



The Oxfordshire Innovation Engine

REALISING THE GROWTH POTENTIAL

October 2013

FRONT COVER IMAGES:

1. **Paster Maldonado competes for the Williams F1 team at the 2013 British Grand Prix.** *Courtesy of LAT Photographic / Williams F1.*

Williams is a leading Formula One team and advanced engineering company. Founded in 1977 by Sir Frank Williams and Patrick Head, the Williams F1 Team has secured 16 FIA Formula One World Championship titles and 114 race wins since its establishment, making it the third most successful team in the history of the sport. Operating from its technology campus in Grove, Oxfordshire, Williams is also active in applying its Formula One derived intellectual property and know-how to a growing range of commercial applications through its Advanced Engineering division. This includes the development of flywheel and battery energy storage systems, the design and manufacture of high performance vehicles, commercial applications of Williams' motorsport simulation technology, and engineering consulting services.

2. **Artist's impression of the James Webb Space Telescope (JWST).** *Courtesy of the European Space Agency (ESA).*

Due for launch in 2018, JWST is an infrared space observatory that is the successor to the Hubble space telescope. It will orbit 1.5 million km from Earth in deep space and examine the physical and chemical properties of solar systems. JWST is a joint mission between NASA, ESA and the Canadian Space Agency with the UK's involvement funded by the UK Space Agency. The STFC UK Astronomy Technology Centre is leading the European consortium of more than 20 institutes including the STFC Rutherford Appleton Laboratory at Harwell Oxford.

3. **Scientists grow research cells in the laboratory of Immunocore Ltd, Milton Park, Oxfordshire.** *Courtesy of Immunocore.*

Immunocore is a biotechnology company developing breakthrough therapies for cancer and viral disease. Their novel drugs called ImmTACs harness the power of T Cell Receptors, part of the body's immune system, to target and kill cancerous cells while leaving healthy tissue undamaged. The most advanced drug, IMCgp100 for the treatment of melanoma, is in clinical trials in the UK and USA. Immunocore has recently entered into major research and licensing agreements with leading pharmaceutical companies, Genentech and GlaxoSmithKline. The company traces its roots to Avidex Ltd, founded as an Oxford University spin-out in 1999 to develop the novel T Cell Receptor technology.



*This report was commissioned by the University of Oxford and Science Oxford
with support from the Oxfordshire Local Enterprise Partnership.*



This report was prepared by SQW in consultation with representatives from the research, government, financial and business communities of Oxfordshire:
www.sqw.co.uk

The Oxfordshire Innovation Engine



This report shines a light on the scale and quality of the science and high tech business base."

Foreword

The decision by the University of Oxford and Science Oxford, with support from the Oxfordshire Local Enterprise Partnership, to commission an independent assessment by SQW of the Oxfordshire high tech cluster is both timely and welcome.

It comes at a time when debate about the generation of growth and jobs from science is high on the political agenda and it shines a light on the strength, scale and quality of the science and high tech business base that resides in the region.

This report, drawing on contributions from local high tech firms, local government, research establishments and the investment and professional services communities, is both thorough and thought provoking.

It provides an analysis of the factors that have led Oxfordshire to become one of the UK's most significant centres for science based research and enterprise. It puts these factors into a wider national and international context and it highlights the strategic importance of the area in fields as diverse as life sciences, high performance engineering, space, motorsport, ICT and particle physics.

Most importantly, it also identifies the constraints that are currently preventing Oxfordshire from realising its full potential and it provides a clear set of recommendations.

I congratulate the University of Oxford and Science Oxford on leading this work, and recommend this report to decision-makers in government, academia and business with an interest in this area and encourage them to bring their contribution to this important initiative to accelerate the 'Oxfordshire Innovation Engine'.

A handwritten signature in blue ink, reading "Paul Drayson".

Lord Drayson, PhD FREng
Managing Partner, Drayson Racing Technologies

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Executive Summary

Oxfordshire's assets

1. Oxfordshire has outstanding science and technology based assets and credentials, including:

- a global brand, conveying an image of academic excellence, historical significance and of a beautiful place in which to live
- the University of Oxford, which is among the top few in the world, with outstanding research and teaching, and Oxford Brookes, one of the best performing new UK universities
- a unique grouping of 'big science' and other research facilities, including the UK Atomic Energy Authority Culham Centre for Fusion Energy; the Science and Technology Facilities Council (STFC) Rutherford Appleton Laboratory; Diamond Light Source, the national synchrotron facility; the Medical Research Council's facilities at Harwell, and the Satellite Applications Catapult Centre
- a highly skilled labour force, with a higher proportion of graduates than any other English county
- around 1,500 high tech firms (on a conservative estimate), many with a strong focus on R&D across a range of technologies and employing around 43,000 people
- a superb strategic location, 40 miles from Heathrow, one of the largest hub airports in the world, and 50 miles from London.

2. These assets provide huge opportunities and resources for high tech business growth, and much has already been achieved. Over the last 50 years, there can be no doubt that Oxfordshire has acted as an 'innovation engine': many high tech firms have started up and grown in the county, benefiting from – and contributing iteratively to – the development of a technology cluster with outstanding strengths in four overlapping technologies: (i) bioscience/medical tech/pharmaceuticals; (ii) physics-related specialisms, including cryogenics, instruments, and magnets; (iii) engineering and electronics, including motorsport; and (iv) telecomms and computer hardware and software (**Figure 1**). These are closely aligned with the 'eight great technologies' identified by the UK government¹, and they bring with them intrinsic growth potential.

