; Glasmeier 1991).

The Keeble and Wilkinson (1999) study of Cambridge demonstrated the way that the University of Cambridge adopted a liberal positive academic attitude to research collaboration with firms. This attitude was also fundamental in fostering the growth of university spin-off companies. This culture of collaboration was seen as crucial to the successful growth of SME companies and in enhancing and shaping the overall collective learning capacity of the area. As Hall et al (1987) noted in their work on the growth of high technology companies, these institutional advantages obtained from universities and government research establishments produced instant agglomeration benefits for an area.

The dissemination of R&D through institutions, such as universities and government research establishments, plays a particularly important role in the collective learning process and creation of enterprising places. The nature of the innovation process means that it is very much spatially concentrated and localised. This is attributed to the geographical rigidity of R&D activities that are relatively immobile and place-specific, related to University and research institutions within an area. New research units locate close to existing ones due to the high cost of moving and the need to maintain good research communication flows and retain research staff that might join another company if the research operation moved elsewhere (Oakley, 1995).

Hall et al's (1987) study of high-tech companies found little evidence of fragmentation of R&D activities, finding instead that firms tended to keep the production of technology for global markets close to their original home base. Hall et al (1987) concluded that university and government R&D was one of the most critical factors in the development of technology-based industries within the UK. Similar studies in the US noted this tendency towards regional concentration of R&D labs and equally argued that this had implications for the generation of knowledge, innovation and growth in certain locations (see Howells, 1984; Hall and Markusen, 1985). An exception is the establishment of R&D operations near key markets, a phenomenon studied by Kang (2006) and referred to earlier.

Studies in Europe have found that supportive local business services and non-business institutions have played a critical role in fostering economic growth. Cooke and Morgan's study of the French Diringiste approach to growth poles in Sophia-Antipolis, as well as De Bernardy's (1999) study of the Grenoble region acknowledge the role of municipal organisations in reinforcing communal solidarity and encouraging the exchange of information among companies. Brusco's (1982) work in Emilia-Romagna and Tuscany, as well as Lindholm's (1999) work on Goteborg equally supported these findings. However, as noted earlier, all of these studies argued that whilst these local support networks are critical to an area, wider national as well as international relationships are becoming more important. Porter's more recent work (2001) considered "institutions of collaboration" as key parts of industry clusters. Benner (2003), studied what he called 'labour market intermediaries' in Silicon Valley. He found that these intermediaries facilitated labour market adjustments by playing three fundamental roles:

- Reducing transaction costs
- Building networks
- Managing risk
2.4.1 Opportunities and constraints on change

The previous discussion suggests that we are witnessing a sea change in the organisation of economic activity around the world. Companies are moving themselves and their functional units to different areas in order to maximise their competitiveness. At the same time, civic leaders are competing to position their places as competitive choices. Therefore is a particularly important time to understand the role of change agents.

With respect to public sector organisations, Porter (1990), Bresnahan et al (2001) and others suggest that government need to stay out of the way, acting at most as an enabler. Meanwhile, people like Kathryn Foster (2001) and Henton, Douglas, Melville, and Walesh (Henton et al 2002) in their work ‘Collaboration and innovation: the state of American regions’ argue for an activist role by civic leaders, including those in government.

There is certainly a need for greater understanding as to the mechanisms by which all of the relevant agents of change in a particular place, including public institutions, can work together to maintain the success of the place as a thriving location for technology producing industry. This would not seem to be a trivial issue. Many commentators recognised that the benefits of geographical clustering to technology producing companies in some locations might be eroded by physical constraints, rising housing/property costs, congestion effects and the like, in the area concerned. What, if any, are the critical masses involved in the settlement scale? Such discussions fit into the literature on city regions and “citistates”, coined by Pierce and Johnson (1993) to describe economic regions that compete in the global economy, and research that has examined the opportunities for regions to specialise functionally (Sommers and Carlson 2003).

Of related interest is whether regions may lack the appropriate institutions to solve problems such as the congestion and rising costs of living that retard business success. Thus, Downs (2004) explored potential regional institutional forms in the context of the need to solve regional traffic problems. The author argued that the predominant governance system in US regions – consisting of many small, highly fragmented local governments – is not capable of dealing effectively with a variety of problems, including rising infrastructure costs and traffic congestion. Some authors have emphasised that the ability of a particular place to adjust to the requirements of the New Economy is very much a function of its history. Maskell and Malmberg (1999) argued that “firms locate and build their competitiveness in interaction with localised capabilities, which are primarily based on the region’s infrastructure and built environment, the natural resources accessible in the region, the region’s specific institutional endowments, and the knowledge and skills in the region.” These authors, and others, lend support to the view that enterprising places should be seen as systems of core competencies tied together in relationships that influence the underlying competitiveness of the place concerned.

This raises a corresponding problem: inertia within systems is a key barrier to change. The places we studied faced considerable challenges in overcoming ‘lock-in’ associated with their past development patterns (Grabher; 1993, Boschma 2005, Hassink, 2005). (For a recent excellent set of readings see Gerhard Fuchs and Philip Shapira, 2005). The lock-in was not limited to land, infrastructure and labour but included institutions that had evolved over time. Some have also suggested that institutional rigidities associated with the legacy of the past may contribute to a sort of ‘institutional lock-in.’ (For a summary of the literature see Martin and Sunley, 2006.)

Finally, change often occurs through the efforts of individuals, and in our research we sought to develop a greater understanding of this aspect of change. We looked at how those responsible for delivering change particularly when it involved bringing the state and the market together, acted to enable a dynamic environment.
3. What technology-based companies need from place

3.1 Introduction

Drawing on an extensive survey of the CEOs in technology-based companies in our case-study areas, this section begins by examining the place-related attributes that technology-based companies identified as important in both their choice of a specific location and their decision to remain there. The survey results were examined according to the geography, stage of development and broad sectoral characteristics of the companies responding. In presenting the results the focus is on the responses of all companies, whether in the US or the UK, and by stage of development.

We then examined in more depth the attributes associated with the chosen location in terms of innovation, technology, networks, collaboration, finance, labour force, infrastructure and premises. We assessed the relative merits of a range of quite disparate factors that have been identified as being important in location decisions by technology-based companies. The focus here was on the all company results and by whether the companies were young and thus newly established or more medium sized and thus fairly well established.

Companies included:

- start-up-companies, at invention and proof of concept stage or developing a prototype product or service
- young companies, producing and selling their first products and services
- medium-sized companies, with established manufacturing and sales of products and/ or services
- mature companies with numerous products and/or locations and/or subsidiaries

Company managers cited a number of factors related to the cost and location of inputs. However, traditional policy levers - tax policy, financial incentives, and regulatory policy – turned out to be fairly unimportant. Quality-based factors were much more important to the location of technology producing companies. These factors included the suitability of space: the quality and availability of the local workforce; the quality of the infrastructure; and the quality of the residential environment and its social and cultural amenities. These were the focus of policy interventions in the places we studied, and we discuss these later in the paper.
3.2 What influences company location?

3.2.1 Why do they come?

We first asked senior managers of companies in the study areas what factors had influenced them to locate where they did. The results appear in Table 3.1. Workforce and space-related factors were the most important, led by the location of the founder’s home. There was little difference between companies in the US and the UK.

What most distinguished responses from one another was the stage of development of the company. When our sample companies first decided on their current location, almost half were start-ups, another 30 percent were young companies; 14 percent were medium-sized companies; and only 1 percent identified themselves as mature. Except for affordable space, the factors valued by start-ups related to the characteristics of the local community and its residents. These included where the founders/directors lived; where existing employees lived; the quality and availability of the local workforce; the presence of local contacts and networks; and the quality of the residential environment. Young companies placed more importance on space and infrastructure as well as on proximity to their markets. Medium-sized companies were more loosely tied to their founders but placed more value on their own workforce and the quality of the workforce in the community. Factors related to their own premises (affordability but also suitability and availability of parking), were also more important for them than for younger companies.

Table 3.1. Criteria influencing technology producing companies’ initial decision to locate in a place

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Rank for all companies</th>
<th>Country</th>
<th>Initial stage of company development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>UK</td>
<td>US</td>
</tr>
<tr>
<td>Location of the founders'/directors' home</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Convenience to your existing employees</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Availability of affordable/low cost space</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Availability of suitable facilities</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Good transportation links (e.g. roads, rail and airports)</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Quality and availability of the local workforce</td>
<td>6</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Quality of the residential environment, social and cultural amenities</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Availability of parking for employees, customers and suppliers</td>
<td>8</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Good communication infrastructure</td>
<td>9</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Presence of local contacts and networks</td>
<td>10</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Proximity to customers and clients for your products/services</td>
<td>11</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Proximity to colleagues working in the area</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Image”right address”</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Availability of facilities for manufacturing</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Proximity to key suppliers and sub-contractors</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Availability of specialised business support services</td>
<td>16</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Proximity to research institutions to recruit quality workforce</td>
<td>17</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>Presence of similar companies for collaborations &amp; tech spill-overs</td>
<td>18</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Capacity of utilities: power, water, sewerage, waste disposal</td>
<td>19</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Proximity to research institutions to use facilities</td>
<td>20</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>Availability of area targeted government assistance</td>
<td>21</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Supportive national regulatory framework (e.g. standards &amp; laws)</td>
<td>22</td>
<td>23</td>
<td>22</td>
</tr>
<tr>
<td>Availability of specialised finance (e.g. angel and venture capital)</td>
<td>23</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Favourable local taxation/Policies</td>
<td>24</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Proximity to research institutions to obtain intellectual property</td>
<td>25</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Proximity to research institutions to train existing employees</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Supportive land-use planning policies and procedures</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Source: Enterprising Places Company Survey</td>
<td>28</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>Outcome of a merger or acquisition involving another company</td>
<td>29</td>
<td>28</td>
<td>29</td>
</tr>
</tbody>
</table>

1 At the time of the initial decision and at the time of the survey, a small number of companies identified themselves as “other.”
3.2.2 Why do they stay?

In the traditional location equation, the prices companies pay over time for factors of land and labour reflect both the original benefits associated with a particular location, as well as those associated with geographical concentration\(^4\). Moreover, increasing levels of activity in a particular place increase pressures on the resources available in the place to meet the increased demands. Combined, these result in higher costs and lower quality services. Companies would then seek to move to lower cost areas. Markusen, Lee, and DiGiovanna (1999) offered an alternative scenario. They explained the “stickiness” as well as the success of new smaller “second tier” cities, which are not necessarily the lowest cost option for companies, as a function of the place’s industrial organisation and the role of “active agents — firm managers, state sector decision-makers, local economic development boosters, and worker and community groups.” (p.335)

To see what kept high tech companies in their current location, we asked company managers to identify the three factors most important to their decision to remain where they were. Table 3.2 summarises the results. As the table shows, once firms made their location choice, including the choice of premises, they stayed for other reasons. Proximity to customers and clients was the most important such reason. Other factors that kept firms where they were (rather than attracting them there in the first place), were connections to research institutions (to use facilities, obtain IP, and recruit workers), as well as, to a lesser degree, targeted government assistance.

US and UK companies reported some interesting differences. For US companies, the quality and availability of the local workforce; the presence of local contacts and networks; the quality of the residential environment; proximity to research institutions to use facilities; and the availability of manufacturing facilities, were more important in keeping them in place than they were to UK companies. For UK companies, the availability of suitable (and affordable) space, good transportation links, communication, the availability of parking, and the availability of targeted government assistance, were more important to than they were to US companies.

Table 3.2: Criteria influencing technology-producing companies’ decision to remain in a place

<table>
<thead>
<tr>
<th>Criteria (Note: 1 is most important; 26 is least important; na indicates that no company identified this as an important factor.)</th>
<th>Rank for all companies</th>
<th>Country</th>
<th>Current stage of company development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>UK</td>
<td>US</td>
</tr>
<tr>
<td>Location of the founders'/directors' home</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Convenience to your existing employees</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Proximity to customers and clients for your products/services</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Availability of affordable/low cost space</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Quality and availability of the local workforce</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Good transportation links (e.g. roads, rail and airports)</td>
<td>6</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Good communication infrastructure</td>
<td>7</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Availability of suitable facilities (e.g. built to suit your company)</td>
<td>8</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Presence of local contacts and networks</td>
<td>9</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Quality of the residential environment, social and cultural amenities</td>
<td>9</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Proximity to research institutions to use facilities</td>
<td>11</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Image/right address*</td>
<td>12</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Availability of parking for employees, customers and suppliers</td>
<td>13</td>
<td>11</td>
<td>na</td>
</tr>
<tr>
<td>Proximity to colleagues working in the area</td>
<td>14</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Proximity to key suppliers and sub-contractors</td>
<td>15</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Availability of area targeted government assistance</td>
<td>16</td>
<td>13</td>
<td>na</td>
</tr>
<tr>
<td>Availability of specialised finance (e.g. angel and venture capital)</td>
<td>17</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Proximity to research institutions to obtain intellectual property</td>
<td>18</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Proximity to research institutions to recruit quality workforce</td>
<td>19</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Availability of facilities for manufacturing</td>
<td>19</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Capacity of utilities: power, water, sewerage, waste disposal</td>
<td>21</td>
<td>20</td>
<td>na</td>
</tr>
<tr>
<td>Presence of similar companies for collaborations and tech spill-overs</td>
<td>22</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Favourable local taxation policies</td>
<td>23</td>
<td>21</td>
<td>na</td>
</tr>
<tr>
<td>Availability of specialised business support services</td>
<td>23</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Proximity to research institutions to train existing employees</td>
<td>25</td>
<td>22</td>
<td>na</td>
</tr>
<tr>
<td>Outcome of a merger or acquisition involving another company</td>
<td>26</td>
<td>24</td>
<td>21</td>
</tr>
<tr>
<td>Support of local political leadership</td>
<td>na</td>
<td>Na</td>
<td>na</td>
</tr>
<tr>
<td>Supportive land-use planning policies and procedures</td>
<td>na</td>
<td>Na</td>
<td>na</td>
</tr>
<tr>
<td>Supportive national regulatory framework</td>
<td>na</td>
<td>Na</td>
<td>na</td>
</tr>
</tbody>
</table>

* unless the effect are so dynamic and significant that they continue to ‘surprise’ the forces of market internalisation.
3.2.3 Deciding to stay in a centre and a company's stage of development

In order to understand how a company's decision to remain in an area might change as it matured, we analysed the responses based on the companies' stages of development for all companies in the sample. At the time of the survey, only 5 percent remained start-ups; over 40 percent were young companies; the number of medium sized companies had reached 35 percent; and 10 percent were mature. Table 3.3 shows the results for young companies, Table 3.4 for medium-sized companies, and Table 3.5 for mature companies. In each case we present the six factors that companies in the relevant group said were most important in their decision to remain in its current location. Each table also shows the priority that companies in the other stages of development gave that factor. We also considered whether or not the factor was “policy” related. Factors involving a company’s current employees, customers, clients, and suppliers were not considered to be policy-related. Space; the general quality of the local workforce; transportation and communication links; the quality of the residential environment; the availability of incentives; favourable tax policy; local planning policies, and political leadership were considered policy-related.

Table 3.3: Factors influencing a young company to remain in place

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Young</th>
<th>Medium size</th>
<th>Mature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of the founders'/directors' home</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Availability of affordable/low cost space</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Convenience to your existing employees</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Proximity to customers &amp; clients for products/services</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Good communication infrastructure</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Good transportation links (e.g. roads, rail, and airports)</td>
<td>6</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

For young companies, company-related factors were the location of the founders'/director's home (although see the discussion of quality of life factors); the convenience of existing employees; and proximity to customers and clients for the company's products and services. Policy-related factors included the availability of affordable/low cost space, communications infrastructure, and transportation links. (Note: Although not shown, the quality of the existing workforce and local contacts and networks both ranked seventh.)

Table 3.4: Factors influencing a medium-sized company to remain in place

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Medium size</th>
<th>Young</th>
<th>Mature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience to your existing employees</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Location of the founders'/directors' home</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Quality and availability of the local workforce</td>
<td>3</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Availability of affordable/low cost space</td>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Availability of suitable facilities (e.g. built to suit)</td>
<td>5</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Proximity to customers &amp; clients for products/services</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

For medium-sized companies, workforce factors tied the company to the place. The convenience of existing workers was the most important factor holding the company in place, followed by the location of the founder's home, followed by the quality of the local workforce in general. Premises-related factors were the next most important, including both affordable and suitable space. Proximity to customers was the sixth major factor.

Table 3.5. Factors influencing a mature company to remain in place

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mature</th>
<th>Young</th>
<th>Medium size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience to existing employees</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Proximity to customers &amp; clients for products/services</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Location of the founders'/ directors' home</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Availability of suitable facilities (e.g. built to suit)</td>
<td>4</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Availability of affordable/low cost space</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Quality and availability of the local workforce</td>
<td>6</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Availability of parking for customers and suppliers</td>
<td>6</td>
<td>9</td>
<td>20</td>
</tr>
</tbody>
</table>

Like medium-sized companies, mature companies placed the greatest value on the convenience of their existing employees and were more loosely tied to founders. Premises-related factors (suitability and affordability of space, parking), were more important than they were to young companies.
3.3 On technology and innovation

Overall, taking all companies together, the most important sources of technology were feedback from customers, research within the company, the Internet, competitors, literature and new employees. This was much the same across the different stages of development (Table 3.6). Universities were not perceived as being particularly important sources of technology per se.

Table 3.6: Sources of technology

<table>
<thead>
<tr>
<th>Rank for ALL companies</th>
<th>UK and US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback from customers</td>
<td>1</td>
</tr>
<tr>
<td>Research in the company</td>
<td>2</td>
</tr>
<tr>
<td>Internet</td>
<td>3</td>
</tr>
<tr>
<td>Competitors</td>
<td>4</td>
</tr>
<tr>
<td>Literature</td>
<td>5</td>
</tr>
<tr>
<td>New employees</td>
<td>6</td>
</tr>
<tr>
<td>Feedback from suppliers</td>
<td>7</td>
</tr>
<tr>
<td>Previous work colleagues</td>
<td>8</td>
</tr>
<tr>
<td>Professional conferences</td>
<td>9</td>
</tr>
<tr>
<td>Research within the company group</td>
<td>10</td>
</tr>
<tr>
<td>Specialised business support services</td>
<td>11</td>
</tr>
<tr>
<td>Investors in the company</td>
<td>12</td>
</tr>
<tr>
<td>Previous and current university colleagues</td>
<td>13</td>
</tr>
<tr>
<td>Formal networking organisations</td>
<td>14</td>
</tr>
<tr>
<td>Trade association</td>
<td>15</td>
</tr>
<tr>
<td>Contract research from a consultancy</td>
<td>16</td>
</tr>
<tr>
<td>Patent disclosures</td>
<td>17</td>
</tr>
<tr>
<td>PhD undertaken by employees</td>
<td>18</td>
</tr>
<tr>
<td>Contract research from a research institute</td>
<td>19</td>
</tr>
<tr>
<td>Purchase of IP from another company</td>
<td>20</td>
</tr>
<tr>
<td>Acquisition from another company</td>
<td>21</td>
</tr>
<tr>
<td>Chambers of Commerce</td>
<td>22</td>
</tr>
<tr>
<td>Assigned or licensed IP from a research institute</td>
<td>23</td>
</tr>
</tbody>
</table>

However, universities and research centres did play a role in helping companies to innovate and translate technology into new technologies. Whilst market factors (market opportunities and the sophistication of a company’s customers), were identified as the most important influences on innovation, the next most important factors were university related: networks with research institutions and technology developed by other companies and by research institutions.

Table 3.7: Factors assisting companies to innovate

<table>
<thead>
<tr>
<th>Rank for ALL companies</th>
<th>UK and US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key local market opportunities</td>
<td>1</td>
</tr>
<tr>
<td>Sophisticated customer base</td>
<td>2</td>
</tr>
<tr>
<td>Strong networks with research institutions</td>
<td>3</td>
</tr>
<tr>
<td>New technologies introduced by other local companies &amp; research institutions</td>
<td>4</td>
</tr>
<tr>
<td>Diversity of local technology companies</td>
<td>5</td>
</tr>
<tr>
<td>Local financing favouring specific locations</td>
<td>6</td>
</tr>
<tr>
<td>Collaboration opportunities with corporations</td>
<td>7</td>
</tr>
<tr>
<td>Supportive regulations, standards &amp; laws.</td>
<td>8</td>
</tr>
<tr>
<td>Innovative activity of local competitors</td>
<td>9</td>
</tr>
</tbody>
</table>

All companies taken together identified the top five factors assisting them to innovate as being key local market opportunities; sophisticated customer base; strong networks with research institutions; the new technologies they introduced; and the diversity of local technology companies (Table 3.7). Thus, companies ranked market-related factors both as the most important sources of technology to them and the factors that influenced their ability to innovate (the demand part of the Porter diamond).
3.4 On relationships with local research institutions

Table 3.8 below indicates the nature of the relationships that the technology-based companies had with their local research institutions. For all companies, the most common factors were that their employees maintained informal relationships with the faculty and that the company hired the institute's graduates. However, other more indirect relational pathways were highlighted, including that the company benefited from the intellectual dynamism of the institute's presence. Company employees attending courses, academics acting as consultants and collaborative endeavour occupied the middle ground in terms of ranking ahead of direct use of the institute's facilities. It was of interest that this position was much the same in the UK as the US (not shown in table).

Table 3.8: Relationships with local research institutions

<table>
<thead>
<tr>
<th>Rank for ALL companies UK and US</th>
<th>Table 3.8: Relationships with local research institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Company employees maintain informal relationships with the faculty</td>
<td></td>
</tr>
<tr>
<td>2. Company hires institute's students and graduates</td>
<td></td>
</tr>
<tr>
<td>3. Benefits from the intellectual dynamism resulting from the institute's presence</td>
<td></td>
</tr>
<tr>
<td>4. Company employees attend courses</td>
<td></td>
</tr>
<tr>
<td>5. Academic acts as a consultant</td>
<td></td>
</tr>
<tr>
<td>6. Company undertakes collaborative research with the institute</td>
<td></td>
</tr>
<tr>
<td>7. Company uses the institute's facilities</td>
<td></td>
</tr>
<tr>
<td>8. Company is a spin-out</td>
<td></td>
</tr>
<tr>
<td>9. Company contracts Institute to do research</td>
<td></td>
</tr>
<tr>
<td>10. Institute licenses IP to the company</td>
<td></td>
</tr>
<tr>
<td>11. Company's employees are adjunct professors</td>
<td></td>
</tr>
<tr>
<td>12. Academic serves as board member</td>
<td></td>
</tr>
<tr>
<td>13. Company uses institute's incubator</td>
<td></td>
</tr>
</tbody>
</table>

3.5 On networks

Companies were also asked about their networks. The results are summarised in Table 3.9 below. Overall, all technology-based companies in the UK and the US emphasised contacts with customers; contacts with suppliers and sub-contractors; contacts with previous employees/ers; joint projects with other companies; contacts with research institutions; and informal contacts with similar companies.

Table 3.9: Important networks

<table>
<thead>
<tr>
<th>Rank for ALL companies UK and US</th>
<th>Table 3.9: Important networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Contacts with customers</td>
<td></td>
</tr>
<tr>
<td>2. Contacts with suppliers and sub-contractors</td>
<td></td>
</tr>
<tr>
<td>3. Contacts with previous employees/ers</td>
<td></td>
</tr>
<tr>
<td>4. Joint projects with other companies</td>
<td></td>
</tr>
<tr>
<td>5. Contacts with research institutions</td>
<td></td>
</tr>
<tr>
<td>6. Informal contacts with similar companies</td>
<td></td>
</tr>
<tr>
<td>7. Membership of a trade association</td>
<td></td>
</tr>
<tr>
<td>8. Use of common specialised business support</td>
<td></td>
</tr>
<tr>
<td>9. Sharing equipment with other companies</td>
<td></td>
</tr>
<tr>
<td>10. Membership of a networking organisation</td>
<td></td>
</tr>
<tr>
<td>11. Contacts through financial community</td>
<td></td>
</tr>
<tr>
<td>12. Contacts with business advice centre</td>
<td></td>
</tr>
<tr>
<td>13. Participation of the board of directors of other companies</td>
<td></td>
</tr>
<tr>
<td>14. Contacts through business mentors</td>
<td></td>
</tr>
<tr>
<td>15. Membership of the chamber of commerce</td>
<td></td>
</tr>
</tbody>
</table>

3.6 On collaborations

The collaborations that companies undertook are summarised in order of importance in Table 3.10 below. For all companies taken together in the US and the UK, collaborations with customers and suppliers were the most important. This was followed by product collaborations with other companies; market and distribution collaborations with other companies; R&D collaborations with other companies; collaborations with specialised business support; informal collaborations with colleagues at research institutions; and formal collaborations with research institutions.

Table 3.10: Types of collaboration

<table>
<thead>
<tr>
<th>Rank for ALL companies UK and US</th>
<th>Table 3.10: Types of collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Collaborations with customers</td>
<td></td>
</tr>
<tr>
<td>2. Collaborations with suppliers</td>
<td></td>
</tr>
<tr>
<td>3. Product collaborations with other companies</td>
<td></td>
</tr>
<tr>
<td>4. Market &amp; distribution collaborations with other companies</td>
<td></td>
</tr>
<tr>
<td>5. R&amp;D collaborations with other companies</td>
<td></td>
</tr>
<tr>
<td>6. Collaborations with specialised business support</td>
<td></td>
</tr>
<tr>
<td>7. Informal collaborations with colleagues at research institutions</td>
<td></td>
</tr>
<tr>
<td>8. Formal collaborations with research institutions</td>
<td></td>
</tr>
</tbody>
</table>
3.7 On finance

Table 3.11 below summarises the views of companies in relation to sources of finance. Overall, the most important sources of finance were identified to be (in order of importance): company earnings; owner equity; family and friends; debt finance; small business loan guarantees; development of specific technology and grants; venture capital; area-targeted grants; early stage grants; angel finance; and the stock market.

Table 3.11: Sources of finance

<table>
<thead>
<tr>
<th>Rank for ALL companies</th>
<th>UK and US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company earnings</td>
<td>1</td>
</tr>
<tr>
<td>Owner equity</td>
<td>2</td>
</tr>
<tr>
<td>Family &amp; friends</td>
<td>3</td>
</tr>
<tr>
<td>Debt finance</td>
<td>4</td>
</tr>
<tr>
<td>Small business loan guarantees</td>
<td>5</td>
</tr>
<tr>
<td>Development of specific technologies' grants</td>
<td>6</td>
</tr>
<tr>
<td>Venture capital</td>
<td>7</td>
</tr>
<tr>
<td>Area targeted grants</td>
<td>8</td>
</tr>
<tr>
<td>Early stage grants</td>
<td>9</td>
</tr>
<tr>
<td>Angel finance</td>
<td>10</td>
</tr>
<tr>
<td>Stock market</td>
<td>11</td>
</tr>
</tbody>
</table>

3.8 On type of employees

Companies were asked about the relative importance of certain types of employees to them in their present location. Table 3.12 below ranks them in order of perceived importance. All companies taken together identified information technology specialists, marketing and sales personnel and business managers as the top three.

Table 3.12: Employee types

<table>
<thead>
<tr>
<th>Rank for ALL companies</th>
<th>UK and US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information technology specialists</td>
<td>1</td>
</tr>
<tr>
<td>Marketing and sales personnel</td>
<td>2</td>
</tr>
<tr>
<td>Business managers</td>
<td>3</td>
</tr>
<tr>
<td>Clerical and administrative</td>
<td>4</td>
</tr>
<tr>
<td>Technicians</td>
<td>5</td>
</tr>
<tr>
<td>Strategic board members</td>
<td>6</td>
</tr>
<tr>
<td>Newly graduated engineers and scientists</td>
<td>7</td>
</tr>
<tr>
<td>World class experienced scientists</td>
<td>8</td>
</tr>
</tbody>
</table>

3.9 Constraints on recruitment

The most significant constraint on recruitment was identified to be the cost of housing, followed by competition from similar companies and a lack of specialist technical scientific skills (Table 3.13). This position varied somewhat between the UK and the US (not shown in table). In the US, the second most significant factor identified was high local wages.

Table 3.13: Constraints to recruiting employees

<table>
<thead>
<tr>
<th>Rank for ALL companies</th>
<th>UK and US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of housing</td>
<td>1</td>
</tr>
<tr>
<td>Competition from other similar companies</td>
<td>2</td>
</tr>
<tr>
<td>Lack of specialised technical/scientific skills</td>
<td>3</td>
</tr>
<tr>
<td>Labour shortages</td>
<td>4</td>
</tr>
<tr>
<td>High local wages</td>
<td>5</td>
</tr>
<tr>
<td>Commuting problems</td>
<td>6</td>
</tr>
<tr>
<td>Lack of managerial and marketing skills</td>
<td>7</td>
</tr>
<tr>
<td>Lack of a range of housing types</td>
<td>8</td>
</tr>
<tr>
<td>Limited family support facilities – schools</td>
<td>9</td>
</tr>
<tr>
<td>Limited technical and business training facilities</td>
<td>10</td>
</tr>
<tr>
<td>Limited similar job opportunities</td>
<td>11</td>
</tr>
<tr>
<td>Parking problems</td>
<td>12</td>
</tr>
<tr>
<td>Limited leisure facilities</td>
<td>13</td>
</tr>
<tr>
<td>Poor quality of the physical environment</td>
<td>14</td>
</tr>
<tr>
<td>High turn-over of staff</td>
<td>15</td>
</tr>
</tbody>
</table>
3.10 On infrastructure

All companies highlighted the importance of broadband access, good transport links, affordable/low-cost space and good mobile telecom reception. Flexible leasehold conditions and parking facilities came next in the ordering (Table 3.14). There was considerable variation between areas and, to some degree, stage of development. In the UK, good transport links rated first, whereas in the US, the first position was given to affordable, low-cost space (not shown in table). Both placed broadband access second and good mobile telecommunication reception fourth.

<table>
<thead>
<tr>
<th>Rank for ALL companies UK and US</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Broadband access</td>
</tr>
<tr>
<td><strong>2</strong> Good transport links</td>
</tr>
<tr>
<td><strong>3</strong> Affordable/low cost space</td>
</tr>
<tr>
<td><strong>4</strong> Good mobile telecommunication reception</td>
</tr>
<tr>
<td><strong>5</strong> Flexible leasehold conditions</td>
</tr>
<tr>
<td><strong>6</strong> Parking facilities</td>
</tr>
<tr>
<td><strong>7</strong> On-site expansion</td>
</tr>
<tr>
<td><strong>8</strong> Utilities capacities</td>
</tr>
<tr>
<td><strong>9</strong> Range and type of premises</td>
</tr>
<tr>
<td><strong>10</strong> Space for manufacturing</td>
</tr>
<tr>
<td><strong>11</strong> Laboratory space</td>
</tr>
<tr>
<td><strong>12</strong> Premises in high-tech science parks</td>
</tr>
<tr>
<td><strong>13</strong> Adjacent developable land</td>
</tr>
<tr>
<td><strong>15</strong> Incubator space</td>
</tr>
</tbody>
</table>

3.11 Summary

The evidence from the survey of technology producing companies and other respondents pointed to a number of factors that were important requirements in maintaining the competitive advantage of a location. The quality of the residential environment, a range of workforce related issues and the importance of communication/transportation and premises were highlighted. If places were to remain competitive locations for high technology, the regional leadership often had to find ways of meeting and financing substantial changes to the traditional patterns of infrastructure and settlement.

Companies often started up in one of the study areas because that is where the founder lived. They stayed and grew because of the connections they had with customers and because of a good workforce. However, young and medium-sized companies faced workforce-related issues. They were in competition with similar companies, especially for IT, marketing and sales personnel, who were perceived to be in short supply. Bringing workers to areas like the Eastern Region in Cambridgeshire (UK), Eastern Massachusetts or San Diego (US) was problematic because of the high cost of housing. The availability of good quality premises and sites became more important as companies began to grow and develop.

Universities and research institutions played an important role in the development of the companies, mostly through the people they provided. These institutions facilitated start-ups, providing world-class scientists and strategic board members. Companies realised that networks with universities and research institutions facilitated innovation (although they were not an important direct source of technology). These companies went on to identify the most important relationships as those that were personal, connections to faculty, and the pool of students that constituted potential employees. Their presence also helped to create a general intellectual dynamism that companies valued.

New companies also identified government programmes, such as grants and loan guarantees, as being important sources of finance. They depended on government provision of critical infrastructure (especially transport and key services), and other factors that government had the ability to influence, such as the quality of the residential environment and the availability of land. These actions were considered to be important in influencing a company’s decisions to locate and grow in an area.

Competitive and attractive locations were those that were able to flex their resource bases to accommodate the needs of technology-based industries. Their ability to do this was clearly influenced by where they started from, their industrial legacy and their ability to bring together the key players who could initiate change.
4. Creating the innovation network

4.1 Introduction

Academic researchers and the people we interviewed for this project agreed that universities and research institutions, what we call ‘knowledge-based institutions’ (KBIs), were important regional assets and potentially central elements in the portfolio of assets that contributed to a region’s competitive advantage and enterprising capability.

As technology has become increasingly important to a firm’s competitiveness, so have KBIs as central institutions in enterprising places. They raised local capabilities and competences in many ways. They produced a steady output of qualified and skilled labour; they increased the stock of ‘codified’ useful technology; and they played a role in the process of innovation by interacting with the business community through formal and informal channels. KBIs with large and diversified research bases supported by substantial public and private sector funding attracted high-quality scientists, talented graduates, and post-docs to the local area. They, in turn, started new technology-based companies, joined existing companies and became the conduits for technology transfer from the KBIs to the business community. Large-scale high-quality research in KBIs and a pool of labour with advanced technical and scientific training also attracted research functions of multinational companies and collaborative research activity with KBIs, which further enhanced the technology and innovative capacity of the region.

In our research, we explored the various roles played by KBIs in our study areas by looking at the connections between high-technology companies and KBIs and their relationships to policy and place.

In our survey, we asked companies several questions about their connection to knowledge-based institutions. We asked them about the factors that caused them to innovate, their sources of technology, and their most important relationships with local research institutions. Young and medium-sized companies reported that their markets and customers were their most important sources of innovation. Networks with research institutions were the next most important for young companies, but medium-sized companies reported these networks to be less important than opportunities to collaborate with other companies. Companies at all stages of development reported that assigned or licensed IP was almost the least important of all sources of technology to the company.

When asked about the nature of their relationships with local research institutions, start-ups valued their relationships with faculty, they used the institutes’ facilities, and they employed academics and consultants in their companies. Young and medium-sized
companies reported that the three most important relationships were: hiring of the institutes’ students and graduates; informal relationships with faculty; and the intellectual dynamism in the place resulting from the institution’s presence.

We asked similar questions of the leaders of companies and KBI’s, policy makers, and civic leaders in our place-based interviews. They confirmed the survey findings and provided a great deal of explanatory detail. In brief, our interviewees reported the following:

- The most important contributions that KBI’s made to high-technology companies and enterprising places were people: a stream of educated graduates who might start or become employees at technology-based companies or who provide key civic leaders to enterprising places. Academic excellence and excellence in basic research were the drivers for this flow.
- The real output of company sponsored or collaborative research was not necessarily technology; it was company access to a cadre of bright students trained in appropriate research methods.
- Most early stage companies were based on intellectual property owned by the founder or the company.
- Start-up companies often cited university ownership of IP as inhibiting the development of their businesses. As companies grew, those that began based on specific university-owned IP often abandoned it as the company developed and diversified its product line; and companies that used university-owned IP did so without regard to the location of the university.

Each of our case-study areas included world-class centres of scientific excellence in their universities and research institutions. The areas also contained a variety of technical, community, and teaching colleges and universities. Together, these KBI’s were widely perceived as critically important in their contribution to economic development. Not only were they considered important as national economic assets, but also as local assets playing a significant role in supporting the growth of the local high-technology sector and contributing more widely to the innovative capability and competitiveness of the local business community. As Mary Walshok observed in describing the San Diego experience of becoming a leading high-technology location: “You need a critical mass of intellectual capital”, and KBI’s were a critical source (Walshok 2004).

People we interviewed who were associated with KBI’s engaged in a variety of activities, beyond what might be considered their traditional functions of education and research. Such activities brought them in direct contact with high-technology companies. These could be grouped as follows:

- facilitating interactions of various kinds between the KBI, companies, investors, and others in the high-tech centre
- investing in real estate and related services
- holding intellectual property, funding its development, and making it available for commercial exploitation
- investing in companies
- providing specific continuing education for company employees
- participating in civic partnerships and providing civic leadership.

4.2 Investment in research

Increasingly, many of the new technology platforms of potential significance for company innovation were based on multi- and inter-disciplinary research, and the capacity to undertake such research was an increasingly important feature of the research capability of a high-technology region. Such research often required depth in multiple areas of specialisation, thus the greater the scale and diversity of a region’s science and research base, the greater its potential as an enterprising place. Although each of the case-study areas hosted world-class research capabilities, the scale and depth of this capability differed across the case-study locations: from the relatively specialised strengths of the Scottish science base, to the more diverse and wide ranging research capability identified in the Boston area, Cambridge UK, and San Diego.

One of the key issues facing KBI’s in both countries was how to attain a critical mass sufficient to support the scientific and technological specialisation required for inter-disciplinary exploration given that, increasingly, much cutting-edge research was occurring ‘at the fringes’ or ‘on the margins’ between the various disciplines, especially in areas related to nano- and biotechnology. One mechanism was interdisciplinary research within the university. Another mechanism for promoting such interdisciplinary research, used more in the UK, has been the establishment of collaborative centres of excellence based around a specific technology. These centres usually involved a number of research institutes, government agencies and industry, and focused on applied research and technology. Such centres were intended to attract and lever various sources of private and public funds and pool them to achieve a critical mass in a particular discipline. They could encourage and facilitate the movement of ideas and people across their respective organisations. Their separation from the university assisted in reducing the conflict between basic and applied research. Similarly, because their purpose was often to undertake applied research and to commercialise intellectual property, the commercialisation process would be smoother and less fraught with problems than those experienced in university-related commercialisation processes. Furthermore, while these centres may have had public university participants, as independent institutions they could pay market-related salaries to attract and retain high-quality scientists and managers. Lastly, especially in the
UK, these centres could provide the opportunity for students to interface with industry and to work on commercial applications while completing their studies.6

In some cases, such centres essentially commissioned research that was undertaken by the various institutional participants. The North Carolina Biotechnology Centre and the Scottish Intermediary Technology Institutes were examples, although this was only one aspect of their operations. The new Scottish Intermediary Technology Institutes (ITI) will funnel resources to support industry-related research in three sectors: energy, life sciences and communications/digital media markets, where Scotland has acknowledged strengths. Run in collaboration with industry and academic institutions, the institutes will act as the hubs for commissioning and supporting pre-competitive research in anticipation of future market opportunities. Other centres undertake research directly; examples included MCNC in North Carolina, and the Institute for System Level Integration in Scotland (ISLI), located on the Alba Campus. The latter focused on education for the electronics design community and supported related research.

Government R&D funding was typically attracted by institutions with a well-developed and proven capacity and capability to host the research (including, where appropriate, facilities and institutional arrangements for interdisciplinary research). The presence of established research institutions not only played an important role in attracting government R&D expenditure into those specific areas of research in which a region excels, but also assisted greatly in attracting national research institutes and companies with strong R&D functions into an area. The increasing concentration of diverse well-funded KBIs attracted high-quality scientific and engineering talent, faculty and students that further strengthened the capacity of KBIs in the region to attract public and private sector R&D funding. In some cases, new high-technology firms spun off from research done at KBIs. In other cases, it was the graduates who went on to start companies in the area. Corporate spin-offs often followed. Access to local high-quality manpower; a network of specialist business service suppliers to the high-technology sector, combined with opportunities for collaboration with KBIs and other high-technology companies facilitated company growth and innovation. Innovation not only gave rise to new companies with strong R&D functions but also had the potential to transform traditional industries in the region.

KBIs also contributed to the development of tacit codes of conduct as well as formal protocols that facilitate KBI-business collaboration. For example, a xenotransplantation company approached Tufts University School of Veterinary Medicine with an idea for a protocol for clinical trials. Tufts implemented the protocol, training its own staff, but also trained the company’s staff in tissue harvesting and animal husbandry.  

4.3 Knowledge-based institutions and companies: it is about people

What emerged from our interviews on KBIs and companies? The first important finding was the importance attached by the business community to the role of local KBIs as a source of highly qualified scientists, engineers and technicians.

Founders and managers of companies at all stages of development pointed to the universities as essential sources of people. The founders of new companies in our study most often came from the local universities, many as students. Mature companies relied even more on the universities for their workforce. For example, in North Carolina, both IBM and GSK hired extensively from the North Carolina State University (NCSU), a public institution, and the presence of high level research facilities and high quality graduate labour was an important factor in their decision to locate there. In fact, IBM nationwide hired more employees from NC State than any other school in the US. At the same time, the NC State has been an important customer for high-technology companies such as IBM.

4.3.1 Continuing education

KBIs not only turned out undergraduates, post graduates, and those who have received post-doctoral training in research institutes. They provided continuing education programmes for the local workforce as well as entrepreneurship training initiatives. One of the striking findings from the UCSD case study, for example, was the numbers of the workforce participating in Extension/Continuing Education Training. Programmes covering subjects ranging from computer programming to regulatory practices and professional business development for high-technology company executives. Courses provided by the university are typically largely self-supporting. Their importance derives from the role they play in qualifying generally educated students with industry specific skills and competencies and because they reflect industry’s needs for competencies (Lee and Walshok 2002).

San Diego City College had a Centre for Applied Competitive Technology (CACT), one of twelve applied technology centres in California which helped small firms upgrade their production techniques and workers skills, particularly technicians for maintaining and servicing equipment in high-technology firms. CACT was also building its training capability in the biosciences area and had established a ‘biolab’ to provide training and demonstration on advanced equipment.

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6 The Intermediary Technology Institutes are in the process of being rolled out and therefore it is too early to comment on their effectiveness.
4.3.2 New companies in enterprising places

Technology start-ups were an important way in which the universities and research institutions contributed to the local and regional economy. Most of the founders of new companies in our study came from the local university, many as students. They chose to start their businesses locally in part because they lived there and were socially entrenched in the area. Many also relied on contacts at the institution. Some used their former supervisors or professors as technical advisors. Others used the facilities available at the university, at least at first. These start-up companies directly and indirectly contributed to the growth and development of high-technology industry in each of the study areas. Their direct impact resulted from the jobs and local value added that the companies generated and the technology and knowledge that they carried from the science base. Their indirect impact occurred through their role in spawning subsequent corporate spin-offs and through the collective learning role that they played in diffusing new technologies and innovations throughout different parts of the local economy. They also attracted growing and mature companies seeking new ideas and technologies, that usually end up acquiring them.

University-related technology start-ups were important in almost all our study areas. Segal Quince and Wicksteed (1985, 2001) estimated that one quarter of new technology start-ups in Cambridge UK had a founder either from the University or a research establishment, and Keeble and Wilkinson (2000) estimated that between 15 and 20 percent of Cambridge high-technology small and medium sized enterprises originated in Cambridge University. UCSD’s first biotechnology firm, Hybritech Inc., created by two UCSD researchers in the late 1970s, has spawned many offspring and has been credited with the birth of the biosciences industry in the San Diego region7. San Diego’s renowned Scripps Research Institute and the Salk Institute for Biological Studies have also provided a rich source of spin-offs. According to CONNECT, at least 41 San Diego-based communication and telecommunication companies were either founded by students or faculty or spun off from firms with ties to UCSD, (Innovation Associates 2000). Dundee leaders claimed that their local bioscience industry owed its origins to the efforts of a small number of individuals from the University of Dundee who started new companies.

In Cambridge Massachusetts, MIT was renowned for its institutional culture that encouraged entrepreneurship and it has been estimated that as of 1997 there were 1,065 MIT-related firms employing 125,000 people in the state. MIT-related firms comprised one third of manufacturing firms and sixty percent of electronics and instrumentation firms in the Boston area. Almost half of the MIT-related firms in the state maintained contact with the institute, mostly by retaining consultants from MIT and using the institute for professional education and to recruit employees8.

4.3.3 KBIs: making the connection to enterprise

Recognising the powerful connection between KBIs and enterprise, leaders in our study areas worked to build entrepreneurship. They also sought to exploit the relationships between KBIs and companies by connecting people to opportunities. San Diego provided some good examples of efforts to facilitate connections between KBIs and enterprise.

In 1985 UCSD started the now famous CONNECT programme to foster University-Industry cooperation and to promote the growth of high-technology entrepreneurship. It now operates independently of the University and receives its income from membership fees, events income and grants. It sees itself as an ‘incubator without walls’ providing training for high-technology CEOs and entrepreneurs. It provides newsletters, operates a TV show and organises a number of activities designed to support entrepreneurship (e.g. Meet the Researchers, Technology Financial Forum, Corporate Partnership Forum and Most Innovative Products Award).

UCSD’s Corporate Affiliates Programme (CAPS) is another example of an innovative initiative designed to forge partnerships with industry and fuel the region’s economy. The programme involves a very active role for affiliates including annual research reviews of their current work, poster sessions by graduate students, and displays by CAP member companies. This frequently results in some form of collaborative research project and CAP members contribute to the future research strategy and educational directions of the University.

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7 See Porter’s family tree.
4.4 Technology, technology transfer, and intellectual property

Considerable attention has been paid to the issue of IP developed by KBIs and its commercialisation. Technology-based companies were seen as crucial elements in the technology transfer process in that they could embrace new technologies that had the potential to render existing technologies in established firms obsolete. Moreover, because of their propensity to locate near to the parent institution from which the technology originates, spin-outs played an important role in supporting local innovation, particularly in industries well placed to exploit new technology platforms emerging from the local science base. Yet how this should happen, and the role of KBIs in technology ownership, is an area of some debate.

4.4.1 Different approaches to IP

Different rules and practices govern ownership of intellectual property in the US and the UK. In the US, federal policies on IP are drivers, through rules governing federally funded research. Throughout the 1970s, the Federal government retained rights to IP for all the research it funded, although it seldom enforced those rights. The concern that publicly-funded research was not being commercialised led to the passage in 1984 of the Bayh-Dole amendment, which transferred the IP rights of the Federal government to the universities in which the research was undertaken. The consequence is that, today, in most US universities, the university has rights to IP developed using its facilities.

In the UK there has been no national legislation comparable to Bayh-Dole, and historical practices prevail with respect to IP. These vary across the different universities and research institutes. For example, at the University of Cambridge, IP generated by externally funded research, (Research Councils and Charities, except where the University has agreed otherwise) is owned by the University; however, this is not the case for IP generated by Higher Education Funding Council for England (HEFCE) funds or income from other sources such as Cambridge’s endowment fund. All IP created by employees in the normal course of their employment, including that covered by the 1977 and 1988 Patents Act, is not therefore covered.

By way of contrast, the University of Cranfield in the UK differentiated IP ownership on another basis. If the university contracted with a life-science company to do research and development work on its behalf, the university owned the resulting IP. However, if the university contracted with an engineering firm with which the university had a long-standing relationship, the firm kept ownership of the resulting IP.

4.4.2 Licences versus spinouts

Similarly, the assignment of IP to a company took different forms in the two countries. In the US, commercialisation efforts focus on licensing, an activity that gained momentum after the passage of Bayh-Dole.

MIT’s policy governing the distribution of licensing income and its licensing office, the Technology Licensing Office (TLO), were often cited as US models. MIT retained outside patent attorneys to manage the patenting process. The TLO licenced the patents on MIT-owned inventions to businesses that would develop the technology commercially. The TLO was staffed by people with substantial private sector backgrounds. After recovering costs associated with obtaining a patent, the TLO retained 15 percent of the royalties paid by the licensee. The remaining income was split one third to the inventor, one third to the academic department and one third to MIT’s general fund. The role of MIT licensing staff was not limited to the initial process of negotiating the licence, but also to ensuring that the milestones for bringing the product to market were met by the licensee. If a licensee was not successful, MIT could recover the rights and the licence.

The TLO’s licensing process effectively separated academic research and the development of new technologies from their commercialisation by industry. Scientists shared royalties from their MIT patents, but independent companies, by and large, licensed and developed the technology. The scientist might participate on the company’s scientific advisory board, but the assumption was that the scientist stayed with the University and continued with academic research. University personnel policies supported this separation: MIT prohibited direct company management by its faculty, discouraging participation in companies other than as a consultant or member of a scientific advisory board. The personification of this approach, suggested by several interviewees, was Professor Robert Langer, responsible for over 400 MIT patents. Despite his connections to many companies, the centre of his work remained his lab and students at MIT.

As a policy, the TLO did not make investments in companies that use MIT technology. However, the MIT treasurer’s office, which managed the university’s endowment, did have a venture capital fund that it invested in business start-ups. It made these decisions on a market basis without consideration as to whether the technology came from MIT.

In the UK, the scientist, his or her inventions, and the developing company were often considered as a bundle. In a parallel way, universities and research centres have focused more on spin-out companies, that is, companies started by a university’s academic staff, using university-owned IP, and in which the university retained an equity interest. When the company “spun out,” it often took the academic with it.

1 Because of the mingling of federal and other funds at research institutions, virtually all research is covered by Bayh-Dole.

2 MIT in turn based its practices on those of Stanford University. MIT reorganised the TLO in the 1980s in response to the Bayh-Dole amendment, and MIT hired Stanford’s Technology Licensing person to manage the reorganisation.
Greater commercialisation has been associated with more spin out companies, and policies to encourage this often focused on teaching academics to become entrepreneurs. People we interviewed at several university commercialisation offices noted a dilemma – when a company spun out, the university could lose valuable people. Some commercialisation offices discouraged spinouts involving faculty for this reason. Where universities did receive income from licensing of IP, the rules varied widely even within institutions. Academics at the University of Cambridge could expect to receive between 15 percent and 70 percent depending on the level of net income received by the university; different classes of employees had different rights in their IP and IP from different income streams was treated differently.

4.4.3 Companies, technology transfer and IP

Company founders and managers that we interviewed in both countries raised several kinds of problems related to the commercialisation process. One involved the ownership of the intellectual property by universities; another concerned the actual procedures and processes involved in a company’s securing rights to the IP; a third issue was the price.

Start-up companies in both countries reported that ownership of the IP by a research institution was problematic. Company investors were reluctant to finance ventures where the company did not have secure IP control. A second problem related to the bureaucratic and time-consuming negotiations between the company founders, investors and technology-transfer offices. Again, this was seen as problematic in both countries. Companies noted that technology transfer offices with which they dealt, and MIT was cited as an exception, were staffed with people that lacked business experience, and our interviewees felt that university-owned IP was under-developed and over-valued. An analogy was often made with the IP being a seed that was not worth anything until it had been nurtured and developed into a commercial, income-generating product.

As a consequence, company managers interviewed reported efforts to avoid university-owned IP at the start. As companies grew, those that began based on specific university-owned IP often abandoned it as the company diversified its product line. And companies that used university-owned IP as part of their business strategies did so without regard to the location of the university.

In practice, university-owned IP represented a small proportion of local patents, and spinout companies were a small proportion of the university-related technology companies. For example, MIT was generally acknowledged to be the biggest technology engine around, and its impacts were well documented in the 1997 Bank of Boston study. Yet most patents in Massachusetts are issued to individuals and companies, not to KBIs. In 1999, the patent office issued about 3,600 patents in the state, of which 16 percent went to all of its universities. Another 5 percent went to hospitals. In San Diego, Walshok at UCSD pointed out that very little of the research done at UCSD resulted in specific technology out of the university. Rather, the professor’s role is one of an intellectual hub. The university creates a platform where interactions can take place. In the UK, Hughes (2003) concluded that “spinouts were an important but small and variable part of the overall range of ways in which the industrialisation of scientific advances can occur.”

4.4.4 Connecting IP to place

Yet (perhaps) because of the success of institutions such as MIT in generating and licensing university technology, universities and regional leaders remained interested in this process as an important policy lever. KBIs have some control over intellectual property arrangements, and if they manage the process well, they can generate revenues for the institution.

MIT made no effort to affect the locational decisions of its licensees, but analysis demonstrated that many licensees end up at least within reach of MIT. According to the TLO, about one third of the companies licensing its technology were located within Massachusetts, most in the eastern part of the state. About one third of the licenses went to start-ups, one third to companies with less than 500 employees, and one third to large companies. According to one MIT professor active in the development of biotech IP, there were three types of companies around the university. These were large fully integrated companies that wanted ideas and people; small companies with an MIT license and who needed contact with the inventors to complete the technology transfer; and small companies without MIT licenses who wanted access to people. Thus without explicit local programmes, MIT contributed to local innovation.

North Carolina State took a more pro-active approach. In an effort to increase the odds that commercialisation would occur locally, the technology transfer office of NC State has been very open to commercialising intellectual property by taking an equity position in a local start-up, as opposed to receiving royalty payments. But it also had the flexibility to negotiate lower royalty rates for firms that agreed to commercialise their IP locally (and a penalty clause discouraged out-migration of the enterprise). NC State has also established PATTI (Patenting and Technology Transfer Initiative) that is the first attempt by a University to attract intellectual property donations from firms by offering tax breaks in return. The initiative aimed to tie such donations to a core research strength of the University and PATTI was affiliated with the Centre for Environmentally Responsible Solvents and Processes focused on CO2 technology.
4.5 Facilities and incubation

4.5.1 Incubation

Universities incubated companies using laboratories and formal incubators. New firms requiring specialised equipment and interfacing across disciplines or requiring interdisciplinary research capabilities, such as those in the biotech industry, were more reliant on the presence of universities and research centres than other firms. Even for these firms, however, the connection to the KBI became less important as the company and technology centre matured. Generally, as companies aged, their R&D became more internalised and they established links with a broader range of research institutes, often located outside the region.

Some universities and research institutes in the study areas provided direct support for start-up and early stage companies through incubator facilities that included premises and support services for new ventures. In each of the UK study areas, universities provided formal incubator facilities. For example the St Johns College Innovation Centre in Cambridge provides incubator space and business advice to University spinouts.

The Scottish Microelectronics Centre, and the Edinburgh Technology Transfer Centre are both on the campus of the University of Edinburgh. Luton hosts the Dunstable Innovation Park and in Cambridgeshire there is Babraham Bioconcepts for start-ups and Babraham Bioincubator for companies with between 20 and 50 employees. The Research Triangle Venture Centre is based on the NC State Centennial Campus. The Tufts Cummings School has an on campus incubator.