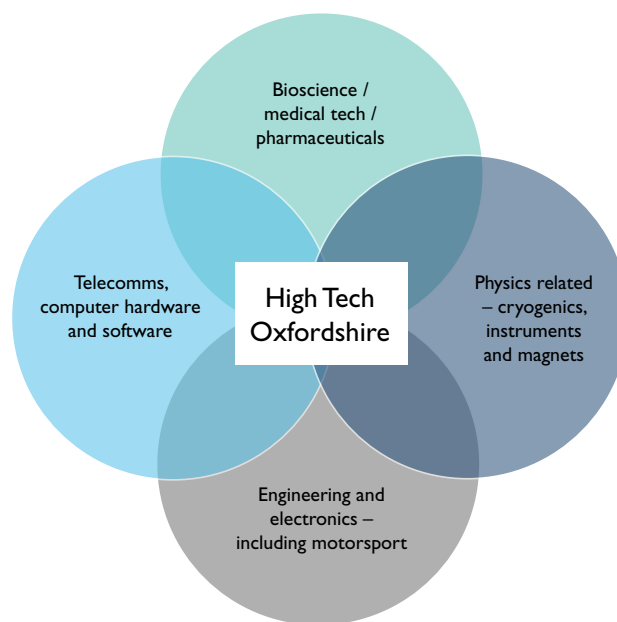


FIGURE 1: Understanding high tech Oxfordshire: core overlapping technologies

Purpose of this report

3. The University of Oxford and Science Oxford wish to ensure that Oxfordshire builds on its position as a leading high technology cluster and that the Oxford brand is more consistently associated with science and innovation. They therefore commissioned SQW to analyse the characteristics of high tech Oxfordshire today, its future growth potential and the challenges involved in realising that potential. Following consultation with a large number of stakeholders, this report recommends actions to generate greater economic benefits from Oxfordshire's assets in ways which enhance, rather than detract from, the attractions of the place, and which are in the best interests of both Oxfordshire and the UK.

Realising the growth potential

4. Based on a review of published data, a business survey, an employees' survey and over 100 face to face in-depth consultations and discussions, this report suggests that high tech firms in Oxfordshire are becoming increasingly outward-facing; and their location within an hour of a major hub airport and a global city is becoming more important. An overwhelming imperative to internationalise is creating new and often transient relationships, allegiances (spatial and otherwise) and behaviours.

5. This trend is challenging the norms and expectations of the past. However, Oxfordshire is very well placed to seize the implicit opportunities: it is an intrinsically good place from which to run a research team or build a business with global links. It has an outstanding local knowledge base allied to the established benefits of international connectivity, and it offers an excellent quality of life for internationally mobile people.
6. But for many firms, their links with Oxfordshire's outstanding research and knowledge base may be diminishing. This trend is not universal, and it is not necessarily detrimental, but it does raise questions about whether Oxfordshire's asset base could be exploited more effectively to the benefit of the high tech businesses, the universities and research institutes, and the national economy.
7. Oxfordshire needs to decide how to respond. In the past, there have been ambiguous attitudes to growth, particularly in Oxford city and the south of the county. For example, most businesses are emphatic about the need for improved infrastructure and more housing, yet current planning policies constrain the growth of Oxford and the record of delivering new housing – or even approved plans to enable it to happen – is poor. Similar issues confront the University of Oxford, which has both the land and the academic potential to develop stronger research and business hubs, networks and infrastructure in the region. As a result, it is recognised that external perceptions of Oxfordshire are nowhere near as positive as they should be.
8. This report recognises that significant steps have been taken recently to resolve these ambiguities, and it encourages organisations to build on that progress and to go further in some areas. It proposes measures to accelerate the growth of the high tech community, making recommendations in four main areas: the research-based institutions; the 'soft' infrastructure to support the growth of technology-based businesses; issues relating to physical infrastructure and spatial development; and overall leadership. These recommendations are summarised in the paragraphs below and **Table 1** on page 8.

The research infrastructure

9. The University of Oxford is central to technology and knowledge-based development in the county. It is one of the world's leading universities, with an outstanding depth and breadth of research and a global perspective to all of its activities. Oxford Brookes University has established itself as one of the leading new universities. It complements the University of Oxford with a greater emphasis on high level training and applied research.
10. The University of Oxford can demonstrate many examples of economic and social impact, locally, nationally and internationally, and its licensing and spin-out activities have created and supported many local firms, including some that are now among the largest and most successful in Oxfordshire. However, links with local firms tend to decline as they grow, and more active maintenance of these networks could benefit both the University and the high tech business community.
11. The University is developing an estates strategy for the Science Area². Along with the development of the Radcliffe Observatory Quarter, this will lead to the co-location of cognate disciplines and additional space in new buildings in order to encourage interdisciplinary working. This should make it easier for firms to identify and establish relevant contacts within the University because interdisciplinary centres tend to be better aligned with current and evolving business needs than traditional departmental structures.
12. However, space will remain at a premium in central Oxford. It is unlikely, for example, that firms will be able to locate adjacent to, or be embedded within, University laboratories. Yet university-business interactions of this nature are potentially very important to achieving both academic and economic benefits. If the University of Oxford is to host more of such activity, it will need to be based at non-central locations.

¹ The eight great technologies were identified by David Willetts, Minister for Universities and Science in the Department for Business, Innovation & Skills, in Jan 2013: www.gov.uk/government/speeches/eight-great-technologies.

² This is a well-recognised area in the city centre to the south of University Parks where most of the University's science departments are located. This area is in transition as some departments, such as maths, move to new buildings in the Radcliffe Observatory Quarter.

13. There are major opportunities to expand university-business interactions at both Begbroke Science Park to the north of the city, and the Harwell campus to the south:
 - Several University research groups are already located alongside small high tech firms at Begbroke Science Park and the University and Colleges own very significant areas of land around the site. The whole of this area offers tremendous potential to create a dynamic interface between University and corporate research facilities and creative new businesses. It could enable the expansion of engineering and other applied sciences, and also provide much needed University-related housing. Begbroke also benefits from improving connectivity due to its proximity to Oxford Airport and a new railway station planned to open at Water Eaton in 2015 that will connect to Bicester, Oxford and London. The realisation of this potential will require changes to Green Belt boundaries, but this could involve adjusting both inner and outer boundaries to avoid reducing its overall extent.
 - Harwell already has some large scale and internationally important research facilities and an extensive area for development which benefits from Enterprise Zone status³. There are some joint appointments between the University and research organisations at Harwell, but this arrangement could be extended to facilitate a greater University presence for mutual benefit. Having more research teams that are able to take advantage of the two locations should lead to more cutting edge research at the University and a livelier research environment at Harwell.
14. There are challenges for the University and the relevant district councils in moving academic activity from the city centre because of planning restrictions on the Begbroke site and the difficulties in transport between the Begbroke and Harwell sites and the central University area. However, there are also transport, communication and planning solutions which could enable the realisation of major long term benefits to the University and the local economy.