On the other hand, MIT provided no office space or laboratories to companies, but it did have what it termed a ‘virtual incubator’ facility around its campus, space where entrepreneurs can locate companies and have access to a full range of business support facilities.

4.5.2 Research parks and conventional real estate

KBIs also participated in the conventional real estate market, providing space for growing and mature technology companies. The University Park at MIT developed by Forest City Commercial began in the 1960s with land acquisition by MIT and a recommendation by its treasurer that it consider direct development of this land. MIT assembled the land “to protect its flanks” from adverse development and to anticipate future development of this land. MIT assembled the land “to protect its flanks” from adverse development and to anticipate future development of this land. MIT provided the financing and partnered to develop commercial office space, ultimately leased by MIT researchers and companies such as IBM. MIT sold the property in 1973 and repurchased it in 2001. It is now part of MIT’s investment portfolio, and its major tenant is Novartis, the Swiss pharmaceutical company, which has relocated its corporate research headquarters from Switzerland to Cambridge Mass. Novartis wanted access to scientific talent, and its presence further strengthens Kendall Square ‘as being the epicentre of the biotech world.’

In Worcester; the expectation some twenty years ago was that the development of real estate adjacent to the University of Massachusetts Medical School would attract biomedical research firms, and that manufacturing activity could be co-located in the region, a former heavy manufacturing centre. The Tufts Cummings School of Veterinary Medicine made a more pro-active decision, to link research collaboration with real estate development. Its strategy recognised that as companies develop, their real estate needs change as do the types of collaborative links with the University. In addition to its incubator, the school was developing a biomedical science park to house, among others, firms that outgrow the incubator: Other traditional science parks include the Cambridge Science Park and the Edinburgh Technopole.

4.5.3 Mixed-use developments

More recently, KBIs in both countries have helped in planning or in development of mixed use projects that build in KBI-company interactions. Thus, NCSU has been very pro-active for more than two decades in building research centres involving industry as a substantive partner and over 40 industrially focused centres now host some 300 companies. Its most visionary concept was the Centennial Campus that has become a unique 1,334 acre academic-industry technopole that integrates academic and industrial research facilities, leisure facilities, hotels and conference facilities. Uses in individual buildings were mixed, including, for example, national research operations, classroom, and private company space. The Centennial Campus hosted university operations including the graduate school of engineering as well as more than 70 companies and government agencies with ties to the University. UCSD was planning a new mixed-use science park on 30 acres of land focused very much on research collaboration that will provide premises for both research institutes and companies. The University will provide the ground leases. The development provided no speculative premises and around $6m has been budgeted for infrastructure; funding the infrastructure was seen as the major challenge.
4.6 KBIs and place

4.6.1 Branding

World-class universities and research institutions played key roles in establishing a brand for an area, important in attracting companies, students and prospective employees. Companies valued the association with a brand of excellence and being seen at the centre of an industry with related institutions and renowned companies. As one respondent from Massachusetts put it, "There is a halo effect on companies if they locate near brand-name institutions like Oxford or MIT". The research institution was usually the source of the brand, which was then marketed by local leaders (See Chapter 6). The University of Cambridge, UK is the basis of the Cambridge brand with companies identifying with a desire to have a Cambridge postcode. The University of North Carolina, North Carolina State University and Duke University are the three brand focal points of the Research Triangle. The MIT features heavily in the Cambridge MA brand, and in San Diego, it is San Diego State University, University of California – San Diego, The Salk Institute, and the Scripps Research Institute. Similarly, two universities in Dundee were a good example of how KBIs could establish themselves as being world-class in their fields, and BioDundee is rapidly replacing that of an old declining industrial city based on jute. Notwithstanding this, the universities in Scotland do not appear to play such a strong individual branding role in marking their regions. Rather Scotland as a whole, with its numerous world-class universities, is associated with engineering and scientific excellence, and regional leaders have created Smart Successful Scotland as a broader brand.

4.6.2 Regional partnerships and leadership

Universities and research institutions were often significant regional entities in their own right. In Cambridge MA, the largest employers by far were Harvard and MIT. In Worcester, the largest employer was the University of Massachusetts Medical School. These institutions were key participants in a number of multi-institutional partnerships to advance the development of their regions. Examples in the US included the Massachusetts Technology Collaborative, which included the deans of all the state’s engineering schools; the Massachusetts Biotechnology Initiative, which included the leaders of Worcester Polytechnic Institute, the University of Massachusetts Medical School, and the Tufts Cummings School of Veterinary Medicine; and the Research Triangle Foundation, whose board includes the three research universities which are also the beneficiaries of the foundation. Partnerships in the UK in which universities played key roles include the Dundee Partnership, BioDundee, the Hertfordshire Prosperity Forum, and the Cambridge Partnership.

Finally, the key players in these institutions often provided important leadership in their regions analogous to the leadership that captains of industry provided in the industrial era. Such leaders included Mollie Broad, president of the North Carolina university system; Jim Hunt, former governor of North Carolina; Frank Loew, former dean of the Tufts University School of Veterinary Medicine; Charles Vest, former president of MIT; Alec Broers, former vice chancellor of the University of Cambridge; and Richard Atkinson, former chancellor of the University of California at San Diego. We discuss the issue of regional leadership in more detail in Chapter 7.

4.6.3 Using KBIs to create place

In our study, strategies to create and build places from universities and research centres were in part connected to the nature of the KBI; institutions such as MIT and the University of Cambridge played on the global stage, yet each had a clear local impact. Institutions in both countries assumed a more activist role in local development, but more so in the US than the UK. One reason may be that, in the US, state-based university systems, plus the much longer tradition of academic-industry collaboration, facilitated an activist role by US KBIs compared with those in the UK. UK activism was complicated by the view, widely held until relatively recently, that the science and research base is primarily a national asset supporting the competitiveness and innovation of the business community nationally rather than locally or regionally. Another reason might be the perceptions of the role of KBIs by other local stakeholders, including in particular local and regional policy makers. In the US study areas, there was a greater recognition by university leaders of the mutual benefits to be derived from their engagement in supporting the growth of the local high-technology community. Substantial research funding flowed from industry to a number of universities through sponsored research programmes. Encouraging local innovation through the exploitation of technologies developed in the universities provided a justification for local/regional public sector support. Helping retain highly skilled PhDs in the local economy provided opportunities for ‘reverse’ technology transfer and a source of consulting and collaborative research opportunities. Local economic growth and concomitant population growth generated more demand for student places. Although for the UK case studies some of these benefits were recognised, there is not the same understanding of vested self-interest in the fortunes of the local economy by the local universities and research institutes.

It is also the case that in the UK there were few incentives for the university to encourage commitment and involvement in the local economy and this typically limited technology on how to exploit local economic assets. University budgets in the UK are centrally rather than locally or regionally decided.
Interestingly many UK academics made the point that their promotion and the financial well-being of their institution depended on doing well in the Research Assessment Exercise. This stressed the importance of publishing research in academic journals rather than evidence of applied research endeavour targeted to assist and facilitate local economic development.

However, the growing importance given by policy makers to localised clusters and the ‘technology economy’ in delivering innovation; and the pressures on all regions to improve their competitiveness, has given much more emphasis to the role of universities and research institutes in local and regional innovation systems.

4.7 Lessons

A central message emerged and it was the importance of investing in systemic academic excellence. High quality teaching and research enhanced the reputation of the institution – and the place. It attracted the brightest students, and in turn released them into the region when they had finished their studies. It was essential to engage in the kind of activism that ultimately increased research funding.

It was important to ensure that students had the kind of education that made them flexible, able to take on new and novel problems, and that provided them with the research and laboratory skills appropriate to their field. It was clear that graduates should not have to get basic research training after they finished their studies. (Nor should the KBI have to provide company-specific training as part of its core programme.)

A key goal was to encourage collaboration by the KBI s with companies in their research. This helped to ensure that students had the relevant research and laboratory skills, and broadened the funding base for research. Since most companies did not fund such research in expectation of usable proprietary technology, it was desirable to manage the research in as open a way as possible, in order to maximise the flow of ideas.

It was desirable to take advantage of all the opportunities available to open up the KBI to business since this encouraged many points of contact among companies, faculty and students. These interactions in turn can generate serendipitous results. Ways of managing these interactions have to evolve in a manner that is appropriate to the individual situation. Extending the university’s resources to address the continuing education needs of former graduates and businesses in the region appeared to be one way by which revenue and business contacts could be increased with the KBI.

Maximising the overall commercialisation potential of technology was assisted by KBI s helping their staff to understand how companies use IP and to ensure that IP programmes were designed to optimise commercialisation opportunities, rather than concentrating on the shorter term goal of revenue maximisation for the institution concerned. This is an important area for further research.

Facilitating connections between academics, entrepreneurs, and investors was important in maximising the opportunities for business development. However, this did not mean that KBI s should try to be all things to all people and recruit staff accordingly. The best business advisors, patent attorneys, and other specialists were usually to be found outside the academic institution and it was desirable to find ways of referring people to the best.

KBI s are landed institutions, and it was appropriate for them to use these resources to their, and their regions’, advantage. If this was to be done successfully it required a programmatic approach that reinforced the goals of the institution whilst recognising the requirements of the market.

Finally, KBI s were key players in regions, because of their size, their status as major employers, and their long time horizon. As such, KBI leaders should engage in the kind of civic leadership appropriate to this significant institutional position.
5. Financing the enterprise

5.1 Introduction

The availability and characteristics of financing influenced how technology-based companies developed in a particular area. Different kinds of funding were essential at different stages of technology development, from the germination of an idea in an inventor’s basement or university research lab, to the establishment of a successful line of products. Companies at different stages of development had different financing needs. Finance was also a key component of place-building, from investment in the facilities that allowed universities and research centres to thrive, to the creation of public infrastructure.

The kinds of financing provided in the places we studied related to the area’s prevailing economic development policy. In general, policy makers in high tech centres sought a mix of indigenous technology-based firms, research and development operations, and headquarters functions of large companies. Such policy objectives dictated financing policies focused on meeting the capital needs of start-up and young companies; promoting the commercialisation of new technologies; as well as facilitating the development of appropriate sites for larger companies. This approach to economic development differed from efforts in the 1960s and 1970s to recruit larger companies and to encourage them to make a major investment in a region. Such efforts were associated with financial incentives aimed at lowering the cost of doing business in a particular region. Policy makers had since found that when companies made investments based on costs, it was difficult to hold those companies in place in the face of competition from even lower cost areas.

We found important connections between the availability of financing and a company’s location in an enterprising place. First, high-tech companies did not necessarily relocate from place to place in response to the availability of funds. However, the availability of the right kind of financing made it possible for companies to start, to develop, and to grow past key thresholds, and to thrive in a place. Policy makers in turn tried to ensure that the right kind and mix of financial resources were available. Hence the concern with whether a place has a critical mass of venture capitalists, the invention of “ignition grants” to boost the development of ideas developed in academic labs that are commercial, and the creation of “proof of concept” and related technology development grants.
We saw significant efforts to create appropriate regional financial systems to support emerging and young companies and to ensure that they developed in the home area. We saw concerted local efforts to maximise the flow of generically available financial resources to a particular region; and we saw a proliferation of programmes to match entrepreneurs to ideas and resources.

People we interviewed identified two financing targets associated with the growth and development of high-tech companies. One concerned the development and commercialisation of new technologies. Of particular interest were technologies that originated in research institutions and moved into the business realm. Figure 5.1 illustrates this financing target and the two divergent funding streams that supported it.

Figure 5.1: Financing the development of technology

Respondents identified several key problems. The first involved the availability of funds for very early stage concept development, before traditional venture capital investment took place. Others concerned the need by fledgling companies when they reached critical thresholds. Such thresholds coincided with the exit of venture capitalists, an acquisition of another company, or a need to begin product manufacturing. Each transition, especially if associated with a financing “gap,” presented a place-related risk: that the company would not get off the ground or that the company would relocate to another area. Thus some respondents suggested the need for an ‘escalator’ of funding sources, each laying the base for and feeding into the next.

On the subject of manufacturing, everywhere we heard debate about whether it was worth the effort to try to keep manufacturing in a high tech centre. Yet we heard companies say that they wanted to keep at least the initial stages of manufacturing close to their R&D operations, if they could only make it work financially.

In this Chapter we explore the relationships between finance, the stages of development of ideas and companies, and their connections to place, policy, and sources of technology revealed in our business survey and site interviews. In the survey, we asked companies to describe the role of finance in their businesses and decisions about business location. In our interviews we explored the role of finance in more detail.

Figure 5.2: Development expenditures and company revenues

Respondents identified this movement across the boundary between the research institution and the market as a special problem. One observer characterised this as the ‘valley of death’ for new technologies.

The second and related financing target was high-technology companies themselves. Figure 5.2 below illustrates the range of activities that required financing, many occurring well before the company had positive net revenues to apply to the costs.

13 Adapted from a presentation by Stephen Markham, NCSU Centre for Innovation Management studies, February 10, 2003.
5.2 Summary of survey findings

Companies started where they did without much regard for the availability of finance, whether specialised finance such as VC funding or government grants. However, company managers reported that they considered the availability of financing in subsequent locational decisions. For start-ups, the availability of angel and venture capital finance was the second most important factor in the company's decision to stay where it was (proximity to research institutions to use facilities was first). That is, it kept them in place. Once companies were in production and selling their first product, however, the availability of angel and venture capital finance in a particular place became much less important to their decision to remain there. Targeted government assistance became more important to the decision to remain.

The financing needs of companies in our survey also varied considerably depending on their size and stage of development. For start-ups, owner equity and family and friends were the two most important sources of financing. Other important sources were earning, early stage and technology grants, and venture capital. For young companies, producing and selling their first products, and medium sized companies, the most important sources had shifted to company earnings and owner equity. Young companies and medium sized companies continued to rely on family and friends, loans, including those with small business loan guarantees, and technology grants. Medium sized companies also relied on grants targeted to particular geographic areas.

The following sections describe in more detail the interconnections between finance, company development, place, and policy revealed by the interviews.

5.3 Investing in Institutions and Infrastructure

5.3.1 Overview

In this section we discuss investments in research and academic institutions from regional systems to universities and research centres, as well as infrastructure such as premises, roads, and the like. The chapter focuses on the financial tools, while Chapters 4 and 6 examine the financial targets such as knowledge-based institutions and place-specific infrastructure systems.

5.3.2 Investment in research institutions

The big story was that aggregate investment in research was itself a key to place making, according to almost all people we interviewed. This occurred in two ways. First, the flow of national research money to a place was a key indicator of the potential power of that place and its store of technology. Second, our interviewees cited the role and timing of investment in institutional capital, land and buildings.

Local leaders both tracked the flow of national research funds and sought to influence these flows. To those interested in building biotechnology centres, the National Institutes of Health were the key funds to watch. In its study of US biotech centres (Cortright and Mayer 2002), the Brookings Institution found National Institutes of Health fund flows to be a key measure of the strength of biotechnology centres in the US. Leaders in each of the US study areas both quoted the Brookings study and used NIH flows in benchmarking their regions against others nationwide. They also pursued strategies to maximise this flow. (See Chapter 4, Creating the Innovation Network.)

When asked to account for the growth of the Boston region after 1990, when analysts such as Saxenian (1994) and Castells and Hall (1994) were writing of the region as a technology has-been, one interviewee suggested looking at another investment indicator: institutional investment. He pointed out that if one looked at the cycles of building construction in the area over time, commercial construction had responded to economic cycles. Investment in public educational facilities also followed economic cycles, since they were related to state sales and income tax revenues. However, private institutional construction at the Boston hospitals, medical schools, Harvard, MIT, and related institutions, had increased steadily through
massachusetts kept this "teenaged company" in the state and helped it finance a pilot manufacturing plant there. bonds financed public education improvements in north carolina. in durham north carolina, the city and county issued bonds to finance structured parking associated with the conversion of a former american tobacco plant to a mixed-use project designed to appeal to high-technology workers in the triangle. in the uk, the university of hertfordshire has expanded its campus by building a mixed-use commercial, residential, and sports-related complex. the university has financed the development through asset sales and reserves and a bond that repaid by development revenues. public-purpose bonds have also been used to finance much larger infrastructure projects, especially in massachusetts. projects include the state's share of boston's central artery/third harbour tunnel project, the cleanup of boston harbour, and renovations at logan airport.

we suggest that the area of innovative bond financing is one for further exploration.

5.4 investing in ideas and technology

This section covers investments intended to advance the development of marketable technologies. this includes investment in ideas before there are companies, as well as awards made to companies to facilitate technology development. as noted in the introduction, there were inherent difficulties in funding concept development. company executives we interviewed praised technology grants made to companies, including small business innovation research (sbir) grants in the us and SMART and SPUR grants in the uk, and others reported wide use of these grants by start-ups and other companies. one interviewee in worcester noted that SBIRs are the biggest economic engine around, and a company founder reported that the "SBIR grant kept the company alive."

5.4.1 university-based proof of concept financing

One funding stream involved investment in ideas that had commercial value but that were too embryonic for companies to use. generally known as "proof of concept" funding, such investment was identified as important to expand the pool of new ideas and technologies that may have further commercialisation potential. the funding was a mechanism for getting ideas off the shelves and into the market, even if many were later found not to be viable. it was intended to help research institutes to export their ideas and inventions from the lab to the global marketplace and to support the development of early stage ideas, which have reached patent level. some interviewees argued that small amounts should be
MIT created the Deshpande Centre in the School of Engineering in 2002 to address the gap in getting research from engineering labs to the marketplace.

**MIT’s Deshpande Centre**

**Origins & Aims:** MIT’s Deshpande Centre was launched with a private gift of $20 million from the founder of a major electronics company. A three-person “steering committee” guides the operation supported by a small professional staff. The centre identifies and provides grants to promising technologies that could benefit from “proof-of-concept” funding. The centre supports research that crosses the boundaries of chemistry, biology, and engineering. The Centre’s director is an MIT graduate who started and sold several companies.

**How it operates:** The Deshpande Centre has introduced a proof-of-concept funding programme, called the “Ignition Grants” as well as follow-on funds for product development. These programmes support the development of specific technologies and their movement toward commercial markets. However, while funding specific research to market initiatives is a significant part of the centre’s programme, it is seen by some as less important than the centre’s efforts to connect the venture capital market with the research community. The centre provides “structured networking,” for MIT graduate students; it sponsors events that showcase MIT technology, and it sponsors other events focused on technology but on “market opportunity.” These activities provide participants with access to the perspectives of players from other sectors (windows) and forums through which individuals can meet each other to discuss specific mutual interests.

The Edinburgh Technology Fund in Scotland has a comparable mission.

**Edinburgh Technology Fund**

**Origin and aims:** The Edinburgh Technology Fund (ETF) was established in 1999 by a consortium comprising the University of Edinburgh, The Moredun Foundation, The Roslin Institute, The UK Astronomy Technology Centre, and the Edinburgh station of the British Geological Survey. It was set up to address a gap in funding for demonstrating the commercial value of university research discoveries. The fund received a total of £3.75 million from the University Challenge Fund, the University of Edinburgh, Lothian and Edinburgh Enterprise Ltd., City of Edinburgh Council and Midlothian Council. The funds support the development of new commercial initiatives by universities, bringing them to the point where the venture capital market would take them up. How it operates: Consortium members submit proposals to the ETF on ways to improve the commercial prospects of relevant projects. There are three levels of funding available. The first phase involves relatively limited amounts of funding (£5,000 - £10,000), with greater amounts available in phase 2 and 3. The closer a project is to commercialisation, the greater the level of matching funding the project sponsors are expected to contribute. This is aimed at highlighting the need for commitment to the development and exploitation of the project. All awards made by ETF obligate the consortium members to actively pursue exploitation and to return to ETF a share of its commercial income, with levels of return being set down on a case-by-case basis.

Edison-based, proof of concept funds in the UK were criticised for often only being available to university-based researchers, start-ups and spinouts. And, as a result, many interviewees suggested that similar funding initiatives be made available to corporate and other non-academic start-ups and spinouts. Another criticism was that many interviewees felt that the proof of concept funds were being seen as research grants rather than commercialisation tools. This resulted in them being over-subscribed and many commercially relevant ideas not being funded.

**5.4.2 Technology grants to companies**

Technology grants were widely used and identified as significant sources of capital for new companies. The primary programmes were SBIR, SMART, and SPUR grants.

**Small Business Innovation Research Grants (SBIR Grants)**

**Origin and aims:** SBIR/SBTT is the largest source of early-stage technology financing in the U.S. The programme is designed to stimulate technological innovation, increase private sector commercialisation of federal R&D, increase small business participation in federally funded R&D and to foster participation by minority and disadvantaged firms in technological innovation. Federal agencies with extramural R&D budgets over $100 million are required to administer SBIR programmes using an annual set-aside of 2.5%. Total Federal funding in FY 2003 was $1.6 billion. In 2003 the main contributing departments to the SBIR/STTR programmes were the Department of Defence (47.6%), NASA (7%), Department of Energy (6%), National Science Foundation (4.9%) and the Department of Health & Human Services (3.1%). Through 2003 over $10 billion had been awarded by the SBIR programme to various small businesses.

**How it operates:** The programme targets US for profit firms that have 500 or fewer employees. Companies apply first for a six-month Phase I award of up to $100,000 to test the scientific, technical, and commercial merit and feasibility of a particular concept. If Phase I proves successful, the company may be invited to apply for a two-year Phase II award of up to $750,000 to further develop the concept, usually to the prototype stage. Proposals are judged competitively on the basis of scientific, technical, and commercial merit. Following completion of Phase II, small companies are expected to obtain funding from the private sector and/or non-SBIR/SBTT government sources (in “Phase III”) to develop the concept into a product for sale in private sector and/or military markets. During Phase I, a minimum of 2/3 of the effort must be performed by the proposing firm, a minimum of 1/2 of the effort in Phase II, and the Principal Investigator must spend more than 1/2 of the time employed by the proposing firm. Every year each contributing department identifies research topics. For example, the Department of the Energy’s annual solicitation contains topics in technical areas such as basic energy sciences, biological and environmental research, high energy and nuclear physics, fusion energy sciences, advanced scientific and computational research, energy efficiency and renewable energy, nuclear energy, fossil energy, environmental management, and non-proliferation and national security. The intellectual property generated through the use of the SBIR funds usually rests with the applicant company with the government department having a royalty free licence to use the IP. Publication of the research results can only be done with permission from the sponsoring department.

Note: SBTT is an acronym for Small Business Technology Transfer.
SMART: SCOTLAND awards were viewed very positively as an important source of early stage funding. Interviewees said the awards forced young entrepreneurs to be professional; they gave credibility to entrepreneurs; and they were relatively flexible. Because the awards were allocated on a match basis, private-sector parties were responsible for doing the necessary due diligence. This permitted the allocation of funds on a simple and non-bureaucratic basis. Notwithstanding this, some interviewee’s criticised early-stage funds such as the Smart Awards based on the difficulty many early-stage entrepreneurs had in securing matching funds. Furthermore, some interviewees stated that the awards were not integrated with other early-stage funding initiatives and the funding cycles/deadlines created problems. Lastly, it was felt that the funds concentrated too heavily on the development of the technology and not enough funding was allocated to market research and the development of the company itself.

SPUR Grants

Origin and aims: SPUR is an R&D support scheme whose aim is to help small and medium-sized businesses improve their competitiveness by developing new products and processes to the benefit of the national economy.

How it operates: The scheme provides grants on a discretionary, non-competitive basis for development up to pre-production prototype stage of a new product or process that involves a significant technological advance. Companies with less than 250 employees that have either an annual turnover not exceeding EURO 40 million or a balance sheet not exceeding EURO 27 million are eligible for the award. A fixed grant level of 35% of eligible costs, up to a maximum grant of €150,000 may be offered in arrears to projects of between six months and three years in duration, which involve eligible projects costs of at least €75,000. Applications can be submitted, and are appraised, on an on-going basis. Inter alia, applicants need to show that the proposed project will:
1. Represent a significant technological advance for the UK industry or sector concerned.
2. Significant technical risks are associated with the project.
3. The applicant owns, or has the rights to exploit, the intellectual property needed to undertake the project, the applicant will own all intellectual property arising from projects supported by SMART: SCOTLAND.
4. The commercial prospects for the end product or process are good.
5. Realistic and effective routes have been identified for realising the commercial potential for the product or process.
6. The necessary management and technical expertise and resources are in place to complete the project.
7. Both the project and the business are financially viable.

SPURPLUS Grants

Origin and aims: In addition to SPUR, a limited number of SPURPLUS grants of up to £500,000 at 35% of eligible costs are available to support the development up to pre-production prototype stage of world-beating products and processes that demand particularly expensive leading edge technology.

How it operates: Companies must have less than 250 employees and projects must cost at least £1 million and be between 6 months and 3 years in duration. SPURPLUS applications are adjudicated using the same criteria as those used to adjudicate SMART awards and SPUR grants. Neither SMART awards nor SPUR and SPURPLUS grants can be used to fund defence-related research.

SPUR and SPURPLUS R&D grants encouraged existing companies to enhance their products and processes through innovation and have helped to facilitate the formation of new leading edge businesses. According to interviewees in Scotland, the programmes have been particularly effective in encouraging commercialisation of Scotland’s science base.
5.5 Investing in company development

5.5.1 Overview

In addition to using the technology grants discussed above, executives of early stage companies we interviewed patched together financing from an assortment of other sources: loans from family and friends as well as their in-kind contributions. As the president of a five year-old biotech start up in Massachusetts noted: “I married well: one brother-in-law renovates labs, and the other is a [local] realtor.”

Angel funds were important and positively regarded. Entrepreneurs saw angel investors as knowledgeable about the technology and more aligned with the entrepreneur than venture capitalists. VC funds were controversial. Some entrepreneurs didn’t like them, and one we interviewed described counselling he had received from a mentor about the impact VC funds were likely to have on him and his company, preparing him for the loss of control. When entrepreneurs could, they avoided taking this money. If the company had a source of revenue, it was able to avoid taking VC money. For example, some entrepreneurs used their equipment to do contract manufacturing for other companies while they undertook their own product development. In other cases, the company was able to produce and sell early products, although not in volume.

Those who accepted VC financing reported that it caused the company to grow faster than it would have otherwise, in some cases too fast, encouraging a company to enter a new market that it then could not serve. It then had to withdraw from that market and contract.

The exit strategies used by VCs had place-related implications, especially if it resulted in the acquisition of the company. The acquiring company might or might not leave the core company in place. In some cases, the acquiring company was buying the intellectual property, and the company needed to maintain close contact with the inventors to complete the technology transfer process. In this case, the company might remain in place. In other cases, companies were acquiring marketing, distribution, clinical trial, or manufacturing capacity. The result could be a company that remained relatively small but had multiple locations.

Meanwhile, none of the medium sized companies we interviewed, except those that had resulted from the acquisition of several firms, had developed without resorting to VC funding in their start up phase. “Constraints on growth are capital, capital, capital,” said a young San Diego biotech entrepreneur.

5.5.2 Angel and venture capital funds

Angel and venture capital investors helped grow companies in numerous ways. They helped them take products to market, both by providing capital and by acting as mentors at both a technical and business level, placing experienced business people on to the company board and appointing experienced, external CEO’s.

The angel and venture capital investors that we interviewed consistently reported the importance of being located in a particular area and near their investments. As one venture capitalist said, you need to be near investee companies to “grow the child.” “Near” in another case meant being able to visit investees three times per week. This was necessary because technology-based activity was complicated and developed at a rapid pace. Communication between investors and entrepreneurs was seen as critical. In addition, focusing investment in a geographical area allowed these investors to see opportunities early on. That is, they relied on the local network as a source of information. Similarly, they often invested in a particular person “who can expand and develop the technology or idea”, rather than a product, and they wanted to know who they were investing in and be able to “keep an eye” on them. Furthermore, most investors wanted to have regular formal and informal input into the running of the business and therefore needed to be close enough to attend board meetings, etc.

Because the technology was often complex, entrepreneurs needed face-to-face interactions for them to sell their idea and for investors to understand them. To help investors understand the technology, they often relied on technical experts to advise them. These advisors came from local research institutions and businesses. Investors also favoured having a management team assist the entrepreneur to develop the technology and company. Investors reported that finding such management expertise was very difficult, making it important for the investor to know and have contact with the local management pool. Similarly, investors said that trusting and having an on-going relationship with the local business support services (legal, accounting), greatly assisted in the successful development of a young business. Finally, many venture capitalists wanted to tap into the local angel networks to get access to potential investments. Having a local presence and face-to-face interaction greatly facilitated this.

Thus investors, as a general rule, tended to invest in proximate geographical regions. However, the decision-makers we interviewed pointed out that in places with perceived limited deal flows, and in times of economic slow-downs, investors looked beyond their immediate areas to fund appropriate ventures. When these investors did venture further a field, they usually entered into syndicates with investors from that region so they could still achieve proximity benefits. Our interviewees noted that having a ‘local’ presence was not so much defined in terms of geography as in accessibility. A high proportion of the
Scottish investors pointed out that it was easier for them to strike a deal in London, which is only an hour away by plane, than, for example, in Aberdeen.

Our interviewees noted that places that attracted retired CEO’s and serial entrepreneurs often became good pools of venture capital and angel funding, and that quality of life factors played a strong role in attracting such people. Thus places with good environments, such as San Diego as an example, often had a disproportionate supply of angel funding. Similarly, as one interviewee said: “Seattle has Microsoft, which created 250 millionaires. Now they are venture capitalists.”

Meanwhile, venture capital is increasingly made-up of formally constituted companies that invest and manage funds pooled from institutional investors, the banking sector, universities and even the public sector. The objective is generally to invest in above risk companies with high growth potential that will provide returns in excess of 30 percent.

The establishment of critical mass of investors appears to be very important for two main reasons. The first is that if there are a limited number of angel and venture capital investors, they tend to be thinly spread across technology types and cannot specialise in any one sector or technology. This can result in a poor understanding of the market and the technology which in tum can result in poor investments and consequently greater risk aversion. Secondly, having a limited number of investors may mean having a limited number of ‘lead investors’. If companies cannot secure a deal with one of these ‘lead investors’, it is very difficult for them to convince lesser investors to invest in their company. These are the reasons interviewees cited constrained angel and venture capital investment in Scotland.

Venture capitalists in the UK also complained about the limited investment opportunities and lack of ‘deal flow’. Similarly, the lack of exit opportunities in the form of a company buy-out or a public listing was often highlighted as a problem. Conversely, a US policy maker with a background in business pointed out that an advantage of having a mix of large and small companies in the Boston area was that the exit of venture capitalists did not mean companies had to move. “We don’t want our hatchlings taken away.”

Another issue identified by companies in both countries, but more so in the UK, was the entry level of many venture capitalists. Venture capital investment was high risk because it was in an information poor environment involving new ideas and technologies with long time horizons in untested markets. As a result, the screening and selection of deals is an intensive and expensive process and post-investment monitoring and supervision was required. It was therefore often not viable for investors to invest small sums of money into a company. In the UK, the entry level appeared to be between £2,000,000 and £5,000,000, although some venture capitalists did indicate that they would invest less initially provided the total investment eventually reached this level. Another reason for the low level of early stage investment by venture capitalists was the fact that the recent drop in the valuation of companies meant that it was now easier to invest in the second and third round of company funding. This reduced the risk but not necessarily the return and consequently investors were choosing to invest in the latter stages of a company’s development.

Growing companies often needed to raise substantial funds beyond that provided by venture capitalists, and the public markets were an important source of new capital. This also provides an exit point for venture capitalists. In the US, the NASDAQ was a key market for technology stocks, however, interviewees pointed out that the lack of a public market for technology stocks in the UK constrained the use of the initial public stock offering (IPO) as an exit strategy there. The ‘TT Bust’ at the end of the 1990s cooled investor enthusiasm for high-tech companies in the UK, and markets such as the Alternative Investment Market (AIM) in the UK do not play the same role as NASDAQ does in the US. Furthermore, many interviewees stated that the capital markets in the UK were undervaluing technology-based companies and thus limiting the ability of companies to raise capital through these markets. The alternative exit strategy for venture capitalists with investments in UK firms was for the firm to be acquired at this point, often by out-of-country firms inclined to relocate the operation elsewhere.

5.5.3 Creating local venture funds

Policy makers in each country created regional venture funds for several reasons. One was the lack of a venture capital community in a particular area. The other was that the threshold for deals was too high to meet the needs of local companies. For example, in 1978 the Massachusetts legislature created the Massachusetts Technology Development Corporation, a public purpose venture capital fund, to address what was at that time a capital gap for start-up operations and early stage technology companies. The fund was capitalised with state bonds but is now self-supporting.

Some UK policy makers have identified the high entry level for venture capital investment as a policy problem, and focused on the ‘gap’ in early-stage funding for companies who need between £250,000 and £2,000,000. In response to this, a number of public venture funds have been, and continue to be established. For example, Scottish Enterprise established Scottish Equity Partners and then later privatised it, while some English RDAs have recently established such funds in the English regions.
Scottish Enterprise has sought to overcome the shortage of capital by establishing joint investment funds such as the Scottish Co-Investment Fund with angel investors and private venture capitalists. Similarly, many banking institutions invest in high technology through venture capital funds such as East Scotland Investments.

**The Scottish Co-Investment Fund**

**Origin and aims:** The Scottish Co-Investment Fund (SCF) is a £20m fund recently launched by Scottish Enterprise and financed by the Scottish Executive to increase the amount of risk money invested in start-up and early stage ambitious Scottish companies.

**How it operates:** The Scottish Co-Investment Fund invests in partnership with private sector investors - venture capital funds, business angels and business angel syndicates. The fund can invest up to £500,000 in a single deal. The private sector partner finds the investment opportunity, negotiates the investment deal and offers to invest their own equity cash. If the opportunity needs more money than the private sector partner can provide, the partner can call on the Scottish Co-Investment Fund to participate, on equal terms, with the SCF becoming part of the investment syndicate. In 2003/04 the Scottish Co-Investment Fund will conclude arrangements with approximately 15 private sector investment partners and invest £6m in 25 companies.

Doran and Bannock (2000) have highlighted many of the issues surrounding public venture capital funds in the US, and our discussions with venture capital firms raised similar pertinent points regarding such funds in the UK. To begin with they are driven by local economic development objectives and therefore are regionally based. This constrains the company in terms of accessing profitable deals outside of the region. Secondly, it is often difficult to attract and retain competent staff because they cannot offer the same remuneration packages and career prospects as the private sector. Lastly, there is an inherent contradiction with public venture capital firms. On the one hand, the company is expected to be commercially viable and yet on the other hand it is expected to invest in deals that private venture capitalists are not prepared to invest in.

5.5.4 Brokers: Improving access to financing

In every study area we found organisations focused on connecting entrepreneurs, investor, and investors. A number of people engaged in this kind of activity described themselves as “brokers.” For some organisations, brokering these connections was its central mission. The Centre for Entrepreneurial Development in North Carolina was undertaking entrepreneurship education. It was running forums at which investors could meet inventors and entrepreneurs, and it offered forums for investors alone on various topics of interest, for example, a new direction in technology development. CONNECT in San Diego was a 650 strong membership organisation that also offered entrepreneurship education and investor, inventor and entrepreneur forums. An interviewee observed that the key to the early success of CONNECT was that the early entrepreneurs and service providers had connections outside the region, and CONNECT was effective at bringing investors to the region by showing them good technology and deal flow. CONNECT Scotland was a replication of the San Diego CONNECT programme, begun at the University of Edinburgh but now an independent organisation. Hertfordshire Business Link assists small and medium sized companies in getting finance through an angel brokerage programme and a “fit for business” programme that helped businesses to become investor-ready.

Other organisations performed this broker function as a complement to other core activities. Incubators, such as the Massachusetts Biomedical Initiatives (MBI) brought venture capital investors to Worcester to make connections with start-up and young companies there. The North Carolina Biotechnology Centre itself provided early stage financing to biotech companies, and it worked with angel and V.C. networks to help companies get the next stage of financing. The San Diego Regional Technology Alliance helped would-be entrepreneurs and technology companies to win federal grant awards, and it also put these companies in touch with investors, sometimes through CONNECT and sometimes independently. As part of its mission to promote the development of commercialisable technology, MIT’s Deshpande Centre sponsored events that showcased this technology to investors, among others. We found deal brokers that worked quite closely with investor networks, for example, LINC Scotland, which defined itself as a deal broker for angel investors. Finally, university commercialisation offices also maintained links to investors interested in university-owned technology.

5.5.5 Maximising the use of available programmes

In the US particularly, we found local leaders seeking to maximise the flow of financial resources to their regions. Previously, we discussed such efforts with respect to federal research funds. But we also saw such activity with respect to other kinds of nationally available resources. For example, interviewees in San Diego reported with pride that it was the largest centre in the nation for Small Business Administration loans. In a parallel fashion, the Massachusetts Development Agency’s annual goal is to ensure that the state uses its entire allocation of industrial revenue bonds.14

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14 Each state receives an annual allocation of authority to issue industrial revenue bonds. Within the state, this authority is distributed to different bond-issuing entities. In the case of MassDevelopment, if other entities issue less than their allocation, MassDevelopment steps in to make up the shortfall.
5.6 Lessons: using finance to support place

Our exploration of the relationships among finance, the stages of development of ideas and companies, and their connections to place, policy, and sources of technology suggests the following lessons for sustaining enterprising places:

• Invest in systemic academic excellence. High quality teaching and research enhanced the reputation of the institution – and the place. It attracted the brightest students, and in turn released these into the region when they finished their studies. Engage in the kind of activism that will increase research funding.
• Investment in institutional assets was an important investment in place. Maximise the use of these assets in the community.
• Invest in the development of embryonic ideas. However, to ensure that the market picks the winners, consider investing in collaboration with business.
• Pay attention to what works. For example, technology grants such as SBIRs in the US and the SMART and SPUR awards in the UK received high praise from companies and were heavily used.
• Venture capital funding was critical to move companies beyond certain thresholds. However, we did not explore this topic in sufficient detail to make specific recommendations, and there was considerable debate over public entry into this domain. This is an area to explore.
• Maximise the use of currently available financing programmes by making sure companies are aware of and have access to them.
• Pay attention to companies at key junctures beyond the start-up and design appropriate financing programmes. One such juncture is when a company begins pilot manufacturing. Track company development to facilitate retention at key junctures.
• Explore the use of bonds as financing tools. This is one area where the US has useful experience.
• Invest in infrastructure and engage in the kind of activism that will bring the necessary infrastructure to the region.
6. Creating places

6.1 Introduction: issues and players

Companies look for locations that will provide them with key inputs, whether these are human resources and premises or access to knowledge-based institutions. Thus, as section three showed, three things mattered the most when a company decided to locate in a particular place. These were the location of the company’s roots; the availability of appropriate premises and infrastructure; and the quality and availability of the existing workforce. Workforce-related factors were the most important in holding companies in place.

For start-ups, the roots were social and environmental: where did the founders live, where did they have networks and contacts, what was the quality of the residential environment and social and cultural amenities? Roots of medium-sized companies were more operational and thus where did existing employees live?

The availability of the right premises and infrastructure followed roots in importance to start-ups, and it was even more important to companies in the next stages of growth. Start-ups valued low-cost space. Young companies narrowed their sights to premises and infrastructure: factors that facilitate production.

Specific factors included the cost and suitability of space, transportation, parking, and communications infrastructure. For companies that had crossed the start-up threshold and had established manufacturing and sales operations (but remained “medium sized”), these premises-related factors became even more important and another factor - availability of facilities for manufacturing - rose in importance. The quality and availability of the local workforce was of some importance to start-ups and medium-sized companies as they made their initial decisions to locate in a particular place, but as companies began to produce and sell their first product they tended to bunker down and to address immediate operational issues before re-focusing on company growth.

Workforce-related issues were the predominant factors holding companies in a place. Young and medium-sized companies faced workforce-related issues. These companies were in competition with other similar companies with similar needs, especially as it related to IT and marketing and sales personnel, who they said were in short supply at the time of the survey. Bringing workers from other areas to their home was problematic because of the high cost of housing, and wages in these areas also tended to be high.

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15 Definition of startup; invention and proof of concept stage, prototype product/service.
16 Definition of medium-sized company; established manufacture and sale of product/service.
17 Definition of young company production and sale of first product/service.
The quality of the place was based on a judgment about how well it was able to meet the ongoing needs of the technology-based companies. As these needs changed, then what the place provided has to adapt or risk becoming a relatively uncompetitive location for the companies concerned. Successful places in this respect are therefore those that were able to accommodate change in a timely fashion.

In this section we are concerned to examine what the evidence from the research suggested was important in enabling places to adjust to meet the needs of technology-based companies. The ability of the place to adjust its resource base in a mixed economy depends on policy actions by both the market and the public sector. This section is concerned to assess in the case study areas the strategies that were employed by the relevant agents to:

- provide physical place and infrastructure
- provide appropriate premises and facilities
- provide social and professional place and thus to develop environments that were attractive to technology workers and potential entrepreneurs through the development of the workforce; the fostering of networks and contacts; and the attraction of an entrepreneurial base
- brand and market the place.

Places vary according to a number of physical, economic and social characteristics that affect the ease with which they can adjust to meet the needs of technology-based companies and their employees. They differ in terms of their relative accessibility and thus how well they are connected with other places. There will also be differences in the quantity and quality of services that they can offer to businesses and residents, reflecting where they are in the settlement hierarchy. And the economic legacy of the place is clearly formative in determining the nature of the existing human resource base, the land and premises stock and thus the ease with which it can be switched to new uses. The quality and quantity of the housing stock and the availability of good quality services including education and health will affect the attractiveness of the place to inward businesses and their workforces.

### 6.2 Physical place and infrastructure; making liveable places

The quality of the residential environment was a key issue in attracting skilled people to an area. This has been the subject of much study (Castells and Hall (1994), Castells (2001), Florida (2002), Salvesen and Renski (2002). The in-depth interviews with leading companies in the study areas provided further insight as to what contributed to a high quality environment. The respondents listed a number of features. These included short travel times; low congestion levels; affordable house prices; the quality of local schools and social facilities; the quality of the cultural facilities, including nightlife, shopping, the design and appearance of a place; and the presence of peers and colleagues. All of these features were seen to contribute towards the making of a high quality environment. On the other side, stresses on the physical characteristics of successful centres were important liveability constraints. These included traffic congestion and the high cost of housing, both of which interfered with the recruitment of new employees.

The company executives surveyed said that the cost of housing within the locality was the most important barrier to recruitment (ranked 1st). Analysis by study area indicated that this was particularly true in Cambridge UK, San Diego, and Massachusetts, but much less of a concern in Scotland (ranked 7th). The larger, more mature technology-based companies, were often able to compensate their employees for the high house prices through higher wages. However, start-ups and companies employing large numbers of lower paid technicians were in less of a position to do so. Similarly, people in support sectors such as education, health and entertainment, which contribute significantly to the quality of life of technology-based employees, could not afford to pay the high house prices and rentals often associated with technology-based centres. This undermined the quality of the services that could be provided in these areas and consequently threatened the quality of the environment necessary to attract the high-tech skills and people to drive the growth of these high-tech centres.

As places matured, problems associated with commuting increased and this was particularly so in places like Massachusetts and North Carolina. Road and rail infrastructure was seen as a critical locational requirement for companies. From the interviews, many companies stated that their workforce catchment area was not determined by distance but by the ease and time taken for their employees to get to work. Considering the importance to a company of being able to recruit the right employees, commuting and congestion problems were seen to be real problems in San Diego and Cambridgeshire, and a growing problem in Scotland. Companies needed to interface with each other in terms of everyday business activities and therefore employees had to be able to travel within a technology centre with relative ease. In addition, many technology-based companies operated in niche markets that were global by nature and therefore there was a need not only to be able to get to national and international airports easily but for these airports to provide direct and regular flights to key global locations. The lack of direct international flights from nearby airports was an issue raised by respondents from both Cambridgeshire and Scotland.

The survey and the in-depth interviews both highlighted the importance of communication infrastructure – electronic and physical in developing a technology-based centre.
Telecommunications and access to broadband in particular were regularly raised as problematic in Scotland and Cambridgeshire, compared to the US case study areas. This infrastructure was available in the main centres of these regions but was often insufficient in the outlying areas. This forced many companies to locate in these centres, which put pressure on the existing infrastructure, generated congestion problems and had an inflationary price effect. We should also mention that companies were often concerned about the adequacy of water provision and specialised facilities to handle hazardous products in some cases (e.g., radioactive substances).

Overall, from the survey and interview results, the provision of land and hard and soft infrastructure were deemed crucial for the development of technology-based centres. The problems that arise and the constraints on achieving coordinated policy actions were common to both UK and the US. But there were often significant differences in the type of response that was possible at both the local and the regional level. We examine these in further detail in the next chapter, given the number of players that had to be involved and the complexity of the interactions that arose.

The changes required across the settlement pattern of an area, including those to its built environment, encompassed a range of land use and planning considerations. There was also the need to install new infrastructure, and the ability to finance this at least partly from local resources was central to success. There needed to be sufficient resource levers to bring about the changes required. A lack of flexibility in this respect characterised the system in the UK compared with that of the US. A lack of buoyancy in the local tax base and a heavy reliance on central government for the funding of key infrastructure had even led some areas in the UK to resist accommodating the growth of technology-based activity in their area.

### 6.3 Providing premises and more

The notion that sheer proximity to a research centre would be sufficient to enable businesses to benefit from technology-based spillover effects was misplaced. Many research parks founded on this misconception have learned the relatively hard way that such spillovers do not necessarily occur and that the market may not be sufficiently developed to allow for the real estate activity to stand alone as a profitable venture. Another popular vehicle in the real estate industry has been the creation of a science park with, again, the view that the product label would be sufficient to lure in companies attracted by technology-based market opportunities. The developer took the real estate risk and offered multi-tenanted space. An example of this approach is the Massachusetts Biotech Park.

In advanced centres, land in proximity to universities was at a premium—the market was developed, and there has been an opportunity for institutions and private developers that understand this market to take advantage of this. Examples include the MIT’s Technology Square and the Cambridge Science Park. The Science Park concept reinforced the place but not necessarily at a financial cost to the technology-based institution, although a variety of models were possible. Experience of Science Park developments reinforced the need to take things slowly and to be able to respond to the needs of the market. A classic example of this was the Cambridge Science Park where because the principal landowner was a Cambridge college it was possible to adopt a longer-term view in relation to economic return. Moreover, the design, marketing, and development of Science Parks have to be customised to the specific context. There was no generic model that will work automatically in all locations.

Following on from the Science Park itself has been the promotion of incubators and shared research facilities. Examples included Brabraham Bioscience Technologies, the Massachusetts Biomedical Initiatives in Worcester and NCSU Centennial Park in Raleigh NC. The research services offered can vary considerably. Thus, the Massachusetts Biotechnology Initiative, was formed to support the flow of business to the Massachusetts Biotechnology Research Park in Worcester. The director of its business incubators was a former state legislator, and its board included some of Worcester’s most influential business leaders. In Scotland, the Scottish Microelectronics Centre opened in 2000 and undertook research and development and incubated new companies in the semiconductor industry. It provided wafer fabrication equipment and trained students in fabrication. Research was undertaken through the Institute of Micro and Nano Systems (iMNS) and “allowed companies to get close to the University of Edinburgh’s hot house of ideas.” The University covered the capital and operating costs of the building.

Other examples of the development of incubator units undertaken by universities in collaboration with other parties included the Cranfield Technology Park that provided an example of how local public agencies can coordinate activity with developers and also knowledge-based institutions to meet the needs of technology-based companies. Thus, Mid Bedfordshire Council in partnership with the University built an incubator facility (the University provided the land). This subsequently proved too small and the Council then formed a Partnership with St Modwen Development Ltd who bought the original incubator facility from the Council and struck a partnership agreement with the University. Planning obligations meant that the development had to commit £1.5 million the construction of off-site roads. The ‘Park’ had a close relationship with the University’s commercialisation office.
In the Luton and Dunstable Innovation Park, the university was able to secure regeneration funding from central government to develop an incubator in an existing building. The development has subsequently been expanded to embrace other buildings. There are pros and cons relating to incubator developments being on a university campus and managed by universities. One problem in this case was that the university found it difficult to meet the needs of companies, such as enhanced communications, quickly enough. Moreover, interactions with university research staff in fact proved elusive.

In the case of the Babraham Bioscience Technologies, a private company has been set up. It was responsible for the development of a 160 hectare biotechnology research park. Part of the research park will eventually contain an incubator called Bioconcepts and a technical support services company called Babraham Technics. The idea was to get venture capitalists and universities to feed companies and ideas to the incubator that were not quite investor ready. Bioconcepts then assessed the opportunity/idea and determined whether a company should be formed or whether a licensing opportunity should be explored. To overcome the catch-22 situation whereby early-stage funding required demonstration but this, in turn, required early-stage funding, Bioconcepts is developing a “Technology Development Group” with an equipped and financed laboratory to help develop the idea. Furthermore, companies will be able to access technical support services such as libraries, specialist supplies, analytical equipment and laboratory technicians through Babraham Technics, thereby reducing their burn-rate and time to market. Payment for the use of Babraham Technics and the Technology Development Group will be through a credits system that will be allocated to the company initially and paid back later in the form of cash or equity. A key objective of Bioconcepts was to accelerate the concept stage through the use of the Technology Development Group and Babraham Technics. The intention was to reduce the first two years of a seven-year biotechnology product development process to twelve months.

In Scotland, the Alba campus was part of the Alba initiative that began in 1997 and came about as a result of the recognition that Scotland needed to diversify its industrial base. The campus was owned by a private company in which Scottish Enterprise as the Development Agency had a 50 percent share, and the other 50 percent was owned by a development group. This company owned 96 acres. The biggest building was owned by the occupier: The Alba Centre was owned by the company and was located on the campus. It had a lot of short-term space and an incubator facility that was the result of collaboration between four universities.

A further, more recent example, of how the real estate industry was responding to the needs of technology-based industries was provided by the Granta Park development in Cambridgeshire.
6.4 Social and professional place

Building a place that had a positive and dynamic business environment required a number of key elements to come together that included the training of the workforce; the fostering of business networks; and the encouragement of entrepreneurship in its broadest sense.

6.4.1 Human resources

The importance of recruiting the right type of human resources was confirmed in the survey results and the in-depth interviews. In the survey companies in Massachusetts ranked the quality and availability of a local workforce to be of more importance in the decision to locate within an area (ranked 3rd) than Cambridge (ranked 6th) and Scottish companies (ranked 7th). Information technology specialists, marketing & sales personnel and clerical and administrative staff were identified in the overall survey response as being the most important to a company. Both Cambridge and Scottish companies ranked IT specialists as the most important employee in recruitment, whereas Massachusetts and San Diego companies ranked them second after marketing and sales personnel. Interestingly, world class experienced scientists and newly graduated engineers and scientists were ranked relatively low down in importance. In comparison, the in-depth interviews suggested that the ability to employ high quality graduates and attract leading-edge scientists to an area was a key reason for locating there, particularly in Scotland where local graduates could also be employed at a relatively low cost. This feature was mentioned by numerous operational managers as the key factor leading them to establish a presence in Scotland.

To explore these survey findings further and establish the role that human resources played in determining company location, the in-depth interviews with companies in the case study areas were examined in detail. The majority of respondents interviewed commented upon the importance of there being a critical mass of technology-based companies to attract skilled personnel to an area. This is because it reduced the risk to all involved. Starting a company in an area with a concentration of technology-based firms was what one Cambridgeshire respondent called, “undertaking a risky venture in a low risk area”. This was because if the venture failed, there were usually other opportunities to start new ventures or for employees to take up employment in one of the existing companies in the area. Similarly, an individual was more likely to move to an area where there were numerous employment opportunities, so that if one failed, the individual could find another without having to uproot themselves, and possibly their family, to find employment elsewhere. In addition, individuals were likely to locate in areas where there were also employment opportunities for their spouses and partners, thereby furthering the need for there to be a critical mass of companies and opportunities. Consequently, companies were likely to locate with other similar or related companies to take advantage of the labour pool that was created as a result of this concentration. This phenomenon created a virtuous circle where the presence of a labour pool attracted companies, which in turn attracted further skilled individuals.

High-tech employment was often seen as temporary, risky and flexible by nature and therefore employees were becoming increasingly reluctant to relocate to take advantage of some employment opportunities. For this reason there was a growing move away from the “I.B.M. – I’ve Been Moved” syndrome, with more and more companies having to set up where they can employ the requisite people and skills. For this reason, Florida (2002) has observed that the question should not be why companies locate in certain places but rather, why do the people?

Constraints on recruitment identified in the survey were associated with the quality of the environment. But they were also referred to the skills base within the local area, as well as levels of competition from companies sharing the same labour pool. Both Scottish and Massachusetts companies ranked the lack of specialised managerial and marketing skills in their local area as a critical barrier to recruitment (ranked 2nd and 3rd respectively). Scottish companies ranked the lack of specialised technical/scientific skills as of even higher priority (rank 1st). In comparison, the lack of specialised skills appeared to be less of an issue for Cambridge companies. Instead, competition from other companies sharing the same labour pool was ranked 2nd after concerns over the cost of housing in the local area.

Concerns over the lack of specialised skills to meet the needs of technology-based companies were frequently discussed in the in-depth interviews across all of the case study areas. Companies identified the need to up-date skills and re-train both technical and professional staff, especially within such a changing technological and business environment. In particular, laboratory techniques, quality control and project management were identified as the key skills required. For this reason, an area’s ability to provide on-going training and tailor-made courses was seen as very important.

Training the existing workforce was an important policy issue. In contrast to the role research universities play in training scientists, engineers, and business executives, a different group of educational institutions provided on-going courses required to continuously train the labour force to meet the specialised skill needs of the local companies. And while many of the premier research universities in the US were private, virtually all institutions that do ongoing workforce education were public. The community and further education colleges in San Diego, North Carolina and Hertfordshire are examples of institutions...
that played this role. Institutions other than research universities often provided training to the existing workforce and they tended to be public bodies.

Another key finding regarding human resources arising from the in-depth interviews was that technology-based economies tended to create “hour-glass” employment profiles with large numbers of low-paid, low skill jobs and high-paid, high skill jobs on either extreme, but very few medium-paid, semi-skilled jobs in between. Some of the policy responses to this problem, for example in San Diego, have been to encourage technology-based manufacturing and to create training programmes for people to “up skill” into better paying jobs.