RECOMMENDATIONS:

- Improve visibility of inter-disciplinary research at the University of Oxford, signposting for firms to relevant research and staff, and retention of links with firms as they grow.
- Increase the involvement of the University of Oxford with the public and private sector research facilities at Harwell. This should go beyond the existing joint appointments to establishing academic activities there, such as joint research teams.
- Develop proposals for a major long term expansion of university and corporate research and other related facilities in the Begbroke area, involving the University, its Colleges, other landowners, local government and transport operators.

The soft infrastructure

15. The 'soft' infrastructure comprises specialist services and networks serving the high tech community. In general, it is defined and driven by the private sector and changes within it are usually a straightforward response to shifting market signals.
16. Through the 'soft' infrastructure, the high tech economy is increasingly a product of 'flows' – of capital, of people, of technologies, of markets. These 'flows' ignore administrative boundaries and are increasingly based on international air travel (which is relatively easy from Oxfordshire), internet connectivity and social networking. Historically, there have been many examples of technology-based businesses in Oxfordshire founded through personal friendships that were initially forged at the University of Oxford; today, these same relationships are likely to be between people of different nationalities, hence another fillip to the shift to global networks and alliances. High tech Oxfordshire needs to embrace these changes fully, recognising the underlying strengths that it can bring to bear.
17. Another major issue is the changing role and increasing significance of London and the Thames Valley. The proximity to Oxford of a thriving global city, with its highly specialised services and, in particular, its funding expertise, is a huge benefit to Oxfordshire's technology-based businesses.

Similarly, the large high tech labour market in the whole area between Oxford and London is an important resource, enabling firms to source management and marketing skills as well as science and technology expertise.

18. Despite the proximity to London, Oxfordshire's high tech firms identify a chronic shortage of early stage investment capital and increasing exasperation with the structure and timescales of conventional venture capital investments. Currently, incentives for individual investors work well by de-risking investments, and R&D tax credits and the proposed 'patent box' are good for both companies and investors. However, with the decline, increasing conservatism and short time horizons of venture capital funds, there is a need for measures at a national scale to attract institutions such as pension funds, insurance companies and others with a long term perspective to invest directly in high tech firms, a move which could also increase the alignment of timescales between investors and managers. Another possibility is to stimulate greater involvement and investment in SMEs from major corporates.
19. More locally, improved early stage funding is important. Potentially, various national sources (such as devolved funding from the National Innovation Fund, part of the Business Bank) could be used to match funds from individual investors channelled through the existing business angel investment networks. This would increase the availability of early stage funding and could also help strengthen the business angel networks in Oxfordshire by providing more resources for investment in firms that they showcase.
20. Oxfordshire has some very experienced and successful angel investors. However, it will lose out relative to other parts of the UK unless it succeeds in encouraging a new generation of investors which is equally engaged with, and networked across, the local high tech community. Measures to encourage the transfer of know-how from the most experienced to new angel investors, using the existing networks where possible, should enhance the quality and quantity of future angel funding in Oxfordshire.
21. Despite the strength of Oxfordshire's labour market, high tech firms have an insatiable appetite for highly qualified scientists and engineers. Local shortages are exacerbated by the cost of housing, but there is also a national shortage of some key skills. Firms need to be able to source people with those skills internationally, if they are in short supply in the UK. Whilst the rules concerning immigration to the UK are unlikely to be loosened, the experiences of Oxfordshire's high tech firms, and its universities and research institutions, suggests that the timescale for processing of work permit applications must be dramatically improved.
22. Improved data on high tech Oxfordshire would help to provide accurate and timely information to inward investors, the press, government and other sources, and would thereby help to promote the scale and significance of the high tech (including the research) community nationally and internationally. This report recommends that a database of high tech firms is maintained (probably by Oxfordshire County Council), and that the University of Oxford should systematically collect information on its interactions with high tech businesses. To be useful, both data sources will need to be updated regularly and linked.
23. The evidence from this study suggests that there should be more networking events and activities in Oxfordshire that include representatives from across the whole of the high tech community, as well as from the local government, research, financial and professional services communities. This would support improved linkages, particularly across Oxfordshire's distinctive technology areas, and promote stronger and more consistent messaging regarding priorities to government and others.

³ Enterprise Zones offer business rates relief up to £275,000 over five years, a simplified planning regime, access to superfast broadband, and support from UK Trade & Investment (UKTI) to develop international trade.

RECOMMENDATIONS:

- Lobby Government to develop measures to encourage institutional investors with a long term perspective, such as pension funds, to invest in high tech firms.
- Develop proposals to increase the supply of early stage investment capital by matching local business angel investment networks funds with national sources of funding.
- Encourage the most experienced angel investors in Oxfordshire to pass on their know-how to the next generation of investors, using the existing networks as a vehicle and strengthening those networks in the process.
- Lobby Government to improve, and in particular dramatically speed up, the processing of work permit applications for foreign nationals. As part of this lobbying process, seek Government agreement to decentralise the approval process for work permit applications made by Oxfordshire high tech firms.
- Maintain better information on the high tech community in Oxfordshire. Specifically, this should include a database of high tech firms, and more comprehensive information on interactions between the University of Oxford and high tech businesses.
- Increase networking events and activities in Oxfordshire, to support improved linkages across all areas of the high tech community and with the government, research, financial and professional services communities, and to promote strong and consistent messaging regarding priorities.

The physical infrastructure

24. The spatial strategy for a 'Knowledge Economy Spine' in Oxfordshire⁴ focuses on three main centres: Bicester, Oxford and Science Vale (the area around Harwell, Culham, Didcot, Wantage and Grove).
25. In our opinion, the strategy, as articulated, does not place sufficient emphasis on the crucial economic role of Oxford, instead making the greatest provision for growth of jobs and housing at Bicester and in Science Vale. Oxford is the service centre for the wider economy, it has the fastest growing, best educated workforce, and it is the main centre of research and spin-outs in the county. Most of the employment growth in the county between 2001 and 2011 was in the city⁵, and it is where many high tech firms choose to locate, particularly those which require a close relationship with the universities or related research activities.
26. However, there is a shortage of suitable premises for firms in Oxford city centre, which has seen only two minor office developments in the last 20 years. Two small serviced office facilities and the city's only innovation centre are fully occupied with waiting lists. Some office development is planned in the West End/Oxpens area around a redeveloped Oxford railway station, but this scheme has suffered long delays and housing seems likely to dominate the mix of uses when it is eventually developed. Other planned projects which will increase specialist provision for high tech firms include the expansion of the Oxford Centre for Innovation (planned as part of the Magnet project⁶ to provide a major science discovery and innovation centre in the city centre), and the proposed bioescalator facility for bioscience start-ups on the Churchill Hospital campus. Even allowing for the remaining development potential on other sites (notably Oxford Science Park and Oxford Business Park), demand will continue to outstrip supply in Oxford. Therefore, some outward expansion of the city is essential if it is to fulfil its important role in supporting high tech business growth, both directly by accommodating high tech firms and indirectly by providing space for the research infrastructure and specialist financial and professional services that they use.
27. The capacity of the road and rail links between the three centres (Oxford, Bicester and Science Vale), and their wider regional and national connectivity, is crucial to ensuring the spatial strategy works. Superfast broadband is also essential (and its coverage needs to be improved), but it is not a substitute for good transport links. Whilst significant rail improvements are planned or underway, and are greatly welcomed, these need to be complemented by fast and frequent local public transport links to the main high tech employment areas to encourage more people to use rail for work journeys.
28. However successful these public transport measures are, there will continue to be a high number of car users, and there is a pressing need to improve the strategic road network – particularly the A34, which is the highest priority for improvement for the high tech business community. The A34 acts as a major trunk road between the south coast and the Midlands, a bypass for Oxford and the main road artery for the 'Knowledge Economy Spine'. Its capacity is insufficient to fulfil these multiple roles, and needs to be substantially increased.

RECOMMENDATIONS:

- Implement proposals for a 'Knowledge Economy Spine' for Oxfordshire, by supporting housing and high tech employment growth in the three main foci: Bicester, Oxford and Science Vale. In particular, additional provision for growth to accommodate high tech businesses and employment needs to be made in and around Oxford, including to the north of the city (Begbroke, Water Eaton and the Northern Gateway/Peartree) and to the south (Oxford Science Park and Grenoble Road).
- Provide additional office space (including business incubator provision) in Oxford city centre, particularly by implementing the proposals for the West End/Oxpens area, a bioescalator incubator on the Churchill Hospital campus, and for the Magnet science discovery centre and expanded Oxford Centre for Innovation.
- Improve the capacity and connectivity of strategic and local transport infrastructure within the 'Knowledge Economy Spine', particularly the A34, the main north-south rail links, and fast bus services between the rail stations and main employment centres.
- Implement superfast broadband across the whole of Oxfordshire by 2015.

Leadership and messaging

29. A frequently expressed concern in our consultations is that Oxfordshire has lacked the strong leadership and consistent messaging that have benefited some competitor locations, not least Cambridge. That is not to say there are no strong leaders in the high tech community: clearly there are, and some of them have very considerable influence in government and financial communities. However, the perception of Oxfordshire – both from within the high tech community and from outside – has been of a reluctance to embrace growth positively and manage it for the benefit of future generations.
30. In some ways the situation is improving: local organisations have agreed to work together to enable growth under the remit of the City Deal process, and a Strategic Economic Plan is being prepared. It is well-recognised that both the track

record of delivery and also perceptions need to be changed if Oxfordshire is to attract the scale of investment it merits from both public and private sectors. Various organisations could take leadership roles, including both universities, the Oxfordshire Local Enterprise Partnership and The Oxford Trust⁷. But strong leadership still needs to be demonstrated in practice. It is particularly important that debates among the local authorities about whether and how to accommodate growth are resolved, and that the University of Oxford and its Colleges agree a long term development strategy which the relevant planning authorities endorse.

RECOMMENDATION:

- Provide strong public and private sector leadership and consistent messaging to realise the growth potential of Oxfordshire's 'innovation engine'.

What will success look like?

31. Assuming these issues are addressed, and that there is strong leadership and consistent messaging about Oxfordshire's strengths, growth potential and investment requirements, Oxfordshire's high tech economy will significantly increase its contribution to national economic growth in future, and provide many more high value jobs for future generations of local residents. Indicators of success will include:
- an additional contribution to the national economy of at least £1 billion in Gross Value Added (GVA), at constant prices, within 10 years, representing a 30% uplift on current projections
 - stronger and more productive relationships between Oxfordshire's high tech companies, the universities and research institutes
 - substantially higher levels of private and public investment in Oxfordshire
 - a perception of Oxfordshire, both internally and externally, as a place that is committed to sustainable growth, and which reflects the scale and success of the high tech community and its potential to generate greater local and national benefits whilst also achieving global impact.

⁴ Articulated in the Oxford & Oxfordshire City Deal Negotiation Document, Draft dated 26 August 2013.

⁵ Various sources confirm this, although absolute numbers vary between sources.

⁶ This project was awarded £3m from the Regional Growth Fund in July 2013.

⁷ The Oxford Trust is an independent charity founded by Sir Martin and Lady (Audrey) Wood, Oxford Instruments co-founders, to support the growth of science and technology businesses and public engagement with science. Its public facing brand is Science Oxford.

Next steps

32. The sponsors of this report are committed to providing on-going support for implementation of the recommendations, working collaboratively with other parties in the private and public sectors.
33. They are also committed to ensuring that the Oxfordshire 'innovation engine' plays its part in national economic growth, and that its role should be seen within the context of a 'golden triangle' which also includes the Thames Valley, London and Cambridge. On a global scale, this wider geography is the comparator, and true competitor, with areas such as Silicon Valley and San Francisco, Boston and Massachusetts, and greater Shanghai. Further work is therefore planned to examine the growth potential and respective economic roles and complementarities of other parts of the 'golden triangle'.