Company founders identified the inability to recruit experienced business managers to take on the role of CEOs and business mentors as a major inhibitor to growing a technology company and region. This problem resulted from the fact that different skill sets were required to Research the technology and Develop the technology. Most education institutions tended to address the former but not the latter. High-tech CEOs were seen to be important not only in terms of running the day-to-day operations of the company, implementing cost and stock controls and taking products to market, but also for the contacts they brought to a company and the experience they had in raising finance. The lack of experienced CEO’s was identified across all the study areas but seemed to be more acute in the UK regions. Some UK respondents suggested that management was viewed differently in the two countries, with senior management being something that people aspired to in the US, while in the UK, management was something one did if you failed as a scientist.

Due to the varied set of skills required by a CEO of a technology-based company, there were varying views as to how this skill constraint could be overcome. On the one hand, many respondents felt that large corporates were required in an area to recruit and train people in management and marketing skills, who could then take up posts in young, growing technology-based firms. This view was particularly expressed in Cambridgeshire in the UK. On the other hand, others argued that the skills and experience that one attains from working in a departmentalised corporate are not those that are needed to manage and grow a technology company. Similarly, they argued that individuals trained in large corporates usually lack the entrepreneurial spirit required to be a CEO of a technology-based, high growth company. Technology-based CEOs needed to have gone through the process of starting and growing a technology-based company. An area could only attain a sufficient number of such individuals by growing the local technology-based company base or by attracting such individuals from other technology-based areas. Some respondents also noted that more MBA programmes were needed that were designed and focused around the management and growth of technology-based companies. However, there was a counter argument that MBA programmes do not generate the right kind of technology-based CEO with the unique set of required skills and experiences. Not withstanding this, the absence of quality MBA programmes in Scotland was seen as one of the reasons for the shortage of such people. The exception being the business programme associated with the Royal Society of Edinburgh Fellowship Schemes, which was designed around the needs of technology-based spinouts and start-ups. Many respondents consequently viewed this programme positively. In short, MBA programmes had to cover the entire technology commercialisation process – from technology discovery to the possible public listing and globalisation of the company.

Trade associations and industry were well represented on the various curricula boards in the different study areas and provide input into the design of the various technical curricula. However, there appeared to be a need for a greater input by industry into the business-related curricula of the various institutions. Where this has occurred through the Royal Society Fellowship Schemes in Scotland, for example, the quality and applicability of the related business programmes has been acknowledged as very good.

### 6.4.2 Entrepreneurship and business development

Turning good ideas into products in the market required a range of entrepreneurial actions that included training people to be entrepreneurs and the provision of specific business advice and support through the whole business development process, from basic research to a marketable product and then production. The evidence from the case study regions pointed to a number of different approaches to the encouragement of entrepreneurial activity by the technology-based community.

One aspect was the provision of training to academics in order to enable them to become entrepreneurs, and the creation of a cadre of entrepreneurs who could lead technical companies. Central to the human resource issue was the often-stated point that there was a greater degree of entrepreneurship in the US than in the UK. The UK has however taken significant steps in the past few years to increase the level of entrepreneurship in the country. In Cambridgeshire, the Centre for Entrepreneurship has been established and in Scotland the Institute for Entrepreneurship.

In addition, the Scottish Executive has set up the Scottish Institute for Enterprise (SIE), which is in the process of being rolled out in all 13 of Scotland’s universities. Besides training people in how to start new businesses, one of the main objectives of this initiative was to highlight to graduates that being an entrepreneur was a viable and attractive career option.
Each partner university had a designated commercialisation practitioner. In addition to student support at each school, SIE runs an annual business plan competition plus an annual conference showcasing the finalist plans and offering networking opportunities to students. It also has a patent fund for students. The SIE director from 2001 to 2003 was the director of semiconductors at Scottish Enterprise, seconded to SIE. The current SIE director was previously the director of the Edinburgh Technopole.

In Scotland, a networking and entrepreneurship education programme modelled on the successful CONNECT programme initiated by the University of California at San Diego has been initiated. It began at the University of Edinburgh in 1997, but since 2001 it has been independent from the University. There were three main programmes: springboard, bootcamp, and annual investment conference. The programme brought researchers, entrepreneurs, and investors together. Also, in Scotland the Technology Transfer Partnership was a new name for a traditional programme formerly known as the Teaching Company Scheme. It provided a central arrangement for small and medium sized enterprises to get consulting services from the faculty of six universities and smaller research institutions, including the University of Edinburgh. It was funded by the UK Department of Trade and Industry and its name changed when DTI changed the programme. Academics are seconded to companies to work on projects that the company defines in an application to the centre. The Centre provides grants to support work.

Another example of the approach was the MIT Entrepreneurship Centre. MIT has an objective of creating a cadre of entrepreneurs who understand technology. Some argued that what made the entrepreneurship centre take off was that they put an entrepreneur in charge. When it started there were two courses and two teachers. Now there are 22 courses and 1,500 students. Three quarters are MBAs and a quarter are in engineering. The core audience is management school-based and the Centre’s Director reports to the Dean of the Sloan School, MIT’s graduate school of management. The centre also brought together seasoned executives for senior level training and this represents a formal educational initiative. Corporate sponsors gain access to technology and people. They were “elephants in search of gazelles, in search of the fountain of youth”.

A further initiative was the MIT Enterprise Forum that linked entrepreneurs, new businesses, and commercialisable ideas to the venture capital community. It provided both “windows” on MIT and interactive forums and was promoted by the MIT Alumni Association.

Many UK research institutions have introduced entrepreneurship programmes into their curricula to encourage and guide spinout and start-up activity. However, the role that these institutions played in producing successful entrepreneurs has been relatively limited to date. The 2002 Ernst & Young UK survey of 460 “Entrepreneur of the Year” finalists show that only approximately 41 percent of the finalists had a university degree (Burrage 2002).

A further example was the North Carolina Centre for Entrepreneurial Development. In the early 1980s there were a number of concerns by business, the university and local public agencies in the North Carolina Research Triangle that there was a relative dearth of new companies being established in the area. Moreover, the universities and core cities in each of the three areas that comprise the Research Triangle appeared to be standing apart from each other in the development of commerce and enterprise activity. A number of key players including the local universities came together to establish a Centre for Entrepreneurial Development. It is an educational non-profit body with a staff of 18, of which 9 or 10 are in education. The others deal with external affairs or back-office operations.

At first, the Centre focused on the provision of entrepreneurial education. People came to learn and network. However, the agenda was rapidly expanded to focus on the provision of business mentoring and education in a broader sense, including issues relating to finance and capital. The Centre was funded by the private sector and thus, companies that provided business services such as accounting companies. The idea was that no one outfit or individual owned the Centre and it is neutral territory where everyone can get involved. It had a truly entrepreneurial culture that seemed almost to be in the atmosphere of the place and it was highly regarded by the business community. In its first five years, it focused on assisting companies. In the last five years, it has expanded its remit to consider issues relating to the encouragement of entrepreneurial activity and out-reach amongst the public and university sectors. The broad flavour of the work of the Centre and the way its activities transcended the realms of technology, business and other sectors is illustrated by the comments made by the Centre’s Director when she was asked to describe a typical week: “Today, I went to NC State to meet with the VP for Extension programmes. It was a non-agenda’s meeting. I had a meeting on fund-raising and development. I had a meeting on special initiatives – we are doing a S.E. Biotech conference. I had a meeting with women entrepreneurs – a boot camp gathering.”

Every two years it undertook a survey of the founders of high-growth companies and asked how the Research Triangle was progressing. The surveys are on the website. The Centre worked with companies from the idea stage to the go/no go stage. It dealt with funding, leadership programmes for technical CEOs and promoted conference gatherings. The centre did not invest itself. It regarded entrepreneurs as being blind to technology, whilst scientists were blind to entrepreneurship. Thus: “We take
them both out of that comfortably. We use successful entrepreneurs as a swat team. We address the issue of culture shock. We work in small groups – fifteen people, and promote early intervention. We do a quarterly angel investor forum. It is like many others, but, we also do one with angels alone. For example, we brought in the Dean of Engineering to do a presentation on new technology, such as, this is what photo optics are. We have had significant grants. Foundations are less and less important now because of the economy. We were part of the NC Biotech forum. But our mission is to work in North Carolina with a focus on the Triangle. We are funded by business interests here. It is a transition issue. There is a Centre for Entrepreneurship now at Flagler (Duke’s business school). Our forums seem like the bar scene in Star Wars – we gather people together who look different and speak different languages, but they are all entrepreneurial!

### 6.5 Fostering business and industry networks

Many of the initiatives discussed earlier in this section were helping to provide networking opportunities along with premises and support for entrepreneurship. However, there have been activities that focused specifically on the building of networking activity and which built bridges between business, academia and public policy agencies. In Scotland, Technology Venture was an example of this and it assisted companies in specific sectors to compete globally and create new integrated products. Technology Ventures was a private company funded by SE and the Scottish Higher Education Funding Council. The Scottish Executive brought the two bodies together. It was, however, independent of both and brings business, academia, Scottish Enterprise and others together every six weeks to discuss key issues.

Another example was the Scottish Optoelectronics Association that was started by Scottish Enterprise to establish links with the universities and other companies – general networking, to help develop a strategy for the sector. In 2002, a strategy based on SE’s Cluster Strategy was developed by all parties, to be the voice of industry and maintain the profile of the opto-electronics industry. This was a good example of seeking to get universities to pool their resources. Research needed to be market focused. One way of doing this was through the creation of Centres of Excellence such as the Institute of Photonics at the University of Strathclyde where there was a good interface with business.

The Business Gateway was a programme through which Scottish Enterprise tried to coordinate the business support functions it funds. Participants included local chambers (which provided business services to businesses with 25 employees or less); the Scottish Federation of Business; university commercialisation offices; tourist board; and the business support functions of the local authorities. Scottish Executive funds LINC, which introduced companies and investors and brought investors together to pool risks.

A more recent initiative in Scotland that sought to enhance the development of technology-based businesses was the Intermediary Technology Institutes. The rationale behind the establishment of the institutes was that: “Successful economies around the world have a research base that extends beyond basic science, into pre-competitive research areas with a focus on being driven by global market opportunities”. Research has suggested that institutes or organisations that helped optimise and organise technology generation and exploitation contributed significantly to regional economic growth in the long-term, with the initial impact occurring after 5 years. While the examples addressed the specific strengths and weaknesses of their respective regions, they all focused on the entire spectrum of the development process from basic research all the way through to mass product development. The intention therefore was to build on Scotland’s research base and to target those sectors with particular potential and competitive advantage. Scottish Enterprise has committed £450 million to the Institutes over the next 10 years. There were comparative initiatives in the US which targeted and financed specific technological research with a commercial application, through SBIR and SBTT grants.

It is early days as yet, but it is intended that the Intermediary Technology Institutes will:

- attract leading global players, local companies and researchers to participate in identifying future market opportunities
- generate market-focused intellectual assets by commissioning work from leading researchers in existing research institutions in Scotland and worldwide
- create pre-competitive market-focused technology platforms that will strengthen existing Scottish companies and/or create new firms
- facilitate the movement of staff between research organisations and industry
- retain technology graduates for Scotland by providing career development opportunities
- capitalise upon existing science and technology strengths to develop a critical mass of expertise and a reputation of successful exploitation in specific market niches
- act as a proxy for corporate R&D and significantly increase the levels of R&D in Scotland
- stimulate technology-based companies in Scotland to create their own demand for near-market research.
The operation of the ITI’s involves three processes. The first is to identify emerging market and business opportunities in which Scotland can play a leading role. The second requires the development of a technology base or platform where the relevant technology is researched and developed. The last process involves the commercialisation and product development of the technology through member companies, start-up companies or licensing arrangements. These processes will be carried out by research and commercialisation steering groups, which will be made up of predominantly global industrial players and academics with global reputations in their research fields. Each Institute will have a core staff of approximately 15 people who will manage the steering groups and the day-to-day operations of the Institutes. External engagement with the institutes will be on a membership basis.

The energy, life sciences and communications and digital media technologies were the first sectors to be incorporated into institutes. The Media Institute, located in Glasgow, is headed by David Creed, former vice president of Sony Europe. The Life Sciences institute is located in Dundee and is being led by the entrepreneur John Chiplin, creator of GeneFormatics, who relocated to Scotland from California, USA. The Energy institute is based in Aberdeen and is headed by Tony Amor who worked for Shell International Petroleum and Natomas Company before becoming President of Thermal Power and his own consulting company in San Francisco.

Ultimately, the ITI’s will be evaluated in terms of the way that they:

- increase and sustain the birth rate of indigenous high value-added, technology-based companies
- increase the level of exchange between the research and the corporate sector in Scotland, helping in the transfer of skills and increasing corporate R&D
- further establish and connect Scotland with key overseas markets, promoting Scotland as an important centre for specific technologies and as a location for foreign direct investment, portfolio direct investment and mobile skilled labour
- create a sustainable flow of market relevant technology companies that will attract more local and international venture capital to Scotland
- significantly increase the retention of graduate and professional skills in Scotland.

We also found in some regions a number of market-based companies that provided advice and consultancy to technology-based companies. The extent of this varied considerably. Cambridgeshire in the UK provided one of the best examples of this sort of development, with a number of such companies. The Technology Partnership was set up in 1987 by a number of individuals who had worked for one of the first companies of this sort in that region, PA Consulting. The Technology Partnership helps to grow specific technologies in terms of product application and spin out and develop companies as appropriate.

Again in Scotland, the Biotechnology Association has been created to provide a non-biased voice of industry. Most of their funding came from membership subscriptions and therefore this kept them committed to raising issues on behalf of industry. Companies supported them because they tended to be too small themselves to be heard on their own. The industry was dominated by SME’s and therefore there was a need for an overarching organisation that could speak on their behalf. They sought to raise awareness of the issues facing the industry and had good links with the Scottish Enterprise Biotech Group. They have done a lot to improve international linkages but it is recognized that the need to do more to network and connect the local supply-chains and different regions—Cambridge, Oxford, Manchester etc. There are some national initiatives in this regard such as UK Biomanufacturing, and the evidence points to a number of companies wanting to know how they can access technology transfer from places like Cambridge and Oxford.

Companies faced a number of problems accessing international contacts, markets and collaboration opportunities, all related to the human resource issue of a shortage of good, experienced business managers. Contract opportunities were partly brought to companies by the business managers they recruited and through its activities, the Biotechnology Association can facilitate and network opportunities. They have strong connections with the universities in terms of establishing links between their member companies and the universities and show-casing what the universities have to offer.

During discussions with the Biotechnology Association the view was expressed that there does seem to be a greater feedback by industry into the curricula content in the further Education Colleges than in the universities and the example was given of the Scottish College Biotech Consortium which comprises four colleges across Scotland who work very closely with industry regarding short-course and e-learning provision. Courses include – clean room validation, good manufacturing practice etc. There was the feeling that these local initiatives must have a national focus with a national input. The interaction between universities is considered to be improving. At the post-graduate level there were a number of interfacing initiatives and also activities that brought the various university technology transfer offices together.

There were a number of examples of organisations in the US study areas that promoted the well-being of technology-based industries in specific places. In some cases these bodies advocated for a favourable macro environment (i.e. low tax regimes). But in others the involvement was more sophisticated.
Thus, the Massachusetts Technology Collaborative was created by the Commonwealth as a ‘semi-autonomous economic development authority, with a broad charter to do projects that would promote the growth of technology-based industries or utilising technology in some way that would promote job creation’. The Board of Directors was appointed by the Governor with the informal understanding that it would represent certain constituencies, including all the Deans of all the engineering schools in Massachusetts, including private universities. MIT has always been on the Board although this is not a formal requirement. Over time the entity has become a small agency that advises a group of companies within one industry. An example of the former has been work for the medical device industry to create a trade association for the industry in Massachusetts, as well as a number of other initiatives including the provision of broadband communications in different regions. MTC owns its own campus.

The North Carolina Biotechnology Centre represented one of the earliest approaches to assisting technology-based companies. In 1981, the Governor in North Carolina, Jim Hunt, formed a commission to assess the possibilities for basing a regional economy on living organisms. This commission recommended the establishment of a private non-profit centre for biotechnology. At the time there were three places where biotech research was being done: San Francisco, Boston, and Cambridge UK. The development in North Carolina of biotechnology was the result of targeted intervention that recognised that the State was in for the long haul with any tangible evidence of success at least ten to fifteen years away. It was essential to build a community of relevant parties and the intention was not to duplicate anything that was currently in place. The Centre was seen as an important vehicle in the process. It needed resources and a toehold in every phase of the process required to establish a critical mass of activity. A key regional asset was the Duke University medical school.

Initially it was suggested that the Centre be part of the Board of Science and Technology. That idea was floating around before the centre was finally constituted as a not-for-profit body. The Centre works closely with the three Universities in North Carolina to fund university research (the research must have commercialisation potential), and encourages business development by working closely with entrepreneurs and the Department of commerce. They have been involved in the spinout of 63 companies, 48 of which have survived. There are 50 people at the Centre and it receives 50 percent of its operating funds from the state. It gives loans rather than makes grants and the emphasis is on creating an entrepreneurial spirit by providing an infrastructure that helps to develop people with capability. The Centre holds a forum every fortnight where a range of business support are discussed. Attendance is usually 150 to 200 people. There is a core that comes often, and others that come for topics of special interest. They bring together trusting and purposeful people with creative ideas over time. They work closely with the Technology Transfer offices of the universities.

The North Carolina Microelectronic Centre (MCNC) was founded in 1981. In the late 1980s, through legislative decree, it took on supercomputing for the universities. During the early 90s, the State supported some research projects. Now, however, the Centre is a private non-profit institution fully supported by its constituents. MCNC has a 23-person board. There are five from NC State/ Carolina. The universities are the key constituency. Some seats are statutory. There are both business people and community people on the board. There is some $28 million in revenue. Its research contracts are all from federal agencies like the Department of Defence. MCNC has spun out a number of companies. One made $270 million and these funds were used to set up an endowment.

MCNC takes equity in spinouts and provides a spinout with access to its scientists. It may take a seat on the board of the spinout company. Help is given in finding management expertise - outside of MCNC. It has a partnership with the Council for Entrepreneurial Development to assist companies to be entrepreneurial. Venture funds are the ongoing fuel for the organisation rather than relying on the State. The Defence Department enables the Centre to retain IP and license to companies. There are 50 PhDs at the Centre and there is very little turnover. It is argued that ‘an entrepreneur knows there is reliable assistance here,’ and it is seen as a research-based economic development organisation. In terms of the number of patents and disclosures, the Centre does 10 times that of NC State, and NC State is the leading university producer. The research arm has 90 employees. The supercomputer and network operation has 75 employees. The Centre sees itself as serving the whole university system: public, private, and community colleges. It has developed a Grid Networking computing system that enables academics and the business community to access one petabyte worth of data and applications in bioinformatics. Thus, it is the central holder of genome information in North Carolina. Having the supercomputing facility is important since there are around 800 scientists using the supercomputing facility at any one time, representing 80 to 90 research projects.
In San Diego, Biocom represented yet another example of this sort of organisation. BIOCOM’s first function was educating companies; its second role was to advocate and encourage policy responses that would assist technology-based companies. As one respondent noted:

“We work on three levels of public policy. We are involved with public policy from day one. When we started-up in the mid-1980s, local elected officials didn’t know what biotech was about. This was still a defence industry area. Biotech needed to build reasonable facilities but there were no city standards. A year later, Mycogen wanted to build a greenhouse, but the city manager said the company could only build in an area zoned for agriculture. We worked with the mayor to educate him on what the industry was all about.

“We work on issues of local infrastructure – roads and water. Water is a big issue since San Diego imports 90% of its water from Northern California and Colorado. During the drought of the 1980s, the mayor proposed that companies use water for only two hours each day. In response, the Water for Industry Programme was created in which biotech and other industries reduce their water usage. A reclaimed water plant is now in use – wastewater is recycled through a cooling tower and this water is used for landscaping. Companies that make use of reclaimed water will not have their tap water turned off.

“In the early 1990s, the issues were more at the state level – funding for research and education in the UC and state university system, and regulatory issues. The issue is the cost of doing business. California has environmental regulations that go beyond the federal regulations. We are also liberal on social welfare; workers’ compensation and disability are a huge expense for small companies.

“In 1999, BIOCOM focused more on national/international issues, like stem cells. We’ve finished a new draft of our issues and principles agenda. It’s designed to educate the membership and inform elected officials. We also create spokespeople for the industry. Last year, we created the San Diego Political Action Committee, which supplements our public policy efforts. They collect political donations, do a scorecard and have an advisory board that serves as overseers – 6 CEOs that determine priorities. We are focused on ensuring the success of businesses. Last year, we fought the proposed increase in water rates. At the state level, we proposed legislation to create conformity between the state and federal level on operating losses; we wanted state credits for operating losses. We almost got the bill passed. We work closely with the governor’s office and the mayor’s office.”

“It is also clear that organisations like BIOCOM spent a considerable amount of their time interfacing with their organisations. This was seen as crucial. Thus:

“There is a lot of cross-pollination in the membership and leadership of three groups focused on business—the chamber, the EDC and BIOCOM.” “All have strong policy programmes and work together in a lot of coalition efforts especially with other trade associations. For example, group of all trade association heads from telecom, electronics, the software industry, BIOCOM and UCSD Connect sent a delegation to the World Trade Centre on a trade mission. The idea was to catalyse a convergence of technologies. With San Diego’s strengths in these technologies, it is one benefit we have over other areas and it has a heavy impact on medicine.”

The Regional Technology Alliance RTA was an example of yet another interfacing initiative in San Diego. It was one of six regional technology alliances in California. Its origins lay in the early 1990s when California went through a profound period of defence downsizing and the state legislature wanted to help small scientists, engineers, and technology folks to remain and find federal research grants. It set up a matching grant programme, to match the federal R & D funding which did not pay for the commercialisation components such as market research. The overall intention was to help would-be entrepreneurs and winners of federal awards, develop the business side of their technology. Originally, Regional Technology Alliances were established in LA, Silicon Valley and San Diego, because these were the hardest hit areas. Later, three other areas were added. Each is a private, non-profit, organisation with some annual state fund for managing the matching grant programme. San Diego’s was established in 1993. Each evolved unique capabilities depending on the needs and assets of the community. Along with UCSD CONNECT, described earlier; San Diego’s RTA helped to fill a genuine gap in the existing policy stance at the time. CONNECT helped to commercialise university technology, but no one was working to communicate to the overall community in technology and it was that to which the RTA was addressed. The Alliance had four components to its work: the California Technology Investment Programme, entrepreneurial services, research, and a programme in under-served communities that have a lack of computer literacy and Internet connectivity (bridging the digital divide locally). The RTA worked with VCs, angels, very successful business mentors, and growth-spurt companies, but also in workforce development, economic development, public policy, and community economic development.
6.6 Branding, marketing and promoting place

The research described in this Report has indicated that certain places become thriving locations for technology-based activity by evolving from, and taking advantage of, existing infrastructure, institutions and industries. This evolutionary process can be serendipitous (right place, right time, key individuals etc), and/ or more formally driven by a research agenda and other policy interventions. As we say elsewhere in this Report, it is often the result of both processes. However, it is clear from the research that the process can be influenced and the outcomes significantly enhanced.

We conclude this section by summarising some of the general observations that have emerged from our analysis in the case study areas about what makes for the successful promotion and branding of a technology-based enterprising place. This is clearly a very large and important area and we are only able to provide an indication of the many approaches adopted. The institutional formats and key considerations behind this process are the subject of the next section of this Report.

One of the central lessons that emerged from the research was that the promotion of a successful technology-based location did not occur overnight. It required a sustained and resourced commitment over many years and it was about the long haul rather than the quick result. It is for this reason that the promotion and indeed management of the process does require institutional vehicles that are likely to be there for some considerable time. In some cases this may be achieved through the Development Agency model and this has been a strong feature of the Scottish model in the UK. However, there were a number of variations on the core approach depending on how the delivery vehicle is constituted, who pays for it and, importantly, how it coordinates what it does with other key players that have to be involved if successful outcomes are to be achieved.

Promotion was delivered best when it was the result of a collaborative endeavour. In our case studies, this meant the core universities working alongside the relevant players that we have identified throughout this Report. These were namely those involved with the delivery of finance, real estate and the provision of a wide range of resources that are often mainly the delivery responsibility of government, either centrally or locally. And the key players had to see the benefits to them, and the area taken as a whole, as a result of the promotion process. The approach adopted in the Research Triangle in North Carolina is of great interest in this respect and contains features that have helped to build it as a formidable location for technology-based activity. The role of the Research Triangle Institute has been fundamental.

As with virtually all of the examples examined in our case studies, the creation and then promotion process reflects the importance of a small number of motivated people who had vision and the institutional connectivity to get things done. They recognised that it would be a long slog.

In Massachusetts, the broad approach was indicated by the Massachusetts Alliance for Economic Development. This body was formed in 1993 in recognition of the need for the public and the private sector to come together to promote Massachusetts as a place to do business. It was a consortium of the state’s utility and telecommunications companies, real estate associations, and the public sector in the shape of the Massachusetts Office of Business Development (2002). They founded the Massachusetts Alliance for Economic Development. The Alliance’s founding was an outgrowth of recommendations made by the Governor’s Council on Economic Growth & Technology, a body of civic and business leaders that advised the Governor on issues relating to the competitiveness of Massachusetts.

Originally the Alliance was seen as a non-partisan, professionally-staffed organisation that would serve as the Commonwealth’s central source of available property information for expanding and relocating companies. The Alliance’s Site Finder Service was also founded, focusing on helping companies find appropriate properties for facility expansion in Massachusetts. The service provision has since been expanded to include a Research and Information Service and an Ambassadors programme, both designed to provide decision-support to companies evaluating Massachusetts as a location for their business. As one commentator remarked:

“We market MA as a place to do business, through our information services, site finder services and research. We work hand-in-glove with site finder service providers on research; for example, a biopharmaceutical company considered a number of different locations across the country. We were finding appropriate sites for them to consider, and also trying to demonstrate why MA was the best place to locate—looking at labour force issues, where their closest suppliers were, etc. Some of this is fairly standard stuff, but companies have unique information requirements that we try to meet.”
“We also have an Ambassadors’ network—a commitment from CEOs of different companies to be peer resources for visiting executives. This doesn’t necessarily mean CEO to CEO, sometimes a Director of Operations might be the best contact, or a CTO, but they have pledged themselves to be peer resources.

“We are very focused on implementation. We want to see companies locate here, and it is one of the ways we evaluate our work. We also try to educate the public through forums, which we hold once or twice a year. Another thing, we can bring in our private sector members. We have a structure of corporate members, principally, utilities, architecture and engineering firms and some financial services, and public sector representation from MassDevelopment. Our principal source of funding is from these groups, which pay a fee that ranges depending on the sort of entity they are. But there is more private sector member support.

“Our agenda is set up on a customised basis. It gets people together, if we need to reach across department lines we do so. No other public organisation can do this. We are not a quasi-public organisation technically— the governor doesn’t appoint our board of directors—but we are not totally private.”

Other examples of the different institutional formats that are used to promote and market the particular place across our case study areas could be given. It is noticeable, however, the differences that tend to exist between the UK and the US both in terms of the representation of the private sector interests and those of the knowledge-based institutions. Moreover, representation is often at a level senior enough to make a telling contribution to decision taking.