TABLE I: Summary of recommendations

PARA	RECOMMENDATION
RESEARCH INFRASTRUCTURE	
7.4	Improve visibility of inter-disciplinary research at the University of Oxford, signposting for firms to relevant research and staff, and retention of links with firms as they grow.
7.8	Increase the involvement of the University of Oxford with the public and private sector research facilities at Harwell. This should go beyond the existing joint appointments to establishing academic activities there, such as joint research teams.
7.9 & 7.23	Develop proposals for a major long term expansion of university and corporate research and other related facilities in the Begbroke area, involving the University, its Colleges, other landowners, local government and transport operators.
SOFT INFRASTRUCTURE	
7.15	Lobby Government to develop measures to encourage institutional investors with a long term perspective, such as pension funds, to invest in high tech firms.
7.16	Develop proposals to increase the supply of early stage investment capital by matching local business angel investment networks funds with national sources of funding.
7.17	Encourage the most experienced angel investors in Oxfordshire to pass on their know-how to the next generation of investors, using the existing networks as a vehicle and strengthening those networks in the process.
7.19	Lobby Government to improve, and in particular dramatically speed up, the processing of work permit applications for foreign nationals. As part of this lobbying process, seek Government agreement to decentralise the approval process for work permit applications made by Oxfordshire high tech firms.
7.20	Maintain better information on the high tech community in Oxfordshire. Specifically, this should include a database of high tech firms, and more comprehensive information on interactions between the University of Oxford and high tech businesses.
7.21	Increase networking events and activities in Oxfordshire, to support improved linkages across all areas of the high tech community and with the government, research, financial and professional services communities, and to promote strong and consistent messaging regarding priorities.
PHYSICAL INFRASTRUCTURE	
7.22 & 7.23	Implement proposals for a 'Knowledge Economy Spine' for Oxfordshire, by supporting housing and high tech employment growth in the three main foci: Bicester, Oxford and Science Vale. In particular, additional provision for growth to accommodate high tech businesses and employment needs to be made in and around Oxford, including to the north of the city (Begbroke, Water Eaton and the Northern Gateway/Peartree) and to the south (Oxford Science Park and Grenoble Road).
7.23	Provide additional office space (including business incubator provision) in Oxford city centre, particularly by implementing the proposals for the West End/Oxpens area, a bioescalator incubator on the Churchill Hospital campus, and for the Magnet science discovery centre and expanded Oxford Centre for Innovation.
7.26	Improve the capacity and connectivity of strategic and local transport infrastructure within the 'Knowledge Economy Spine', particularly the A34, the main north-south rail links, and fast bus services between the rail stations and main employment centres.
7.27	Support the implementation of superfast broadband across the whole of Oxfordshire by 2015 through the Oxfordshire Local Enterprise Partnership.
STRATEGIC DIRECTION AND LEADERSHIP	
7.28 & 7.29	Provide strong public and private sector leadership and consistent messaging to realise the growth potential of Oxfordshire's 'innovation engine'.

1. Introduction

1.1 Oxfordshire has outstanding assets to support high tech economic growth:

- Oxford is a global brand, conveying an image of academic excellence, historical significance and of a beautiful place in which to live
- The University of Oxford is among the top few in the world, with outstanding research and teaching. In addition, Oxford Brookes is one of the best performing new UK universities, and the county is also home to the Royal Military College of Science at Shrivenham, where Cranfield University provides academic teaching, support and research
- Oxfordshire hosts a unique grouping of 'big science' and other research facilities, including the UK Atomic Energy Authority Culham Centre for Fusion Energy; the Science and Technology Facilities Council (STFC) Rutherford Appleton Laboratory; Diamond Light Source, the national synchrotron facility; the Medical Research Council's facilities at Harwell, and the Satellite Applications Catapult Centre
- There are around 1,500 high tech firms (on a conservative definition) in Oxfordshire, employing around 43,000 people. Many firms have a strong focus on R&D in a diversity of sectors, and with distinctive specialisms in bioscience/medical technology/pharmaceuticals; physics-related activities including cryogenics, instruments and magnets; engineering/electronics, including motorsport; and telecommunications and computer hardware and software
- The area benefits from a superb strategic location, 40 miles from Heathrow, one of the largest hub airports in the world, and 50 miles from London (*Figure 1-1*)
- Oxfordshire has a highly educated workforce, including a higher rate of degree level attainment than any other English county
- The area has a high quality urban and rural environment for living and working, and offers excellent cultural facilities.

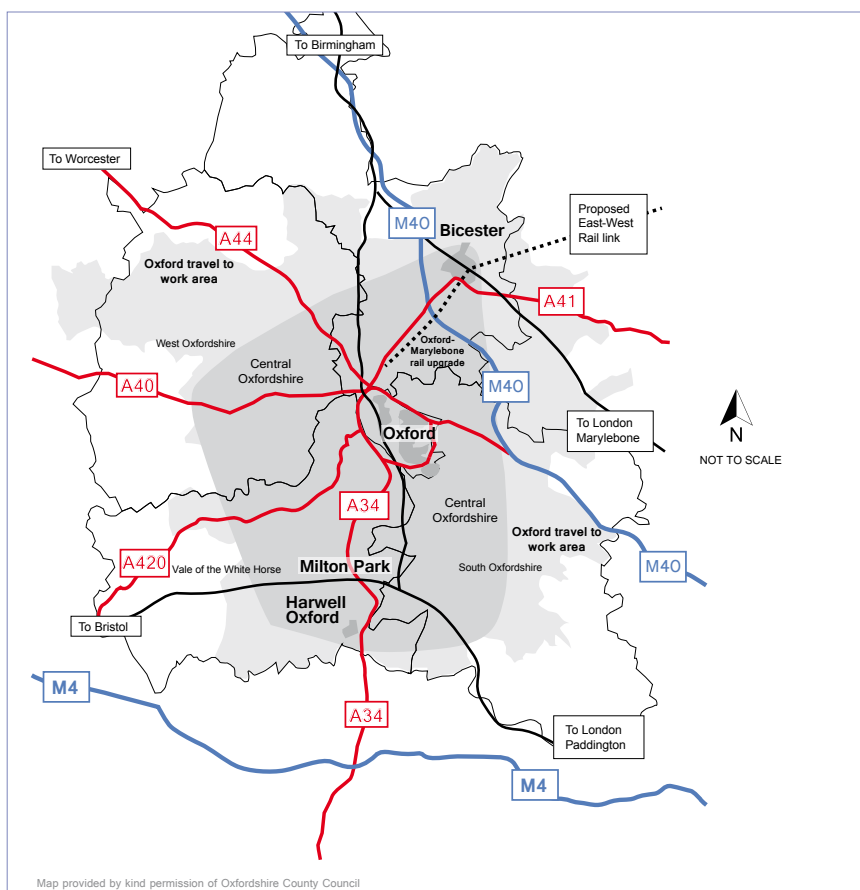


FIGURE 1-1:
*Strategic location of
Oxfordshire*

Source: Oxford & Oxfordshire City Deal Submission, Draft August 2013.

1.2 These assets mean that Oxfordshire's economy is successful. It grew consistently over the period 1997 to 2011, and its Gross Value Added (GVA) per person is well above the national average and comparable with areas such as Cambridgeshire and Berkshire. However, there are some indications from our research that Oxfordshire's exceptional assets may not be generating as much economic benefit for the area, and for the UK, as could be expected. For example:

- Oxfordshire's assets for technology based growth are different from (but at least as good as) Cambridgeshire's, yet Oxfordshire's economy produced £500m less in GVA over the period 1997 to 2011.
- Oxfordshire should be attractive to inward investment, yet only 3% of South East jobs from foreign direct investment located in Oxfordshire between 1999 and 2010, compared with Berkshire (13%), Surrey (16%), Hampshire (13%) and Buckinghamshire (15%)⁸.

1.3 In addition, Oxfordshire also has a remarkably low profile as a high tech centre, considering its assets and the scale of high tech employment and number of firms in the area. Two national newspaper articles in Spring 2013 illustrate this:

- An article in the *Guardian* online on 9 May 2013 ('*Tech City – believe the hype?*') questioned the substance behind Tech City in London, comparing it unfavourably with high tech clusters in Cambridge, Manchester, Newcastle and Brighton. Oxford was not mentioned.
- A full-page article in the *Sunday Times* Business section on 10 March 2013, concerning the potential role of university high-tech spin-outs in creating economic growth and jobs ('*Can the Boffins Save Us?*'), featured various universities with a particular focus on Warwick. In contrast, Oxford was mentioned once, as a place where Imperial Innovations invests.

1.4 As a creative, innovative and entrepreneurial place, there should be ways to exploit the economic potential of Oxfordshire's assets more fully and without damaging its residents' quality of life. This report explores Oxfordshire's assets; the ways in which these are changing; the significant opportunities that are emerging; and recommends actions that ought to be taken in response.

Purpose of this report

1.5 This report provides evidence-based observations on the characteristics of the Oxfordshire high tech economy, and recommendations on how its growth performance could be improved. The main focus is on the current situation and future prospects, in the context of its past evolution. The report starts by examining the main assets that support high tech growth. It then considers the technologies and firms that are the products of that asset base; and it assesses whether the supporting 'innovation ecosystem'⁹ is fit for purpose. Finally, it provides recommendations for improvements.

1.6 The report is aimed at a variety of audiences, including: organisations in Oxfordshire, in order to promote clearer, more consistent messaging, and a more coordinated agenda for sustainable growth; the UK government, in order to influence government policies and expenditure; and a global audience interested in the characteristics and future development of one of the largest and most important centres of research and its commercial application in Europe.

⁸ Oxford and Oxfordshire City Deal Expression of Interest, January 2013.

⁹ The innovation ecosystem includes the high tech firms at its heart, supported by research and education institutions, financial, business and professional services, and the physical infrastructure of specialist property, transport, housing and telecommunications which supports the workforce and business activities in Oxfordshire.

Note on research methods and sources of evidence

1.7 This study has relied on a number of different sources of both primary and secondary evidence and insight. In total, over 100 individuals were consulted and provided valuable input. Findings from the different sources have been triangulated to test and develop different perspectives on the character of high tech Oxfordshire. These different sources include:

- **Analysis of secondary statistical data:** Data from the Business Register and Employment Survey (BRES) and other Office for National Statistics' sources were examined to build up a profile of high tech Oxfordshire and both the Thames Valley and Cambridge sub-region as comparator areas. The findings from this analysis are used in this report but there is, in addition, a stand-alone annex which provides a comprehensive account¹⁰. The annex explains the different definitions that were used (both of 'high tech' and the spatial extent of the different areas). As far as possible, it also seeks to provide longitudinal perspectives on the development of Oxfordshire and its high tech economy.
- **Survey of high tech firms:** A survey of high tech firms comprised a major tranche of primary evidence gathering. The survey was challenging – not least because there was nothing like a comprehensive address list for high tech firms from which to work. Address lists had to be pieced together from a range of business directories, tenant lists from innovation centres and science parks, and through processes of referral. In total, well over 1,000 firms were contacted and 142 useable replies were received. The overall response rate was modest and was supplemented by extensive, in-depth consultations.
- **In-depth consultations with high tech firms:** In addition to the survey, 21 firms were interviewed in depth by senior staff from SQW. These interviews were preceded by a review of companies' annual reports and accounts (where available), press releases and other information, and the interviews themselves were lengthy (typically 1.5-2 hours). They provided rich qualitative information and insight, and some of them have formed the basis of short case studies which are included in the body of this report.
- **Survey of high tech firms' employees:** Within high tech firms, we sought permission to survey staff (using an anonymised online questionnaire). The employees' survey asked questions about individuals' qualifications, career paths and networks within Oxfordshire; and also about travel to work arrangements and perceptions of Oxfordshire as a place to work and live. Many of the firms we approached were cautious in relation to this exercise, but three agreed to take part and in total, responses were received from over 100 staff members.
- **In-depth consultations with senior staff from Oxfordshire's universities, 'big science' facilities, local authorities, property providers, professional and financial service providers, and from amongst its business angels:** We met with 60 individuals with a first-hand interest in different aspects of high tech Oxfordshire. Often these individuals were part of the high tech community, but also observers of it: some had been part of the scene for several decades while others were newer to it, and many were able to compare high tech Oxfordshire to knowledge-based economies elsewhere in the UK or internationally. Their perspectives and insights were therefore very helpful.
- **Other meetings and discussions:** We had meetings with a steering group and four advisory working groups, referred to in the Acknowledgements section below, and discussions (formal and informal) with, and comments from, other individuals from organisations within Oxfordshire. A list of the individuals who participated in the Steering Group, advisory working groups, consultations and discussions is set out in *Appendix I*.
- **A review of spatial planning policies, infrastructure and specialist property for high tech firms in Oxfordshire:** this forms a separate annex¹¹ and provided the source material for some sections of the report.