6.7 Incentives are still important in many areas

A further issue that was noticeable from the interviews in the case study areas was that the attraction of technology-based companies to specific areas was not unaffected by the availability of specific incentive packages. Whilst there has perhaps been a long tradition of the deployment of specific public policy initiatives in Scotland in the UK it was also of interest to note that there was also often fierce competition in the US in relation to the incentives package that was available specifically between areas. There was often concern as to whether the cluster-based benefits themselves would be sufficient, given the international competition for such investment. Thus, by way of illustration, one commentator in North Carolina notes:

“I worked on the Company XXX Pharmaceutical [site selection]. They didn’t or couldn’t build a new facility in YY, where they were. They looked at MA, NC and East Germany [where they got lots of cash as an incentive to locate there]. Unlike NC, [we don’t offer] upfront land and cash. [However,] we did 46 different tax cuts and have a single sales tax factor. We only tax the amount of sales within state. For a company that sells nationally, it’s very beneficial.”

And promoting bodies went to great lengths to customise their pitch to meet the needs of the individual technology-based company and, importantly, their workforces. In some cases there was the ability to use local business taxes to good affect. Thus:

“About 40 percent of the state is in an EOA (Economic Opportunity Area). If a project is one of these areas, the city can offer a TIF (Tax Increment Financing). The business enters into this agreement, in which 100% of the increased property tax revenue [goes] back to the business, and the tax investment tax credit is increased from 3 percent to 5 percent.

“In the bill the TIF, which is just related to commercial and industrial property, now extends to urban areas for housing. The DIF (District Improvement Financing) would segregate the increased tax revenue from the development to specific purposes. So we could project the increased tax revenue and separately segregate the projected revenue, as it comes in, to be used to improve that district.”

And it was also recognised in the US that financial incentives to companies themselves were only a part of the inducement. The provision of quality soft infrastructure was also crucial. Thus:

“Our mandate is broad enough [to include housing]. At a Fall 2000 [agency] retreat we agreed that housing is an economic development issue. Our housing starts are 50% of what they should be. We view it as a supply problem. In accordance with Smart Growth principles, we need to increase housing at all price levels. Building housing with subsidy is important, but building overall is important [to reduce the shortfall in supply].”

Many other examples could be given.

A key feature that emerged from the research was that successful technology-based locations sought to enhance their attractiveness through the provision of a range of infrastructure initiatives that enhanced the public realm. In some cases, as in Dundee in Scotland, this meant redeveloping the City Centre.
and establishing a quality retail pitch, as well as building arts and entertainment in the cultural quarter of the City. These things mattered in the scheme of things, as did the successful promotion of new images that reflected where the place wished to be, rather than the past and decline that had often only too recently occurred.

6.8 The role of research and critical review

It was also of interest to note from the case study research that the most successful enterprising areas for the development of technology-based activities were those that placed strong emphasis on ensuring that they remained at the forefront in exploring new research leads and agendas, even if the payback might be a long way off. The ways in which the key players in the areas sought to ensure this varied in terms of how they found funding, which institution they used to undertake and promote research findings and the like. However, the emphasis given to this in the US case study areas was again striking.

Moreover, successful places did not stand still but sought to review their relative position on a regular basis. One excellent example of this is the Emerging Issues conference held recently in the Research Triangle in North Carolina. This two-day conference brought all of the key players from across the Triangle to examine and benchmark the relative competitiveness of the Triangle as a technology-based location. Attracting speakers from around the US and indeed the world, and ensuring high level representation of the key movers and shakers, the emphasis was on focusing and honing the future policy agenda across all the realms and the boundary interfaces, to ensure that the Triangle stayed amongst the world leaders as a place for technology-based activity.

Moreover, the institutional arrangements adopted in the best examples tended to share common traits. They have each introduced new arrangements in their area to ensure delivery and commitment to planning for the scale and speed and development required. Stakeholder partnerships had been introduced at the city-region levels including not only public bodies but also private representatives. The partnerships were driven by representatives from the respective organisations that could authorise real commitment (and thus usually people at the Chief Executive level). Members of the partnerships tended not to be heavily politically motivated nor have vested interests. The partnerships so formed had clear objectives that were deliverable and action-orientated, with actions being reviewed constantly. This heightened the partnerships’ credibility and helped to ensure the delivery of their policies to support the growth of the technology-based areas.

The evidence from the case study areas was that the ability to facilitate change varies considerably across the key players in the relevant realms. There was a wide variety in terms of the format of the intermediaries and instruments used to broker change. The next section moves to investigate these factors in further detail and identifies the implications for the institutional format of policy response and the resources required.

6.9 Summary

Enterprising places were able to meet the needs of technology-based companies and their workforces by adjusting their resource base through actions taken by the relevant parties from across the public and private sectors. The key characteristic of successful solutions was that they provided strategic planning for these technology-based centres that was bold and visionary, and supportive of the growth of technology-based companies. Moreover, as we shall argue in the next section, there was an emphasis on ensuring that strategic planning policies were stronger and more coherent for the city-region and so helped to co-ordinate transport, infrastructure, housing and economic development more effectively. The policies did not provide a purely local response but also related to regional and national issues. They did not, for instance, confine themselves to the immediate area, but instead benefited the broader sub-regional and regional clusters of high tech business activities.

They also shared a much more integrated and comprehensive approach to infrastructure provision - transport, housing and business premises - which were more effectively linked to land use planning policies. Similarly, they took a longer-term view in securing commitments from companies in anticipation of the scale and pattern of technology-based development.
7. Regional entrepreneurship, institutions and vision

This section deals with how regional entrepreneurs create vision, deliver needed resources, capture regional return, and maintain momentum through new regional institutions.

7.1 Introduction

What stood out from this research was that having the right asset base at a particular point in time - the right companies, the right universities, the land, the right workers - did not necessarily lead to a place being enterprising and successful. A place's success was determined rather by the continual development of these assets. This was usually the product of dynamic and effective partnerships between the parties from each of the relevant realms within a region. Organisations that embodied these partnerships had the following attributes:

- Connection with, but separation from, government. In each place, political leadership and the political climate changed significantly over time. Some separation from government permitted organisations to maintain their operations in this climate of change.
- Connections to multiple realms. This allowed the organisation to draw resources from different sources as the capacity of these sources shifted.
- Structures that enabled entrepreneurship. That is, organisations had both access to resources and the ability to mobilise and deliver them autonomously.
- Independent credibility: they could influence key decision-makers in the core sectors of government, industry, universities, and in other civic enterprises.

The research also indicated that enabling partnerships concerned to maintain the momentum of technology-based locations had to be able to influence and effect land use availability and the provision of key infrastructure. This meant that they needed access to the levers of planning and local taxation. Flexibility in this respect was noticeably different in the US when compared with the UK.

We also observed that regional entrepreneurship was crucial. If the growth and development of technology-based enterprising locations was to be maximised, then it was necessary to bring together expertise that spanned the fields of entrepreneurship and economic development. Interestingly, in our research we found examples of good practice in both the US and the UK, although there did tend to be important differences between
them in the involvement of business per se in local development. This was no different for technology-based activity than it was for other areas of industry and commerce.

The research also indicated that geography mattered. Technology-based clusters did not respect or follow the specific administrative boundaries associated with traditional governance patterns. It was thus necessary for those seeking to enhance the growth of the cluster to recognise key city-region interfaces.

7.2 Civic enterprise: issues and players

Influential policy leaders we interviewed had paid serious attention to the academic literature and to practical understandings of the processes of innovation and entrepreneurship. Innovation was acknowledged to come from fine researchers at universities and research centres as well as from “the shop floor” in companies (Little 1963). Development strategies reflected significant attention to breaking down organisational and disciplinary barriers and facilitating the kind of boundary crossing necessary to promote the growth of new companies and, correspondingly, dynamic regional growth.

Academics have long noted that innovation often occurs at the boundaries of scientific disciplines (Kuhn 1970), of policy (Schön 1971), and of organisations (Peters and Waterman 1982, Saxenian 1994). Such analyses pointed to the ways rigid organisational or industrial boundaries have inhibited the processes of innovation and entrepreneurship. More recent attention has been paid to institutions that foster collaboration among businesses and other organisations in industry clusters (Porter; San Diego, 2001).

Figure 7.1: An array of intermediaries

University-based:
• Real estate programmes
• Commercialisation of technology
• Entrepreneurship education
• Technology research centre

Government-based:
• Technology support
• Public champions
• Enterprise education

Real estate and finance:
• Region-based non-profits
• Private developers

Government-based:
• Venture funds
• Land and business dev. corps
• Industry associations

Business-based:
• Industry associations
• General business support & advocacy

Government-based:
• Economic development agencies
• Land and business dev. corps
• High-tech oriented non-profits:
  • Industry specific support
  • Entrepreneurship support
  • Region specific
  • Business development orgs
In the US, regional leaders from Silicon Valley to Pittsburgh, established to emerging high tech centres, have come together to work for the development and sustenance of their own regions. These leaders give centre stage to social observers such as Neal Pierce (1993), who noted the importance of new regional units he calls ‘citistates’. These leaders were advised by firms such as the Silicon Valley-based Collaborative Economics, founded in the early 1990s by three former employees of Stanford Research Institute (Collaborative Economics 1999). Principals Henton, Melville, and Walesh (Henton et al. 1996) have documented the role of what they term “civic entrepreneurs” in regional economic development. With the support of leading US private foundations, they have created a national support network; the Alliance for Regional Stewardship, to advance ideas of regional citizenship, stewardship, and governance.

To achieve innovation and entrepreneurship in their own communities, the leaders we interviewed were acting to break down boundaries between traditional organisations and realms. The goal was to make these boundaries sufficiently permeable to allow ideas and information to flow in new ways, leading to new ideas. This meant enabling new connections between people. An important focus were connections between universities and business: moving inventions from university laboratories to commercial markets and moving innovators across the boundaries of different organisations. People we interviewed uniformly categorised rigid boundaries, which they often-called “silos,” as a central constraint to innovation. We heard complaints about industry silos in San Diego, leadership silos in Worcester, and cluster silos in Scotland.

Our respondents described an array of programmes designed to span specific boundaries, for example, a programme to finance market testing for university inventions. When we looked more deeply, however, we found these programmes to be embedded in new organisations that built cross-realm collaboration into their ongoing operations. Some of these organisations operated at the edges of traditional institutions. Others operated between traditional institutions, through new and separate organisations. Figure 7.1 identifies in a schematic way the kinds of organisations we found.

These organisations institutionalised collaboration by building into their structures the perspectives of the different constituent realms, through board memberships and through staff appointments. We refer to these organisations as ‘intermediaries’. These intermediaries paralleled Porter’s Institutions of Collaboration (Porter, San Diego, 2001) and Henton et al’s (2002) “civic intermediaries,” although we used the term to apply only to formally structured organisations, rather than ad hoc alliances, as Henton does.

Other organisations sought to make new geographic connections – fostering enterprise in dense sub-city nodes - for example, Kendall Square in Cambridge MA - while simultaneously enabling regional problem solving. Atkinson and Gottlieb (2001, 7-8) pointed out that in the US, the New Economy had transformed the spatial order of economic activity. It had drawn development from older downtowns to the suburbs, creating both dense sprawl in newer growth areas, thinning the metropolis in older areas, and making the working economy whole regions, many of which cross state boundaries. Old political boundaries in the UK have become similarly ill-suited to current economic activity. In study areas in each country, we encountered efforts to define more functionally relevant economic areas with appropriate organisations empowered to act at an appropriate scale. We called the associated organisations ‘regional partnerships’. Henton et al (2002, 10) defines the decision-making processes of such organisations in the US as governance: “the informal process of business, government, and community collaboration that shapes decisions and actions in a region.” This is distinct from government: “the formal structure that makes policy decisions and allocates public resources.”

Within this system of intermediaries and partnerships enterprises, we found entrepreneurs – individual leaders thinking and acting “outside the box.” These entrepreneurs were active in each realm and their actions shaped the realms in a way to foster the growth and development of the enterprising place. Some emerged from traditional institutions, changing them from within. Others built new organisations. They were central to the development and function of the new institutions, and the institutions themselves facilitated the development of the kind of regional leadership on which successful technology-based centres depended. We called these “regional entrepreneurs,” a term parallel to the civic entrepreneurs identified by Henton et al (1996).

Enterprising places in relation to the activities of technology-based industries were those that had institutional structures that could accommodate the needs of the sector and manage the process of change involved. However, effective institutional formats were not in themselves sufficient to attain successful outcomes. The changes required across the settlement pattern of an area, including those to its built environment, encompassed a range of land use and planning considerations. It was also necessary to install new infrastructure, and the ability to finance this was central to success. There had to be sufficient resource levers to bring about the changes required.

This chapter discusses the new institutions, the process of experimentation that has led to their creation, and the entrepreneurs central to their success. In so doing we revisit some of the programmatic activity discussed in earlier chapters to set that activity in a new institutional context. Throughout we are concerned to assess the scope for the transference of best practice between countries and the places within them.
7.3 Three generations of intermediaries

Intermediaries sat on or between the boundaries of different realms that embraced technology, policy, finance, and place. Some of the organisations we saw dated back fifty years, well before the dawn of the New Economy. Given that the continued operation of these organisations depended on their continuing relevance and productivity, their very longevity was testimony to their effectiveness. Others were much more recent. We also saw the evolution of new forms of intermediaries over time, as they adapted to current demands. First generation intermediaries developed on the boundaries of traditional institutions, as entrepreneurs within those institutions sought to adapt their operations to new circumstances. Second generation intermediaries developed as separate organisations spanning traditional institutions and the realms of policy, place, and finance. Third generation intermediaries added the knowledge realm.

We also found that the characteristics of intermediaries in both the US and the UK had changed over time. Intermediaries created through the 1970s were largely government corporations or traditional trade associations. More recent intermediaries were smaller, mission-driven non-profit corporations. A key difference between intermediaries in the US and the UK was the role of the public sector. The initiative for much intermediary activity in the US came from the private business and non-profit communities. In the UK, public action was a more important driver. UK organisations were also more hierarchical relative to each other, often responsible for implementing centrally defined programmes. In the US, Board and staff members often had experience in two or more of the core realms. In the UK, board and staff members were often rooted in one realm.

7.3.1 First generation intermediaries

First generation intermediaries opened the individual realms of technology, finance, policy, and place to industry using basic two-way connections between the realm and particular enterprises. They included:

- public corporations that enabled government to do its business using private corporate models
- centres and departments embedded in universities and research centres with mandates to make connections with industry
- industry organisations with mandates to make connections to policy makers.

These organisations tended to be rooted in a particular realm, while involving some stakeholders representing other realms.

Table 7.1 First generation intermediaries

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Examples</th>
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<tbody>
<tr>
<td>Industry-Policy</td>
<td>Government-based</td>
</tr>
<tr>
<td>University-Industry</td>
<td>MIT Industrial Liaison Office</td>
</tr>
<tr>
<td>Industry-Industry</td>
<td>UCSD Corporate Affiliates</td>
</tr>
<tr>
<td>Policy-Industry</td>
<td>Mass High-Tech Council</td>
</tr>
<tr>
<td>Corporate Growth</td>
<td>San Diego Association for Corporate Growth</td>
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The following are examples drawn from our study areas of first generation intermediaries.

Government-based

In Massachusetts, the private corporation has long been a model for public action. In the 1950s the Massachusetts government created public corporations known as “public authorities” to manage revenue-producing line operations such as the ports, public housing, and urban renewal. The state’s largest public authority, with over 20,000 employees in 2002, was the Massachusetts Port Authority, created in 1959 to operate Logan Airport, the port of Boston, and the various bridges. The state legislature created the Massachusetts Land Bank to convert to civilian use former military facilities being shed by the federal government. It also created the Massachusetts Industrial Finance Authority to issue tax-exempt bonds to support industrial development. These entities had small boards of directors and professional management that reported directly to the boards. The state legislature capitalised these organisations with public funds and/or land, but after an initial period of public support, the organisations were expected to pay for ongoing operations with revenues. Each had the power to raise capital by issuing revenue-backed bonds. The state governor made some or all Board appointments, but with terms phased so that it would take several years until a new governor could gain control of a board.

In the 1950s, the Scottish Land agency sought to use the country’s land resources to attract industry, and it was successful in bringing IBM to the country. In 1965 the British parliament created the Highlands and Islands Development Board and in 1975 the Scottish Development Agency to provide a broader range of support to the business community in Scotland and to build international competitiveness. The Scottish Development Agency’s focus was on the lowlands, including Edinburgh and Glasgow. The agency held and developed commercial land speculatively, and it used incentives to attract multi-national corporations to Scotland.

University-based

In making connections to business, universities often chose first to establish relationships with large companies. These efforts brought companies into the university to showcase research and new technologies, to facilitate corporate recruiting of graduates,
and, in the process, to enhance corporate giving and research sponsorship. Examples are the MIT Industrial Liaison Programme and UCSD’s Corporate Affiliates programme, both described in Chapter 4.

US universities undertook such efforts earlier than universities in the UK. During the 1960s in much of the UK, industry and universities often worked in isolation from each other. As an IBM executive in Scotland reported: “there were three blocks skills, industry, and government, and in those days there was no liaison between those three areas.” Since UK universities are publicly funded, there has been less of a focus on corporations as a source of donations or research support. One of the earliest efforts to make a university–industry connection, begun in 1975, was the Teaching Company Scheme described in Chapter 4. The most active early participants were polytechnics such as Napier University in Scotland.

**Industry-based**

Industries also sought to reach out to policy makers, in many cases joining together to speak with one voice. An example was the Massachusetts High Tech Council, described in Chapter 5. Other industry associations included Chambers of Commerce: the Association for Corporate Growth in San Diego: area chapters of the American Electronics Association; the Software Industry Council; biotechnology industry associations; and other trade associations.

**7.3.2 Second-generation intermediaries**

Second generation intermediaries integrated several of the realms of policy, place, and finance within their structure. They generally emerged in the 1980s and early 1990s. In some cases, existing single-focus agencies merged to create an organisation with a more comprehensive mission. Others sought to exploit the presumed benefits of proximity to universities: this was the era of the university-related research park. Yet others sought to exploit advantages the region had in technology. And others focused on providing venture financing. These second generation institutions focused on the development, or enhancement, of a particular kind of asset: land, financial assets, an expensive commonly needed facility, and intellectual property. These intermediaries also responded to various regional development problems, for example, those posed by the demise of the computer industry in Massachusetts, or by the relocation offshore of the Scottish branch plants of multi-nationals.

As the focus of economic development policy shifted from large companies to small and medium sized companies, new intermediary structures appeared that increased the connections enterprises had to each other and that facilitated connections with the other realms. Some were organisations created in earlier eras that re-oriented their operations to better reflect the needs of the “new” regional economy in the 1990s; others came into being during the 1990s. In the US, these increasingly operated as autonomous organisations in that they were not accountable to outside organisations. They ranged from private non-profit organisations to public corporations (described previously), subject only to indirect state control.

The following are examples drawn from our study areas of second generation intermediaries.

**Evolving public corporations**

The Massachusetts Land Bank and the Massachusetts Industrial Finance Authority merged in the 1990s to form the Massachusetts Development Finance Corporation, or MassDevelopment, which was empowered to provide a range of fixed asset financing for business facilities and equipment. MassDevelopment also undertook land development of state and federal properties such as those previously under the authority of the Land Bank, especially the 4,000-acre former army base, Fort Devens. The legislature capitalised the organisation and granted it authority to issue bonds such as private tax-exempt revenue bonds; it was expected to finance its operations from revenues.

In Scotland too, economic crisis prompted a reorganisation of the institutional support system for business. The most significant move was the merger of the Scottish Development Agency and the Scottish Training Agency and the creation of Scottish Enterprise (SE) in 1992. SE consisted of a central “strategic” body and 12 Local Enterprise Companies (LECs).

### Table 7.2 Second-generation intermediaries

<table>
<thead>
<tr>
<th>Connection</th>
<th>Type</th>
<th>Examples</th>
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</thead>
<tbody>
<tr>
<td>Finance – Place</td>
<td>Multi-strategy public corporation</td>
<td>MassDevelopment Scottish Enterprise Regional Development Agencies</td>
</tr>
<tr>
<td>Technology-Place</td>
<td>Central Technology Asset</td>
<td>Massachusetts Technology Collaborative (in 1980s) MCNC</td>
</tr>
<tr>
<td>Policy – Finance</td>
<td>Business-based capital gap</td>
<td>Mass Technology Development Corp. Scottish Equity Partners LINC</td>
</tr>
<tr>
<td>Technology-Industry</td>
<td>Technology Transfer</td>
<td>MIT’s TLO University of Edinburgh Technology Transfer Centre</td>
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</table>

Table 7.2 identifies some of the second-generation intermediaries with respect to the realms they connected and the type of activity they undertook.
The 12 LECs had their own boards, made up of local people from the public, private and voluntary sectors, with an interest in their local areas. Members of the LEC Boards were volunteers, and the staff were employed by Scottish Enterprise, but seconded to the LECs. The LECs worked closely at a local level with organisations in their respective areas, either through projects and programmes they devised and implemented or through the local delivery of programmes mandated by Scottish Enterprise National. Scottish Enterprise National operated at a strategic level identifying and supported projects that were of national importance. Every year, an LEC Board submitted its plans along with an application for funding to Scottish Enterprise National. Once Scottish Enterprise approved funding, it contracted with the LEC to deliver the economic development activity outlined in its plans.

Scottish Enterprise, like the Welsh Development Agency, was an example of the Regional Development Agency (RDA) approach to delivering development programmes at arm’s length from central government policy makers. On the 1st of April 1998 similar bodies were created in the eight English regions with the ninth in London, established on the 3rd July 2000 following on the heels of the establishment of the Greater London Authority. The RDAs have the statutory requirements of furthering economic development and regeneration; promoting business efficiency, investment and competitiveness; promoting employment; enhancing development and the application of skill to employment; and contributing to sustainable development at the regional level. The work of the RDAs is guided by regional strategies that have been agreed by Government. As part of the Spending Review 2000 in England, the RDAs were asked to increase their role as strategic leaders of regional development. This involved drawing-up Regional Strategies that set out the priorities for economic development and regeneration in their regions.

**Investing in technology-related facilities**

Beginning in the 1980s, several states in the US developed non-profit organisations whose mission was to advance the development of certain kinds of technologies in their home regions. One example was the Massachusetts Technology Collaborative, created in the 1980s to improve chip design by giving engineers in the state experience with fabrication, through access to a common fabrication facility. Among other board members, the Deans of all the engineering schools in Massachusetts, including private universities such as MIT, sat on the board during the 1980s. North Carolina set up a similar organisation, the Microcomputer Centre of North Carolina (MCNC). Both organisations evolved into quite different entities in the 1990s.

**Land and sites**

The development of real property, intended to enhance the attractiveness of the region to high tech companies, was often done by organisations that incorporated the different realms. An example in Massachusetts was Worcester Business Development Corporation (WBDC), a subsidiary of the Worcester Regional Chamber of Commerce, with a mission to attract new businesses to the area through the development of industrial parks. Although its Massachusetts Biomedical Research Park (See Chapter 6), was adjacent to the fledgling University of Massachusetts Medical School, the intent was not to advance the interests of the school (as was the case in the development of University Park by MIT, for example). The intention was to use the school and the park to enhance the attractiveness of the region. To help accomplish this, WBDC’s board incorporated key leaders from business, government, the universities, and other key interests in the region.

Similarly, Massachusetts developed another cross-realm organisation whose mission was to facilitate company relocations to the state. A consortium of utility and telecommunications companies, real estate associations, and the state office of business development, founded the Mass Alliance for Economic Development. It was organised as a trade association, relying on member fees. It served as a central source for property information for high technology and other companies interested in locating in the state. The organisation also had an “ambassadors” network through which member company executives act as peer resources for visiting executives. (See Chapter 6.)

**Financing**

Place-based financial institutions sought to fill gaps that existed at various places in the local financial system, supporting new technology enterprises. Since new ventures require specialised capital, and since venture capital is known to be highly place-related, policy-makers have tried to increase the number of new and growing ventures by creating place-based equity investment institutions. Examples included Scottish Equity Partners and the Massachusetts Technical Development Corporation. These organisations used public money but were structured with private boards. See Chapter 5.

**Technology transfer**

In the mid 1980s universities in both the US and the UK began to focus more on technology transfer. In 1984 the University of Edinburgh established the first technology transfer office in Scotland. MIT’s Technology Licensing Office (TLO) was reorganised in 1985, in response to federal legislation regarding patent rights for inventions resulting from federally-funded research. The essential function of the TLO was to license patents on MIT-owned inventions to businesses that would develop the technology commercially. Most TLO staff have substantial private sector background. The TLO had no board or steering committee: the director reported directly to central MIT administration and ultimately to the MIT Corporation.
7.3.3 The third-generation: building the research infrastructure

Third-generation intermediaries incorporated a greater role for universities, not only as sources of education and technology, but also as players in regional economic development strategies. The new organisations (and re-constituted existing ones), were integrated more firmly into the four realms of place, policy, finance, and technology. This was the result of the convergence of four streams of analysis in economic development. The first stream was cluster analysis, developed out of the work of Michael Porter. The second was the analysis of the role of networks, exemplified by the work of Annalee Saxenian. The third was work focusing on the role of technology transfer and the commercialisation of university research. The success of Stanford and MIT had contributed greatly to the interest in this area. Finally there was the substantial body of work documenting the importance of the flow of national research funds, in the defence industry, in medicine, and in science. Examples included land and facility developments that incorporate organised connections between research-related functions and business development; various kinds of technology-business incubators; research institutions with built-in industry connections; and entrepreneurship organisations that made explicit connections to the university and finance realms. While second generation intermediaries focused on projects, third generation intermediaries took a more systemic approach, seeking to build a research to business system. Leaders we interviewed described this as the “research infrastructure,” which largely involved institutions making the technology-business connection, including the use of public funds to support the development of particular kinds of technology.

Table 7.3 Technology-related Intermediaries

<table>
<thead>
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<th>Connection</th>
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<td>Organised adjacencies</td>
<td>Alba Campus, NC State Centennial Campus</td>
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<tr>
<td>Technology-orientated incubation</td>
<td>Institute for System Level Integration</td>
</tr>
<tr>
<td>Finance-orientated connections</td>
<td>Scottish Microelectronics Centre, Mass Biomedical Initiative</td>
</tr>
<tr>
<td>Comprehensive university services</td>
<td>Edinburgh Research and Innovation, Ltd.</td>
</tr>
<tr>
<td>Network-oriented connections</td>
<td>MIT Enterprise Forum, Scotland CONNECT, MassMedic</td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>Scottish Institute for Enterprise, MIT Entrepreneurship Centre</td>
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</tbody>
</table>

Organised adjacencies

During the 1970s and 1980s, the developers of science parks assumed that if you put enterprises next to universities or research centres, there would be spillovers. However, it is clear from many second-generation efforts that such spillover effects could not be taken for granted. (See Chapter 6.) Such ventures undertaken after the mid-1990s sought to solve this problem by using design to create more opportunities for such spillovers to occur and to broker interactions more actively. Examples included the Alba Campus in Scotland and the Centennial Campus at NC State University in Raleigh. (See Chapter 6.) Another, more recent, example was the Worcester Gateway Project, a joint development of the Worcester Polytechnic Institute (WPI) and the Worcester Business Development Corporation, on a brown-field site near WPI’s main campus. The site will contain a mix of uses, including a federally supported bioengineering facility, campus housing, office, and retail space. The state is providing brown-field cleanup and infrastructure.

Technology-orientated incubation

Business incubators developed early on, focused on the joint needs of small companies, and they were often developed in conjunction with universities. The next step was to create incubators that enhanced the development of certain technologies as well. In addition, the managers of these incubators used the facility as a jumping off point to promote the development of the region. Examples included the Scottish Microelectronics Centre and the Massachusetts Biomedical Initiatives (MBI) in Worcester; both described in Chapter 6. MBI had several incubator facilities for biotechnology companies, and it supported a network of financing and related services. Its board included some of Worcester’s most influential business leaders. Its mission was not just the incubation of biotech companies, it was the promotion of the region as a biotechnology centre.

Enhancing research

Third generation research intermediaries drew together multiple universities as well as key players in the other realms to enhance the innovation network in a region. The Intermediary Technology Institutes (ITIs) in Scotland are good examples. Each ITI brought together Scottish Enterprise, multiple universities, and companies in the relevant industries. Research and commercialisation steering groups, comprising global industrial players and academics with global reputations in their research fields have established overall direction of the institutes. Similarly, the Edinburgh Technology Fund, created in 1999, involved a consortium of institutions including the University of Edinburgh and four research institutions in the region. Funds were intended to complement funds from other sources such as Scottish Enterprise and the UK Department of Trade and Industry.

Comprehensive University services

By the turn of the century, the increased focus on technology transfer had produced new ways of organising the university technology transfer operations. Some universities elected to
create technology transfer operations shared by several institutions. Another alternative was to create an independent operation to manage a range of industry-orientated functions, including technology transfer; The University of Edinburgh was an example. In 1999, the university created the Edinburgh Research and Innovation Ltd. This was a private for-profit company designed to manage technology licensing and outside research; act as a central consulting service for university staff; manage the Edinburgh Technology Transfer Centre – the university’s incubator - and oversee the university’s interest in the Edinburgh Science Park (known as the Edinburgh Technopole). ERI had multiple functions. Its technology licensing was a formal part of the commercialisation process. In its consulting arm it acted as a “broker” between academics and companies. In its research operations it acted as an agent of the university and individual academics as grant seekers.

Although ERI was formally a private company, it is a wholly owned by the University and returned all profits to it. The director reported to the University’s Director of Corporate Ventures Scotland.

**Network-orientated connections**

Parallel to institutions that directly supported research and development were organisations focused on connecting the right players. The idea was to maximise the odds of productive interactions by optimising the opportunities for informal connections. Multi-service support organisations also supported such connections. The leaders of these organisations emphasised several factors as key to their success. One was that the organisation itself was situated on neutral turf. A founder of CONNECT discussed the creation of a “firewall” between the organisation and its university sponsor, to ensure that the organisation would be seen as an “honest broker.” Several other interviewees emphasized the brokerage role, and some indicated that independence from government was a key to this function.

Examples of such organisations included CONNECT; the North Carolina Centre for Entrepreneurial Development; the MIT Enterprise Forum (which is affiliated not with MIT directly but with its alumni associations around the world), and Technology Ventures Scotland.

Interestingly, several of the organisations that functioned as second generation intermediaries when they were created in the 1980s, evolved into third generation intermediaries during the 1990s. An example was the Massachusetts Technology Collaborative (MTC), which sold its chip fabrication facility; leased the property to a private firm, and transformed itself into a public interest consulting organisation that supported technology-based business in general. Its more recent activity is described in Chapter 6. MTC received state funds for its consulting operations; it used lease revenues to finance other parts of its operation; and it housed an endowment, Renewable Energy Trust, which financed the development of alternative energy products.

**Entrepreneurship**

Finally, recognition that building technology companies requires special skills and attributes has led to the development of organisations focused on teaching those skills. In some cases, entrepreneurship education occurred within the university, as at the MIT Entrepreneurship Centre. In other cases, entrepreneurship education crossed university boundaries (Scottish Institute for Enterprise, see Chapter 6), or is embedded in an independent region-based entity (Centre for Entrepreneurial Development in North Carolina).

### 7.4 Regional collaboration and partnerships

Regional partnerships sought to make the geographic as well as cross-realm connections necessary for action at the regional level. There was general agreement that a fundamental role for government was to create a planning environment for business. Similarly, the provision of infrastructure was taken as mainly a public responsibility, although private sector financing involvement was becoming of increasing importance. Downs (2004), using categories developed by Foster (2001), described a range of both institutional and non-institutional strategies used in the US to address regional issues such as traffic congestion. We encountered similar strategies in this study.

#### 7.4.1 Nodes and networks: the dilemma of geography

The institutional problem associated with planning and the provision of infrastructure in technology-based centres was identified as a mismatch in geography, between governmental units and economic units on the smallest scale. High-technology centres could be quite bounded. For example, one respondent noted that the Biotech industry was centred in a few blocks in Kendall Square, not the entirety of the city of Cambridge MA. Similarly, people we interviewed in the Research Triangle noted that the boundaries of the Triangle were both clear and precipitous: the centre did not extend far into the hinterlands.

Meanwhile, planning and infrastructure delivery required decisions to be made on a larger regional scale. Labour markets and housing markets were also regional. Our respondents defined regions in terms of travel time; how far one could drive in one hour. Government administrative units did not correspond to either scale. Municipalities tended to be bigger than localised centres of enterprise, but too small for planning or infrastructure delivery; US states and UK counties did not fit either. For example, policy makers in Scotland sought to define Scotland as a region, yet there was a clear economic distinction between the Highlands and Islands, and the south.
Land use planners in technology-based centres in both the UK and US faced competing demands: to provide for future job growth and development needs, and to retain the quality and character of the area, so that the location remained attractive to entrepreneurs and other high-tech businesses. In both countries, there was increasing emphasis on “sustainable” development and smart growth.

In general, the stock of infrastructure tended to be heavily concentrated in the older urban areas, whilst many technology-based companies sought location centres in more peripheral areas. The old patterns of transit did not accommodate the new patterns of growth well, with people wanting to move around the periphery rather than to go back and forth to the old urban centre. Sometimes the problem was inadequate city-region communication infrastructure, as in the example of Cambridgeshire in the UK. In virtually all the case study areas we considered in the research, growth brought increases in commuting and changes in commuting patterns, creating traffic congestion on roads that were operating above their design capacity. Technology-based development also created significant need for access to international airports and broadband communication.

Civic and business leaders in both the surveys and interviews noted the importance of continued investment in transportation and communication infrastructure (in the US and the UK), and housing (especially in the UK), to the continued viability and competitiveness of the centres we studied. It was of interest to note that there were differing constraints on housing and premises construction between the US and UK, but in both places the high cost of housing was seen as a problem.

The sphere of economic influence associated with enterprising places also provoked a number of important policy implications. In the early phases of the development of technology-based centres it has sometimes been argued that benefits might be transmitted to relatively depressed neighbourhoods in both urban and rural areas. In fact, this has proven to be a very elusive policy objective to secure. For example, people we interviewed noted that the planners of Research Triangle NC anticipated that activity in the triangle would create “trickle down” effects in the wider region. That has not occurred, and policy makers today are trying to figure out how to broaden the group of beneficiaries to the wealth created in the triangle. We heard similar comments from people across both the UK and US case studies, and such issues need very careful consideration in the strategic development of enterprising places.

7.4.2 Existing planning institutions

Policy makers in each country in our case study areas faced similar dilemmas: how to align decision-making with respect to planning and infrastructure needs and delivery?

In the UK there is strong centralised control of regional and sub-regional planning practices and procedures. These regulations control the development of housing, commercial space, and highways. In the US, planning is the prerogative of local governments, as long as they follow accepted procedures for fair decision-making.

The UK planning system provided a hierarchical framework of statutory development plans. National planning guidance (Planning Policy Guidance (PPGs) in England and Planning Policy Statements (PPS) in Scotland) ensured conformity across the country by setting out government priorities with respect to the use and development of land. Local planning authorities were heavily regulated and must work within the framework dictated by PPGs and PPS mandated by central government. Thus local governments could not independently decide to permit new housing or commercial development unless such development was permitted under central plans. At best, the system created long lead times in land use planning and the co-ordination and delivery of infrastructure. This has often resulted in a belated response to growth pressures within technology-based centres. Concern has been growing about whether existing structures of government were capable of delivering and managing growth of technology-based centres within the current planning system.

Other structural problems created disincentives for local authorities to respond to the needs of technology-based companies. Thus, local government had only limited control over local business taxation with further centralisation actually taking place in the early 1990s. The great majority of spending programmes remained centrally controlled. The unequal power relationship between local and central agencies of government weakened the budgetary authority and competence of local authorities. Dependence on the national level also encouraged those concerned in managing growth pressures within a high-technology centre to leave conflicts unresolved, (i.e. they can pass the buck to a higher tier, rather than develop horizontal relations to resolve local issues). Although there were county-wide decision-making bodies - the county councils - they had little autonomous political clout. The UK planning policy framework was subject to inter-authority as well as central-local disputes. Protracted public consultation exercises often result in considerable uncertainty and difficulties in reaching a consensus with respect to predicting growth forecasts and infrastructure demands within high-technology areas.
Planning in the US was much more decentralised. States essentially have the power to regulate land development, and states, in general, delegated this power to individual cities and towns. Land development was controlled through local zoning regulations, although states impose certain requirements if they find localities are acting in discriminatory ways. For example, in Massachusetts state law required that localities permit the development of a certain amount of housing for low and moderate income families: the state could over-ride local zoning decisions if it found a locality was being too restrictive. US localities could also raise local taxes, issue bonds, and expend revenues as they saw fit (as long as they acted in fiscally responsible ways).

The combination of local power to regulate development and local power to tax and spend would appear to allow more flexibility in the US in the provision of local infrastructure, housing and business premises in high-tech centres, compared to the UK. However, it is important not to make too broad a generalisation since there were some important examples where the British response to land use issues was perhaps faster than the American equivalent, with an example being the accommodation of new development on brown-field land.

**7.4.3 Leader-initiated strategies for regional vision and governance**

In our study areas, regional leaders responded to the need to create policy frameworks at the regional level by creating a variety of cross-regional collaborations, which we called regional partnerships. These facilitated the development and implementation of planning policies appropriate for the jurisdictions that spanned the new enterprising places. They also permitted the development of a central vision for the place.

These partnerships took different forms in the different places we studied. They ranged from stand-alone conferences convened at critical economic junctures, to staffed organisations.

In Massachusetts, the most politically decentralised place we studied, the partnership involved a period of gathering together the major stakeholders across the state. This was done at two periods of time, each following an important economic downturn. In each case the gathering was organised on a regional basis, and the product was a document to guide state policy and to support and coordinate the many autonomous local initiatives.

**Massachusetts Regional Competitiveness Forums**

While Massachusetts and its technology highway, Route 128, were famous as centres of high technology industries through the 1980s by the early 1990s the demise of the large computer companies, the national recession, and the crash of the speculative real estate and construction booms dealt severe blows to the state’s economy and its image. The state’s newly elected leadership responded by launching a major strategic review of the state’s economy and its economic development initiatives. Through the University of Massachusetts, the leadership reached out to business and academic leaders, organized regional meetings, and commissioned research on the economic issues facing the state. The result was a strategic document issued in 1993 called Choosing to Compete: A Strategy for Job Creation and Economic Development. The key focus of this strategy was on the state’s education and training programmes and regulatory and permitting agencies, and it set the stage for continued funding of several large infrastructure projects initiated under previous administrations.

In 2001, after the crash of the telecommunication and dot.com stocks, the state undertook another strategic review, again through the University of Massachusetts, and again using extensive outreach to academic leaders, community groups, and knowledgeable individuals. The new strategic framework, Toward a New Prosperity: Building Regional Competitiveness Across the Commonwealth, focused on building seven regional coalitions as fundamental organizing units for economic development.

Leaders in Hertfordshire also used periodic stakeholder conferences, but these evolved into an ongoing forum for the debate of policy and the advocacy of specific initiatives in support of policy agreements.

**Hertfordshire Prosperity Forum**

In response to the economic recession of the early 1990s and the decline of the defence industry, the key players in Hertfordshire have convened three county wide conferences to address the situation. The first conference resulted in the “Bright Green Industrial Strategy,” an economic strategy focused on ways to raise education and training standards, develop key employment sites and promote inward investment in order to restructure the county into a technology-based economy. At the second conference, held in 1995, participants established the ongoing Hertfordshire Prosperity Forum. Its role was to champion Hertfordshire’s cause in socio and economic development, to direct the review of the strategic strategy, to provide a strategic forum for debate and to guide research and special projects. At the third conference, held in 1999, participants revised the county’s economic strategy to include new objectives.

The Forum has been particularly successful in bidding for funds. For example the county was one of the first counties to secure funding to establish a Business Link office and it has been successful in bidding for Single Regeneration Budget regeneration funds. In addition, the Forum has been successful in assisting in the identification and development of key business sites such as the former Hatfield Aerodrome and the proposed Bio-science Park in Hemel Hempstead. The Forum has also been responsible for the establishment of an information observatory for the county, the establishment of various networks and alliances such as the Aerospace Alliance and HertNet-work, and improved marketing and branding for the county. As of 2003 the Forum had some 40 partnership organisations and linkages to a number of other strategic partners.
Taking the organisation of the partnership one step further, leaders in the Research Triangle region of North Carolina established a permanent entity to create a regional vision and coordinate the implementation of individual initiatives. In this case, leaders made use of an organisation called the Research Triangle Partnership, created in 1990 in regions across the state. The original intent was to coordinate regional recruitment of firms to the state. In 2004 the partnership assumed responsibility for coordination of a broad economic development strategy for the Research Triangle region.

It was of interest to note that initial groups in both areas convened, then disbanded until the need for another convention became manifest, then reconvened. In the interim, key players kept up their connections with other key players through their participation in ongoing project-based institutions.

**Staffed regional partnership**

Like Massachusetts, North Carolina policy makers created seven regional planning areas to span that state: the region containing the Research Triangle included 13 counties, an area that respondents indicated went well beyond the real boundaries of the Triangle impact area. Each is defined as a Regional Partnership and has staff.

**Research Triangle Regional Partnership, North Carolina**

The partnership was created in 1990 to coordinate the recruitment of firms to the region. Similar partnerships were created across the state. In 2001, the partnership brought in Michael Porter of Harvard Business School to undertake an analysis of the region’s economy, and for the next several years, a 37 member task force of business and higher education leaders worked to create a plan for economic development in the region. The result was a document called Staying on Top: Winning the Job Wars of the Future, released in 2004. The document outlined a five-year plan, and the implementation will involve dozens of intermediary organisations like the ones described here. The strategy calls for focusing the region’s business, academic, and economic development resources on a shared vision of job creation. Funding is to come from institutional partners, who agreed to redirect their existing resources in support of the initiatives outlined in the plan, private fund raising through business organisations, grants from national and regional foundations, corporate and public sponsorship, and revenue generation. The Partnership and its staff will coordinate the effort.

**7.4.4 Delivering infrastructure**

Infrastructure investment required action at, and beyond, the municipal level. The differences between the US and UK in the planning and financing structures for infrastructure delivery affected the nature of the solutions sought in each country.

**Regional decision-making in California**

**San Diego Association of Governments (SANDAG)**

This is a regional decision making agency for the area’s 19 jurisdictions. All 18 Cities and County governments are involved in identifying regional priorities. They co-ordinate local priorities within a regional framework. These actions affect transportation and land use planning, which have a direct impact on projects to reduce traffic congestion, provide housing and strengthen the economy and protect the environment. SANDAG has advanced a number of innovative transportation programmes. Directors approved an innovative $516 million financing package to complete a number of major transportation projects. They worked in close partnership with the California Transportation Agency to take advantage of the financial market and will use nearly $1.50 billion in bonds to advance construction of highway and transit services. SANDAG is also streamlining regional planning that will integrate local and regional plans for land use, transportation systems and infrastructure needs. In March 2002, Governor Davis awarded $1 million to SANDAG to jump-start the Regional Plan process for the San Diego region. SANDAG is also suggesting the creation of a new regional agency Bills have been introduced in both houses of state legislature dealing with regional governance for the San Diego region.

**Regional decision-making in Cambridge UK**

**Cambridgeshire Horizons**

This non profit-making company was developed from an informal arrangement formerly known as the Infrastructure Partnership. It was set up by the Cambridgeshire local authorities to drive the development of new communities and infrastructure forward in the Cambridge sub-region in accordance with the Structure Plan Strategy for the Cambridge sub-region. Cambridgeshire Horizons is governed by a Board with representatives from all the local authorities in the Sub region, together with representatives from other sectors that have a key role in delivering development and infrastructure: including health, housing and central government agencies. It is funded by its partners along with the Department for Communities and Local Government. The partners comprise English Partnerships, the East of England Development Agency, Cambridgeshire County Council, Cambridge City Council, and the District Councils of Fenland, South Cambridgeshire East Cambridgeshire and Huntingdonshire. The work of the group is divided into four main areas of enhancing the quality of life, assisting in major infrastructure projects, co-ordination of housing development projects and securing funding. While Cambridgeshire Horizons does not have any statutory powers and cannot make planning policies its role is to cut across organisational boundaries, seek to overcome barriers to growth and try to resolve different views; it works closely with the local authorities and operates openly with all Board meetings open to the public. The goal for the area is to provide 47,500 new homes by 2016, 50,000 new jobs and over £2 billion on infrastructure development to help create sustainable communities. There have also been recent proposals to speed up the co-ordination and delivery of UK planning policy in general. The UK Planning and Compulsory Purchase Bill is introducing Regional Spatial Strategies which are to be produced by regional chambers, including a mixture of indirectly elected local authority representatives and other regional interests. This is to strengthen regional planning functions and facilitate the implementation of planning policies. It will also allow regional spatial strategies to be more independent of central government. This regionalisation
programme may counter-balance central control tendencies in the UK and result in more local discretion in funding and policy making in technology-based centres, in turn becoming more similar to the US experience.

7.5 Entrepreneurship and institutions

In most of our study areas, interviewees credited specific individuals with advancing the development of the place. These individuals exercised leadership through the hands-on participation in specific projects, putting in their own time and mobilising the resources necessary to bring these projects about. In some cases, the individuals worked from their base in the traditional realms of technology, government, or industry. But they extended their vision beyond the traditional boundaries of these institutions. The following are some examples.

We saw a number of examples of the importance of university leadership in both countries. An important leader in San Diego was Richard Atkinson, former chancellor of the University of California at San Diego. Described as a charismatic leader who encouraged faculty to commercialise their research, he was credited with the creation of the widely replicated CONNECT programme. Frank Loew, former dean of the Tufts Cummings School of Veterinary Medicine near Worcester, MA was credited with opening this new veterinary school to the community and fostering entrepreneurship as an institutional characteristic. The school developed a unique faculty that excelled at basic and applied research, bringing substantial outside research funds into the university, and thriving without tenure. As he put it: “A relationship is not going to happen if the university CEO turns his or her back. The people running these organisations, including the faculty, are key. They need to be accomplished at reaching out and developing robust relationships. There is a need for community involvement and leadership with community initiatives by university leaders.” When we asked who was behind the successful partnership building efforts in the Research Triangle, we were told Mollie Broad, head of the North Carolina university system, along with governor James Hunt and the area’s business leadership. And Alec Broers, former vice chancellor of the University of Cambridge was credited with making significant changes in attitudes toward entrepreneurship in the Cambridge region.

Entrepreneurship within the university was also important. MIT’s transformation of the real estate adjacent to the Institute into space that would eventually accommodate companies from small biotech firms to the Swiss pharmaceutical giant Novartis originated, our interviewees said, from Glenn Strehele, who served as MIT’s treasurer from 1975 to 1998. When he came to MIT, the trustees presented him with a problem: MIT was holding an assortment of under-performing real estate assets adjacent to the Institute. Most of the property around MIT was itself depressed. Strehele chose to address this problem broadly, as a development opportunity. He advocated that MIT itself become an active player rather than a passive investor in the area, and he sought to involve all elements of the Institute in the planning. He also stuck with this effort over time, actively managing the real estate activities for ten years before hiring someone to head the real estate operations. His successors took a similar entrepreneurial approach to the various issues and opportunities that arose during their tenure. MIT now holds a significant amount of highly desirable real estate in Cambridge, Massachusetts. At UCSD, we heard about Mary Walshok, director of the university’s extension programmes and important in the development of CONNECT. She both ran the programmes that brought the university in direct contact with area businesses, and wrote and spoke about the nature of the university-industry connection. As the president of a San Diego intermediary noted: “The enabling organisations and key leaders like Mary Walshok and CONNECT were so, so critical. The university was the anchor to a lot of technology, and we had Mary, this brilliant sociologist, who saw all, heard all, and was on all the boards.” And the leaders of the Hertfordshire Prosperity Forum asked University of Hertfordshire pro vice-chancellor Tim Wilson to chair the Forum for important institutional reasons: as an institution with a long time-horizon and thus less political than some of the other participants, the university was in a position to mediate between various public bodies and between business and the public councils.

Business leaders also played key hands-on roles, especially in the US, and they did more than simply lend their names to an effort. An example is a story we heard about the president of Worcester’s largest bank, who met for fourteen Mondays in a row with the state’s commissioner of capital assets to negotiate the transfer of state land to an intermediary in Worcester for the development of the Massachusetts Biomedical Research Park.

We saw entrepreneurship and leadership in government as well. In North Carolina, governor James Hunt, during his tenure of almost 25 years and beyond it, committed himself to work on the development of the state’s educational infrastructure, and the growth of industry in the Research Triangle region and other parts of the state. When asked about the role his staff played in researching the various issues, Hunt replied: “This is not staff driven. You have to learn about this yourself, so you can personally explain it to people, to the voters.” Similarly, former Massachusetts state senator Gerry D’Amico is credited with personally negotiating much of the intergovernmental issues associated with the development of the Massachusetts Biomedical Research Park and its support infrastructure in Worcester. As one respondent put it: “Individuals make choices. The biotech park is in Worcester because Gerry D’Amico pushed (then Massachusetts governor) Mike Dukakis to come here on a Saturday afternoon and talk about it. You don’t just need government, you need a component of leadership.”
Tenacious and effective leadership was also present in the intermediary organisations we studied. In these cases, entrepreneurs built the organisations, secured the necessary resources, and delivered to their customers in much the same way that the heads of high technology companies did. Examples included Monica Doss of the Centre for Entrepreneurial Development in North Carolina; Robert Smailes, director of Edinburgh Innovation and Research; Kevin O’Sullivan, director of the Massachusetts Biomedical Initiatives; and Sharon Bamford, former head of the Edinburgh Technopole and now director of the Scottish Institute for Enterprise. These are only a few; there were many others.

7.6 Conclusions

Broad regional partnerships enabled geographic connections to be made that were necessary to create a vision of the region and its future. Intermediaries enabled cross-realm connections. Both provided mechanisms for the leaders in different realms, within business, academia, government, and civic society, to test and build trust relationships with their peers in other realms. This process looked to be necessary for the development of appropriate strategies for future development.

History mattered when it came to policy-initiated intermediaries. For example, in Massachusetts, the private corporation has long been a model for public action. As a result, the institutional structure in the state was heavily weighted toward intermediaries that undertook activities in the public interest, but that remained at arm’s length from government. In contrast, in Scotland, the central UK government has long taken direct responsibility for public action. With devolution of authority from London to Scotland, the Scottish Executive assumed more responsibility. While we saw many intermediaries in Scotland, most implemented centrally defined programmes and were directly accountable to the Scottish Executive for funding and for actions.

With respect to intermediaries we found the following:

• Intermediaries were essentially organic, growing out of place-specific industrial structures, inherited competencies and leadership. They were similarly focused and mission driven, given their origins in specific problem solving.
• Intermediaries facilitated the transformation of places to become competitive regions by providing mechanisms for the leaders within business, academia, government, and civil society, to test and build trust relationships with their peers in other realms. This process was necessary for the development of appropriate strategies for future development.
• The relationship testing and trust building came from the real-time experience of participants in solving problems on the ground. Through these experiences, participants were able to form partnerships. Intermediaries institutionalised the most successful partnerships and those focused on long-term issues.

These intermediaries and partnerships provided economic governance in their regions, enabling their transition to the requirements of the technology-driven global economy. They depended on the participation and support of other more traditional public and private organisations. Because the new organisations were agents of change, they required the participation of the senior executives from the various partners, people who could make decisions and commit resources to the new initiative. The new organisations had clear missions and markets, delivered products to these markets, and survived only if their partners and products found them effective over time.

Civic enterprises in the US included more diversity in realms and were more private sector orientated than those in the UK, which were heavily dominated by public players. This had advantages in that the enterprise maintained access to critical resources despite capacity shifts over time. Independence from government, but with access to government resources, allowed the enterprise to operate through significant political changes over time. The enterprises generated/provided an arena for new regional leadership.
8. Main conclusions and implications for the United Kingdom

The ability of the UK to compete in the New Economy depended crucially on it developing and nurturing its technology-based companies. Many of these companies realised competitive advantage by clustering geographically around knowledge-based institutions. The success of these clusters was an important factor in the ability of the technology-based companies to grow. However, the research described in this report indicated that certain places were more enterprising than others in sustaining such activity. And there were important lessons to be learned as to how best to bring players in the different realms of technology, finance, place and policy together in order to maintain the momentum. We summarise them below.

8.1 Key lessons: building the knowledge base

The central lesson was that investing in systemic academic excellence was of primary importance. High quality teaching and research enhanced the reputation of a university and the place. This drew the brightest students, and many of these remained in the region when they finished their studies.

Respondents identified the flows of research funding to an area as a key factor driving academic excellence, innovation and new enterprise development. Leaders in successful centres made concerted efforts to increase these flows.

The research highlighted the importance of ensuring that students had the kind of education that made them flexible, able to take on new and novel problems, and that provided them with the research and laboratory skills appropriate to their field. Respondents made it clear that graduates should not have to get basic research training after they finish their studies. (Nor should the KBI have to provide company-specific training as part of its core programme.)

Collaboration by the KBIs with companies in their research helped to ensure that students had the relevant research and laboratory skills to make them attractive workers, and it broadened the funding base for research. Most companies did not fund such research in expectation of usable proprietary technology. Respondents stressed the desirability of managing the research in as open a way as possible, in order to maximise the flow of ideas.

The availability of multiple opportunities for contact among companies, faculty and students generated serendipitous results in terms of innovations and enterprise. Respondents noted inherent potential conflicts, and they suggested that strategies to manage these interactions had to evolve in ways appropriate to individual situations.

Respondents favoured extending the university’s resources to address the continuing education needs of former graduates and businesses in the region as one way by which business contacts (and revenues) could be increased with the KBI.

Respondents indicated the necessity for university staff to increase their understanding of how companies used intellectual property if overall commercialisation of technology was to be maximised. They noted that the goal of maximising commercialisation opportunities conflicted, in some cases, with institutional goals relating to revenue maximisation. This is an important area for further research.

Respondents saw facilitating connections among academics, entrepreneurs and investors as key to maximising the opportunities for business development. However, they cautioned that KBIs should not try to be all things to all people, and build staff accordingly. Respondents suggested the importance of recognising that the best business advisors, patent attorneys and other specialists were usually to be found outside the academic institution and said it was desirable to find ways of referring people to the best.