Acknowledgements

- I.8 SQW would like to particularly acknowledge the inputs provided to this study by Oxfordshire's high tech businesses (including those that devoted time to our survey); their staff; and the wider high tech community, as detailed above. All of these people are enormously busy and we are very grateful for the time they made available for this piece of work.
- I.9 The work was guided by a Steering Group chaired by Professor Sir John Bell (Regius Professor of Medicine, University of Oxford) and comprising eminent and highly experienced people from the public and private sectors in Oxfordshire: Dr Paul Brankin (Chairman, The Oxford Trust); Lord Drayson; Ian Laing (co-founder of Oxford Asymmetry and of Milton Park and an investor in many science based businesses); Keith Mitchell (formerly a member of Oxfordshire County Council); Adrian Shooter (Chairman, Oxfordshire Local Enterprise Partnership); Bernard Taylor (Chairman, Isis Innovation); and Professor Ian Walmsley (Pro Vice-Chancellor, Academic Services and University Collections, University of Oxford). It also benefitted from four advisory working groups (each of which met twice) comprising senior people from the research community, the high tech business and financial services communities and the public sector across Oxfordshire.
- I.10 SQW's inputs to the study were made primarily by Chris Green (Chief Executive, SQW Group), Dr Christine Doel (Director & Head of Markets, SQW) and Robin Brighton (Director, SQW). In addition, important contributions to the research were made by Professor Helen Lawton Smith (Oxfordshire Economic Observatory, University of Oxford and Birkbeck, University of London); Professor John Glasson (Oxfordshire Economic Observatory and Oxford Brookes University); Andrew Chadwick (Senior Research Associate, Oxford Brookes University); and Rupert Waters (Department of Management, Birkbeck, University of London). Support was provided by Margaret Henry (Company Secretary & PR Director, Oxford Innovation & SQW Group).
- I.11 However, the conclusions drawn from the evidence and the resulting recommendations are SQW's responsibility.

¹⁰ The annex was prepared by Professor Helen Lawton Smith and colleagues and is available from SQW on request.

¹¹ The annex on spatial issues was prepared by Professor John Glasson of Oxford Brookes University and Chris Green of SQW and is available from SQW on request.

2. The asset base for high tech growth

2.1 There can be no doubt as to the scale and quality of the research infrastructure in Oxfordshire. The two Universities, together, educate over 34,000 students¹², over 14,000 in STEM¹³ and medical related subjects. Within 50 miles there are various other universities with recognised strengths, including Warwick, Reading, and Cranfield (Bedfordshire and Shrivenham campuses), and the good communications with London mean that Imperial College and other London universities are also readily accessible. The research infrastructure is not, however, restricted to higher education institutions. The Atomic Energy Authority's Centre for Fusion Energy is located at Culham; there are several large, and other, scientific facilities at Harwell; and the Natural Environment Research Council's Centre for Ecology and Hydrology has its headquarters at Wallingford. All of these sites are to the south of Oxford. In addition, the University of Oxford works closely with the four main NHS hospitals in Oxfordshire under the aegis of the Oxford University Hospitals NHS Trust (comprising the John Radcliffe Hospital, Churchill Hospital and Nuffield Orthopaedic Centre at Headington and the Horton General Hospital, Banbury).

2.2 High technology development would not have occurred in the county without this infrastructure, or at least not at anything like the scale observed today, and it remains the underpinning factor:

- the two universities educate a large number of students, many of whom remain in the area
- the universities and research institutes work with businesses on sponsored and collaborative research
- they transfer their intellectual property, via spin-outs and licensing
- they provide access to specialist facilities
- more generally, they have raised the profile of the sub-region internationally, and enhanced the quality of life through cultural and other contributions. We have no doubt that this has helped to attract businesses and individuals to Oxfordshire.

The University of Oxford

2.3 The University of Oxford is at the centre of this research infrastructure. It is one of the world's leading universities and was ranked second equal with Stanford in the Times Higher's latest global rankings¹⁴; it was the highest placed European university. The University employs over 4,000 staff, including post doctorates, in the STEM and medical fields and there are over 3,000 postgraduate students working in these disciplines. Over the last five years, the University has secured more external grant income for STEM and medical research than any other UK university, rising by an average of 9% per year to over £400m in 2011/12¹⁵. Research is also of the highest quality. The 2008 Research Assessment Exercise¹⁶ placed research papers in one of five categories and by assigning weights to each of these categories we have calculated an average quality indicator¹⁷. The University was ranked fifth or higher in all but one of the 20 STEM/medical subject areas in which it submitted staff for assessment. There are particular strengths in biological sciences and medicine, with the University ranked first in five of these disciplines. The University was also ranked first in mathematics and statistics. It was placed in the top five in general engineering, materials science and computer science, but did not make submissions in the other engineering disciplines¹⁸ because it covers these within a single Engineering Department.

2.4 The excellence of the University's research attracts the best faculty and students, and increasing amounts of funding, in a virtuous circle. While the proportion of students in the UK taking science and engineering subjects has declined over the last 60 years, at Oxford it has increased from 17% to 30% of all students (45% if medicine is included). Mathematical disciplines, including some computer sciences and statistics, now account for 9% of undergraduates compared to 3% of undergraduates 60 years ago, and the number of post-doctoral students in computer science has doubled during the last five years.