KBIs were landed institutions, and we found them using these resources to their, and their regions’, advantage. Successful strategies took a programmatic approach that reinforced the goals of the institution whilst recognising the requirements of the market.

Finally, KBIs were key players in regions because of their size, their status as major employers, and their long-term horizons. We found KBI leaders who recognised this, who engaged in the kind of civic leadership appropriate to this significant institutional position, and whose actions were credited with having a significant effect on the success of the centre.
8.2 Key lessons: using finance to support place

Our exploration of the relationships among finance, the stages of development of ideas and companies, and their connections to place, policy, and sources of knowledge suggested a number of lessons for sustaining enterprising places. Respondents highlighted the importance of the following:

- Investment in institutional assets as an important investment in place. Respondents suggested maximising the use of these assets in the community.
- Investment in the development of embryonic ideas within universities and research institutions. However, to ensure that the market picks the winners, respondents suggested investing in collaboration with business.
- Paying attention to what works. For example, technology grants such as SBIRs in the US and the SMART and SPUR awards in the UK received high praise from companies and were heavily used.
- Venture capital funding to move companies beyond certain thresholds. However, we did not explore this topic in sufficient detail to make specific recommendations, and there was considerable debate over public entry into this domain. This is an area to explore.
- Maximising the use of currently available financing programmes by making sure companies were aware of and had access to them.
- Paying attention to companies at key junctures beyond the start-up. One such juncture was when a company began pilot manufacturing, and respondents discussed the need for financing programmes appropriate to this stage.
- Using bonds as financing tools. The US had useful experience in this area.
- Investment in infrastructure. Leaders of successful centres engaged in the kind of activism that would bring the necessary infrastructure to the region.

8.3 Key lessons: maintaining the place

Key leaders in the public and private sectors sought to meet the needs of technology-based companies and their workforces by adjusting the area’s resource base. They provided strategic planning for these technology-based centres that was bold and visionary, and supportive of the growth of technology-based companies. Moreover, there was an emphasis on ensuring that strategic planning policies were stronger and more coherent for the city-region, coordinating transport infrastructure, housing and economic development more effectively. The policies did not provide a purely local response but also related to regional and national issues. They did not, for instance, confine themselves to the immediate area, but instead benefited the broader sub-regional and regional clusters of high tech business activities.

They also took an integrated and comprehensive approach to infrastructure provision – transport, housing and business premises – which were more effectively linked to land use planning policies. Similarly, they took a longer-term view in securing commitments from companies in anticipation of the scale and pattern of technology-based development.

Successful centres in relation to the activities of technology-based industries were those that had institutional structures that could accommodate the needs of the industry and manage the process of change involved. However, effective institutional formats were not in themselves sufficient to attain successful outcomes. Centres required public policy actions with respect to land use and planning, the installation of new infrastructure, and the ability to finance this at least partly from local resources. There needed to be sufficient resource levers to bring about the changes required.

Overall, from the survey and interview results, the provision of land and hard and soft infrastructure was crucial for the development of technology-based centres. The problems that arose and the constraints on achieving coordinated policy actions were common to both the UK and the US. But there were often significant differences in the type of response that was possible at both the local and the regional level. A lack of flexibility in this respect characterised the system in the UK compared with that of the US. A lack of buoyancy in the local tax base and a heavy reliance on central government for the funding of key infrastructure had even led some areas in the UK to resist accommodating the growth of technology-based activity in their area.

8.4 Key lessons: building organisations

The success of high-technology centres in the US has been greatly assisted by the establishment of the intermediary organisations discussed in Chapter 7 that implemented high priority economic development strategies and could operate across and thus transcend traditional institutional boundaries. We found that the ability to facilitate change varied considerably across the key players in the relevant realms.

There was a wide variety in terms of the format of the intermediaries and instruments used to broker change across the relevant realm boundaries. Successful intermediaries had the following characteristics:

- They were essentially organic, growing out of place-specific industrial structures, inherited competencies and leadership. They were similarly focused and mission-driven, given their origins in specific problem solving.
• They facilitated the transformation of places to become competitive regions by providing mechanisms for the leaders within business, academia, government, and civic society, to test and build trust relationships with their peers in other realms. This process was necessary for the development of appropriate strategies for future development.

• The relationship testing and trust building came from the real-time experience of participants in solving problems on the ground. Through this experience, participants were able to form partnerships. Intermediaries institutionalised the most successful partnerships and those focused on long-term issues.

• They maintained a separation from government. In each place, political leadership and the political climate changed significantly over time. Some separation from government permitted organisations to maintain their operations in this climate of change.

• They maintained connections to multiple realms. This allowed the organisation to draw resources from different sources as the capacity of these sources shifted.

• Their organisational structures enabled entrepreneurship. That is, the organisation had both access to resources and the ability to mobilise and deliver them autonomously.

• They had independent credibility, that is, they could influence key decision-makers in the core sectors of government, industry, universities and in other civic enterprises.

Broad regional partnerships enabled geographic connections to be made that were necessary to create a vision of the region and its future. Intermediaries enabled cross-realm connections. Both provided mechanisms for the leaders in different realms, within business, academia, government and civic society, to test and build trust relationships with their peers in other realms. This process looked to be necessary for the development of appropriate strategies for future development.

Intermediaries and partnerships provided economic governance in their regions, enabling their transition to the requirements of the knowledge-driven global economy. They depended on the participation and support of other more traditional public and private organisations. Because the new organisations were agents of change, they required the participation of the senior executives from the various partners, people who could make decisions and commit resources to the new initiative. The new organisations had clear missions and markets, delivered products to these markets, and survived only if their partners and products found them effective over time.

Within the system of intermediaries and regional partnerships we found entrepreneurs – individual leaders thinking and acting “outside the box.” These entrepreneurs were active in each realm and their actions shaped the realms in a way to foster the growth and development of the enterprising place. Some emerged from traditional institutions, changing them from within.

Others built new organisations. They were central to the development and function of the new institutions, and the institutions themselves facilitated the development of the kind of civic leadership on which successful technology-based centres depend. We called these “regional entrepreneurs.”

Regional entrepreneurship was crucial to success. The US had a number of development professionals with multiple competencies and relevant management expertise. The research demonstrated clearly that if the growth and development of technology-based enterprising locations was to be maximised, it was necessary to bring together expertise that spanned the fields of entrepreneurship, land use planning and finance (including local government financing issues). In the UK there was a shortage of individuals with the skill base required and we saw an urgent need to provide educational and training support to enhance this important component of the human resource base.

Intermediaries and partnerships in the US included more diversity in realms and were more private sector-orientated than those in the UK, which were heavily dominated by public players. This had advantages in that the enterprise maintained access to critical resources despite capacity shifts over time. Independence from government, but with access to government resources, allowed the enterprise to operate through significant political changes over time. The enterprises generated, provided an arena for new regional leadership.
Annex 1: Methodology

It was recognised from the outset that it was important to gather information from a significant number of key technology-based companies in a range of locations within the US and the UK. As a result, a number of study areas were identified in these two countries. The areas were selected so that they represented concentrations of technology-based companies that were at various stages of development (e.g. embryonic technology-based centres, mature technology-based centres) and had different economic and policy contexts. In the UK, the East Region and Scotland were chosen, with specific attention being paid to Cambridgeshire, Hertfordshire and Bedfordshire in the former, and the "Central Belt" and Dundee in the latter. In the US, Massachusetts, North Carolina and San Diego were chosen, with specific attention being paid to Cambridge and Worcester in Massachusetts and the Research Triangle in North Carolina.

Our research involved field interviews with 193 leaders of technology-based companies, universities and their various departments, government, and others responsible for facilitating the development of the centre. We supplemented these with a survey of 251 technology-based businesses, the 'targets' of economic development policies. Table A.1 shows the distribution of the interview and survey respondents across realms and study areas. Note that the 'others' interviewed were predominantly leaders of intermediary organisations plus some investment and real estate firms.

Table A.1: Interview and survey respondent

<table>
<thead>
<tr>
<th>Region</th>
<th>Technologies-based companies</th>
<th>University and research centres</th>
<th>Government</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interview</td>
<td>Survey</td>
<td>Interview</td>
<td>Interview</td>
<td>Interview</td>
</tr>
<tr>
<td>Eastern Massachusetts</td>
<td>20</td>
<td>35</td>
<td>14</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Research Triangle</td>
<td>3</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>San Diego</td>
<td>4</td>
<td>18</td>
<td>3</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Total US</td>
<td>27</td>
<td>65</td>
<td>21</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>Scotland</td>
<td>30</td>
<td>67</td>
<td>20</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Cambridgeshire</td>
<td>10</td>
<td>47</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Eastern except Camb.</td>
<td>2</td>
<td>72</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total UK</td>
<td>42</td>
<td>186</td>
<td>27</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>All regions</td>
<td>69</td>
<td>251</td>
<td>48</td>
<td>16</td>
<td>61</td>
</tr>
<tr>
<td>Total by realm</td>
<td>320</td>
<td>48</td>
<td>16</td>
<td>61</td>
<td>445</td>
</tr>
</tbody>
</table>

In addition to the interview process, companies from different stages of development, technology types and locations (see Tables A.2 and A.3), were surveyed in the form of a structured postal, web-based and telephone questionnaire. The questionnaire asked companies to rank the importance of the place-related attributes to their business success and consequent location decision, to identify the geographical scale over which these competencies operate, and to identify the policy measures that had been, or should be, put in place to enhance them.

Table A.2: Company survey by region and company's stage of development

<table>
<thead>
<tr>
<th>Region</th>
<th>Start-up</th>
<th>Young company</th>
<th>Medium sized company</th>
<th>Mature company</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I* C** I</td>
<td>I C I I C I</td>
<td>C I C I C I C</td>
<td>C I C I C I</td>
<td>C I C</td>
<td>I C</td>
</tr>
<tr>
<td>Scotland</td>
<td>25</td>
<td>14</td>
<td>27</td>
<td>7</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Cambridge</td>
<td>21</td>
<td>4</td>
<td>8</td>
<td>10</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>East Region</td>
<td>22</td>
<td>19</td>
<td>25</td>
<td>11</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>11</td>
<td>3</td>
<td>8</td>
<td>12</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>North Carolina</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>San Diego</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>10</td>
<td>55</td>
<td>75</td>
<td>24</td>
<td>67</td>
</tr>
</tbody>
</table>

* I (Initial) – Stage of development of the company when it initially chose its current location
** C (Current) – Current stage of development of the company

Although 250 responses were received, not every respondent completed the stage of development question.

Table A.3: Company survey by region and company type

<table>
<thead>
<tr>
<th>Region</th>
<th>Manufacturing</th>
<th>Services</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Region (excluding Cambridgeshire)</td>
<td>32</td>
<td>40</td>
<td>72</td>
</tr>
<tr>
<td>Scotland</td>
<td>34</td>
<td>26</td>
<td>60</td>
</tr>
<tr>
<td>Cambridgeshire</td>
<td>11</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>17</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>North Carolina</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>San Diego</td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>112</td>
<td>210</td>
</tr>
</tbody>
</table>

In order to identify the technology-based centres, it was first necessary to develop a common list of technology-based industries for the two countries and to identify the location of high-technology centres and regions in the two countries. Butchart (1987) defined high-technology industries as those that spend a "substantially above average" percentage of turnover on research and development and employ a "substantially above average" percentage of scientific, technical and engineering personnel. Using this approach, he identified 19 Standard Industrial Classifications that fell into this category.
To overcome the problem of having different lists of high-technology industries for the UK and the US, we decided to use the Butchart list, but to exclude from it any industry that did not appear on the US high-technology lists (US Department of Labour, Cortright and Mayer (2001), DeVol (1999)), and to include any industry that did not appear on the Butchart list but appeared on all the US lists. The final list of high-technology industries used in the research is shown in Table A.4

Using location quotients of these industries, the number of patents per 100,000 population filed and granted by area, and the public and private expenditure on research and development by area, the high-technology regions of the two countries were identified (See Maps X & X). Once the technology sectors had been mapped, smaller study areas were identified in both countries to focus the research. The areas were selected so that they represented high-technology centres in various stages of development (e.g. embryonic high-technology centres, mature high-technology centres), and had different economic and policy contexts.

The key research institutes were also mapped for the East Region and Scotland in the UK. Overlaying these maps on the high-technology location quotient maps suggested that there was a relatively strong relationship between the existence of such institutes and high-technology activity.

Table A.4: Hi-tech industry categories in the UK and US

<table>
<thead>
<tr>
<th>1992 SIC</th>
<th>UK SIC Industry Name</th>
<th>1987 SIC</th>
<th>US SIC Industry Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.16</td>
<td>Manufacture of plastics in primary forms</td>
<td>2821</td>
<td>Plastics</td>
</tr>
<tr>
<td>24.17</td>
<td>Manufacture of synthetic rubber in primary form</td>
<td>2822</td>
<td>Synthetic rubber</td>
</tr>
<tr>
<td>24.40</td>
<td>Manufacture of pharmaceuticals, medicinal chemicals, and</td>
<td>283</td>
<td>Drugs</td>
</tr>
<tr>
<td></td>
<td>botanical products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.00</td>
<td>Manufacture of office machinery and computers</td>
<td>357</td>
<td>Computer and office equipment</td>
</tr>
<tr>
<td>31.20</td>
<td>Manufacture of electricity distribution and control</td>
<td>361</td>
<td>Electric Transmission and distribution equipment</td>
</tr>
<tr>
<td></td>
<td>apparatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33.20</td>
<td>Manufacture of instruments and appliances for</td>
<td>381</td>
<td>Search, detection, navigation, guidance</td>
</tr>
<tr>
<td></td>
<td>measuring, checking, testing, navigating, and other</td>
<td>382</td>
<td>Laboratory apparatus and analytical, optical, measuring,</td>
</tr>
<tr>
<td></td>
<td>purposes except industrial process control equipment</td>
<td></td>
<td>and controlling instruments</td>
</tr>
<tr>
<td>33.30</td>
<td>Manufacture of industrial process control equipment</td>
<td>366</td>
<td>Communications Equipment</td>
</tr>
<tr>
<td>33.40/2</td>
<td>Manufacture of radio and electronic capital goods</td>
<td>367</td>
<td>Electronic components and accessories</td>
</tr>
<tr>
<td>33.10</td>
<td>Manufacture of electronic valves and tubes and other</td>
<td>372</td>
<td>Aircraft and Parts</td>
</tr>
<tr>
<td></td>
<td>electronic components</td>
<td>376</td>
<td>Guided Missiles and space vehicles and parts</td>
</tr>
<tr>
<td>35.30</td>
<td>Manufacture of aircraft and spacecraft</td>
<td>3827</td>
<td>Optical equipment and lenses</td>
</tr>
<tr>
<td>33.40/3</td>
<td>Manufacture of optical precision instruments</td>
<td>384</td>
<td>Surgical, medical, and dental instruments and supplies</td>
</tr>
<tr>
<td>33.10</td>
<td>Manufacture of medical and surgical equipment and</td>
<td>386</td>
<td>Photographic equipment and supplies</td>
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<td></td>
<td>orthopaedic appliances</td>
<td>481</td>
<td>Telephone Communications</td>
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<tr>
<td>64.20</td>
<td>Telecommunications</td>
<td>737</td>
<td>Computer Programming, data processing, and other computer</td>
</tr>
<tr>
<td>72.00</td>
<td>Computer and related activities</td>
<td></td>
<td>related services</td>
</tr>
<tr>
<td>73.10</td>
<td>Research and experimental development in natural sciences</td>
<td>8731</td>
<td>Commercial physical and biological research</td>
</tr>
<tr>
<td></td>
<td>and engineering</td>
<td>8733</td>
<td>Non-commercial research organisations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8734</td>
<td>Testing laboratories</td>
</tr>
</tbody>
</table>
Annex 2: Cluster mapping and study areas
Annex 3: Organisations and people contacted during the research

UK CASE-STUDY AREA 1: SCOTLAND

(A) Central Belt

High-technology companies

Absolute Quality (Europe) Ltd.
Vodi Woods, Managing Director
Alcatel Optonics UK Ltd.
Richard Laming, Chief Technical Officer
Arryjet Ltd.
Howard Planning, Managing Director
Beaver Technologies Ltd.
Bly Mitchell, Managing Director
Compound Semiconductor Technologies Ltd.
Neil Martin, Chief Executive
ExpressOn Biosystems
Peter Sterling, Chief Executive
Glycolytic Ltd.
Richard Tester, Director
IBM UK Ltd.
Ronnie R Allfield, Site Manager
Image Fusion Systems Ltd.
Andrew Mark Peaceck, Director
Intel Corporation
Duncan Bremner, Director
Jabil Circuit Ltd.
Trevor Kay, Senior Director of Operations – Europe
Micronetics Technologies Ltd.
Richard Ord, Managing Director
Motorola
Michael Kay, Director Global Software Group
Nabtech
Allan Cardie, President and Chief Executive Officer
National Semiconductor Ltd
Gerry Edwards, Vice President and Managing Director
Nikon Precision Europe GMBH
Rod Clayton, General Manager UK and Eire
PanTherix
Chris Latham, Chief Executive and Research Director
PPL Therapeutics
Geoff Cook, Chief Executive Officer
Q-One Biotech
David Orions, President
Quintiles Ltd.
Angus Bell, General Manager
R-Biopharm Rhône Ltd.
Carol Dondiey, Marketing Director
SOPA Technologies Ltd.
Michael Norman, Chief Executive Officer and President
Spektra
Euan Robertson, Director of Strategy and Growth
Stein Cell Sciences UK Ltd.
Timothy E Alkopp, Principal Scientist
Ivan Garner, Chief Operating Officer
Sun Microsystems Scotland B.V.
Hugh Allen, Vice President Operations
Viragen (Scotland) Ltd.
Alan J Division, Operations Director
Keren Jarvis, Director of Technology
Voxer Ltd.
Andrew Bisell, Founder and Chief Executive Officer
Xalle
Colin Carruthers, Senior Manager

Universities and research centres

Glasgow Caledonian University, Research and Commercial Development Office
John Marshall, Director
Heriot-Watt University, Technology and Research Services
Gillian E McIntyre, Director
University of Strathclyde, Division of Engineering and Electronics
Peter M Grant, Head of Division
University of Edinburgh, Research and Innovation Services
Bob Smales, Managing Director
University of Glasgow, Institute of Biomedical and Life Sciences
John R Coggins, Director
University of Glasgow, Research and Enterprise Office
Kevin Cullen, Deputy Director
University of Glasgow/Yoshitomi Research Institute of Neuroscience
Brian Morris, Co-director
University of Strathclyde, Hunter Centre for Entrepreneurship
Colin M Mason, Professor of Entrepreneurship
University of Strathclyde, Research and Consultancy Services
Hugh G Thomson, Director
Edinburgh Technopolis
Sharon M Bankford, Director
Scottish Microelectronics Centre
Iain Hykop, Chief Executive

Facilitators/Networking organisations

Biotechnology Industry Assoc.
Barbara Blairy, Director
CONNECT Scotland
Ian McDonald, Chief Executive Officer
East of Scotland TCS Centre
Anne Keane, Centre Manager
Edinburgh Bio-Alliance
John Withers, Chairman
Electronics Scotland
Jane Richardson, Chief Executive
LEIC Scotland
David Grahame, Commercialisation Manager
Murray Beth, Murray WS
Sandy Finlayson, Partner
PharmMains
Alan Harvey, Director
Scottish Institute for Enterprise
Carl Togneri, Director
Scottish Optoelectronics Assoc.
Chris Gracie, Chief Executive
Targeting Technology Ltd.
Arthur Slight, Business Adviser
Arrayjet Ltd.
Sandy Finlayson, Partner

The Royal Society of Edinburgh
Anne Ferguson, Research Awards Manager
Edinburgh Chamber of Commerce
Heather MacNaughton, Business Manager
Midlothian Chamber of Commerce
Graeme Murray, Chief Executive

Financiers

Gill Brown, Managing Director
Copperchop
Ian Ritchie, Director
Edinburgh Technology Fund Ltd
Keith Winton, Chief Executive
Gap Fund Managers Ltd.
Neil Gray, Director
Royal Bank of Scotland
Mac Walker
Scottish Equity Partners
Andrew Davison, Investment Director

Real Estate

The Alba Campus
Neil Francis, Director

Government

Scottish Enterprise
Robert Crawford, Chief Executive
Scottish Enterprise Edinburgh and Lothian
David Caughey, Head of Commercialisation Manager
David Crichton, Chief Executive
Scottish Executive, Enterprise and Lifelong Learning Dept
Eddie W Frizzell, Head of Department

UK CASE-STUDY AREA 1: DUNDEE

(B) Dundee

Universities and research centres

University of Abertay Dundee, Business School
Nicholas Terry, Head of School
University of Abertay Dundee, Research and Enterprise
Paul Durnan, Director
University of Abertay Dundee, Vice Principal
Michael Swanston, Vice Principal
University of Dundee
Sir Alan Langland, Vice Chancellor
University of Dundee, Centre for Enterprise Management
Michael Harrold, Director
University of Dundee, Dept. of Economic Development
Pam Sier, Division Leader
University of Dundee, Town and Regional Planning Dept.
Greg Lloyd, Head of Department

Facilitators/Networking organisations

Dundee Chamber of Commerce
Mervyn Rolfe, Chief Executive

The Royal Society of Edinburgh
Anne Ferguson, Research Awards Manager
Edinburgh Chamber of Commerce
Heather MacNaughton, Business Manager
Midlothian Chamber of Commerce
Graeme Murray, Chief Executive

Financiers

Gill Brown, Managing Director
Copperchop
Ian Ritchie, Director
Edinburgh Technology Fund Ltd
Keith Winton, Chief Executive
Gap Fund Managers Ltd.
Neil Gray, Director
Royal Bank of Scotland
Mac Walker
Scottish Equity Partners
Andrew Davison, Investment Director

Real Estate

The Alba Campus
Neil Francis, Director

Government

Scottish Enterprise
Robert Crawford, Chief Executive
Scottish Enterprise Edinburgh and Lothian
David Caughey, Head of Commercialisation Manager
David Crichton, Chief Executive
Scottish Executive, Enterprise and Lifelong Learning Dept
Eddie W Frizzell, Head of Department
UK CASE-STUDY AREA 2: THE EAST REGION

(A) Cambridge

High-technology companies

3G Labs
Stephen Ives, Chief Executive Officer

Acism
Jonathan Minar, Managing Director

Accessys Ltd.
Stephen P. Ward, Director Marketing Communications

Analys
David Cleerey, Chairman

Cambridge Positioning Systems
Peter Duffield-Smith, Founder

Carnub Ltd.
Nick Collins, Founder

Internet Pro Video Ltd.
Martin Seddon, Managing Director

NCPher Corporation Ltd.
Nick van Someren, Chief Technical Officer

Symptics
Phil Adams, Managing Director

Universities and research centres

Institute of Biotechnology
Christopher R. Lowe, Director

Facilitators/Networking organisations

The Technology Partnership
Gerald Avison

Babraham Bioscience Technologies
David J. Harman, Chief Executive Officer

Real Estate

Cambridge Science Park
Dr. Farbrother, Director

Grants Park
Roger Quinn, Managing Director

Universities and research centres

University of Luton, Business Development Office
Frank Burdett, Director

University of Cranfield – Central Innovation Initiative
Steve Cousins

University of Cranfield, Enterprise Integration
Peter Sackett, Director

University of Cranfield, Commercialisation Office
Tony West, Head

Facilitators/Networking organisations

Business Link: Hertfordshire
John Coller, Director

Hertfordshire Chamber of Commerce and Industry
Tim Hutchings, Chief Executive

Real Estate

Luton & Dunstable Innovation Park
Mike Ansty, Director

Cranfield Technology Park
David Newens, Campus Development Officer

Government

Hertfordshire County Council
John Pryor, Team Leader

US CASE-STUDY AREA 1: SAN DIEGO

High-technology companies

CancerVax
David Hale, President

IDEC Pharmaceutical Corporation
William Rohn, President

MitoKor
William Rohn, President

IDEC Pharmaceutical Corporation
David Hale, President

CancerVax
E. Michael Egan, COO

Diacrin
Una Tyan, CEO

AVANT Immunotherapeutics Inc.
James Frates, Vice President, CFO, Treasurer

Alkermes Inc.
Robert I. Kamen, Former President

US CASE-STUDY AREA 2: CAMBRIDGE MASSACHUSETTS

(A) Worcester

High-technology companies

BAST/Albott BioResearch Center
Robert I. Kamen, Former President

VaCell, Inc.
Murry Kraus, Vice President and CTO

Expressive Constructs Inc.
Mitchell Sanders, President and CEO

GLSynthesis, Inc.
George E. Wright, President

Biomedical Research Models, Inc.
Dennis E. Gubleris, President

Antigen Express, Inc.
Robert Humphreys, President and COO

IDXXX Veterinary Services Inc.
Scott Hamilton, Director of Futures

Biosource Inc.
George E. Wright, President

US CASE-STUDY AREA 2: CAMBRIDGE MASSACHUSETTS

(B) Boston

High-technology companies

Alentor Inc.
James Frates, Vice President, CFO, Treasurer

AVANT Immunotherapeutics Inc.
Uha Tyan, CEO

Dianox
E. Michael Egan, COO

Novartis Institute for BioMedical Research
Dr. Bernard Aebischer, Global Head of Research Facilities Operation

Raytheon Corporation
Gray Shelton, VP Engineering, Technology Manufacturing and Quality
University and research centres

MIT Technology Licensing Office
Lita Nelsen, Director

MIT Office for Corporate Relations – Industrial Liaison Program
Carl A Accardo, Senior Advisor, Office of Corporate Relations and Director, MIT Tokyo Office
Donald A McGowan, Associate Director

MIT Department of Chemical Engineering
Charles L Cooney, Professor of Chemical and Biochemical Engineering
Robert Langer, Professor of Chemical and Biochemical Engineering

MIT Treasurer’s Office
Glen Strehle, Treasurer Emeritus

MIT Despande Center for Technological Innovation
Kristina Holly, Director

MIT Entrepreneurship Center
Ken Morse, Managing Director

MIT Sloan School
Bill Pounds, Former Dean of Sloan School, now School of Management Professor Emeritus

Lincoln Laboratory
Roger Sullivan, Director of External Relations

Whitehead Institute
Thomas Hanks, Director Intellectual Property Office

Facilitators/Networking organisations

Massachusetts Department of Business and Technology/Department of Economic Development
Barbara B Berke, Secretary

Massachusetts Development Finance Agency
David T Blumberg, Senior Executive Vice President

Massachusetts Office of Business Development
Joseph Donovan, Director of Emerging Technology

Massachusetts Alliance for Economic Development
Susan Houston, President

North Carolina Biotechnology Center
Steven Burke, Senior Vice President for Corporate Affairs and External Relations
Kenneth Tindall, Senior Vice President for Science and Business Development

Research Triangle Institute
Reid Maness

NC State University, Centennial Campus Partnership
Bob Geckas, Coordinator Centennial Campus

US CASE-STUDY AREA 3: NORTH CAROLINA

High-technology companies

IBM
Barry Eveland, Vice President of Logistics Personal Systems Group

IBM
Vic Weinstein, former Director of Real Estate

SAS Institute Inc.
Les Hamashina, Director Corporate Public Affairs
Bibliography


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