Relationships with industry

- 2.5 The University encourages academic staff to work with industry and will provide support and advice when requested, notably through Research Services which, inter alia, assists with securing external funding and contract management, and Isis Innovation which is responsible for exploiting the University's intellectual property. There are direct financial incentives for staff, through revenue sharing agreements¹⁹, for the exploitation of University owned intellectual property. Most other forms of work with business do not provide any financial incentive for the individual, but, perhaps especially for collaborative research, bring academic benefits through additional resources and contacts with leading edge knowledge-based businesses. There is also a wish by many academics to see the results of their research applied and recognition that often this necessarily requires commercial intervention in some form. This requirement to demonstrate 'impact' has been reinforced by the *Research Excellence Framework*²⁰ (REF). The University, therefore, provides a permissive environment for those wishing to work with businesses, and is increasingly supportive of commercial exploitation through new spin outs and entrepreneurial activity.
- 2.6 The evidence suggests that research is relevant to industry and that the University is engaged in knowledge transfer:
- industry funding in 2010/11 was £39m, the highest in the UK²¹
 - by 2010/11, there were 235 spin-outs from the University still active, 183 established by graduates
 - the sale and licensing of intellectual property generated nearly £8m in 2011/12, a three-fold increase since 2004/05
 - Oxford generated the highest number of spin-outs from any UK university in the three years from 2010 to 2012²².
- 2.7 There are also numerous individual examples of ways in which the University is generating economic and social impact, a selection of which are included in **Box 2-1**.

¹² FTEs 2010/11.

¹³ Science, technology, engineering and mathematics.

¹⁴ World Reputation Rankings based on academic opinion. <http://www.timeshighereducation.co.uk/world-university-rankings/2012-13/world-ranking>.

¹⁵ HESA Planning Plus 2013.

¹⁶ <http://www.rae.ac.uk/>

¹⁷ We have referred to the RAE because it is widely used as a measure. However, it has serious limitations, because RAE Quality depends on how selective the institution is about who gets submitted. Oxford University's Mathematical, Physical and Life Sciences Division (MPLS) submitted 99% of its faculty to the 2008 RAE, which made its ranking vulnerable to competition from universities which were very selective about who they submitted. Therefore the fact that Oxford University scored as highly as it did in all disciplines is impressive.

¹⁸ Electrical and electronic, chemical and civil.

¹⁹ Oxford was one of the first UK Universities to establish an intellectual property policy.

²⁰ The REF is the key determinant of block grant research funding from the higher education funding councils. From 2014 the results will be in part based on statements of research impact.

²¹ Higher Education Business and Interaction Survey, 2010/11, Table 1b, Contract Research. £39m is an aggregation of SME commercial and other commercial. It excludes non-commercial sources of funding.

²² The PraxisUnico Spin-outs UK Survey 2013.

BOX 2-1: Examples of ways in which the University is generating economic and social impact

- i) Two of Rolls-Royce's 30 University Technology Centres (UTCs) are based at Oxford. The company focuses its academic research on selected world-class university partners, and provides core funding on a long-term strategic basis, including doctoral research, and for individual projects. The two Oxford UTCs are in Solid Mechanics, undertaking research relevant to Rolls Royce's technology base (power systems providing power for land, sea and air), and Turbomachinery, which is located in a new laboratory and also attracts sponsorship from other companies including Alstom, Siemens, QinetiQ and Mitsubishi.
- ii) Begbroke Science Park hosts over 20 research groups from a range of departments in the Mathematical, Physical and Life Sciences Division of University of Oxford (MPLS) as well as around 30 businesses in a range of accommodation. Academic facilities available to on- and off-site commercial users include a Materials Characterisation Service (part of the Materials Department, and one of the UK Technology Strategy Board's Micro Nano Technology Centres of Excellence), and a clean room. Begbroke also provides various knowledge transfer services: (i) EPSRC sponsored Knowledge Transfer Secondments (KTS) are transfers of people between universities and 'users' and Begbroke leads and administers Oxford's KTS project; (ii) Begbroke provides advice and support to projects seeking Knowledge Transfer Partnership (KTP) funding; (iii) Knowledge Transfer networks (KTNs) are national networks in a field of technology or business application which bring people together to stimulate innovation. Academic staff at Begbroke manage the Transport sector activities of the Materials KTN and the Environmental Sustainability KTN.
- iii) The National Institute for Health Research Biomedical Research Centre, Oxford (OxBRC) is based at the University of Oxford Hospitals NHS Trust site on the Churchill campus, Headington and run in partnership with the University of Oxford. The Centre is part of the Government's initiative to improve translation of basic science into clinical benefits. It is one of 11 such centres in the UK and was awarded a five year grant of £57m in 2007. In 2012 it was awarded a further five years funding of £95m. Oxford has one of the largest clinical trial portfolios in the UK and considerable expertise in taking discoveries from the lab into the clinic.
- iv) The Engineering Department was responsible for the supply of software for the Mars Rover, for the submersible in the Gulf of Mexico which was used in the BP oil spillage, for the Kepler space telescope, which is searching for planets of other stars, and for the Square Kilometre Array, which will be the world's largest radio telescope.
- v) The Institute of Biomedical Engineering, opened in 2008, is undertaking research with huge economic and social potential including into liver preservation, therapeutic ultrasound, and smart signal processing using low tech devices (particularly mobile phones) for remote patient monitoring (with particular applications in developing countries).
- vi) The Computing Department has leading specialisms in big data, machine learning (in collaboration with Statistics and Engineering), artificial intelligence, and verification. Examples of impacts include the use of validation programmes by auto and avionics manufacturers, and collaboration with the British military through QinetiQ to apply verification and security to weapons systems. Also within Computing, the Oxford Cybersecurity Centre is developing practical tools to increase security for major government and corporate clients.
- vii) Mathematics at Oxford has had strong links with industry since 1968, when week long study groups with industry were set up to solve business problems. The Oxford Centre for Industrial and Applied Maths has been operating since 1989, and the Oxford Centre for Collaborative Applied Maths was established in 2008 with major themes in: materials science and engineering; resources, energy and the environment; biosciences and bioengineering; and methodologies. Industry partners include firms based in Oxfordshire (e.g. e-therapeutics, Kraft Foods, Numerical Algorithms Group, Oxford Instruments, Sharp, Siemens, Tessella), and nationally (e.g. BT, Amazon).

viii) Isis Innovation is the University's technology transfer arm and it commercialises intellectual property through spin-outs and patenting and licensing. Isis also markets and manages consultancy contracts for academic staff who choose to use its services. Established in 1988, and wholly owned by the University, Isis was one of the first university technology transfer organisations in the UK and quickly established a reputation for effective and innovative commercialisation activities. Amongst other activities, Isis manages an angel investor network and a software incubator programme. Isis has supported over 100 spin-outs since 1988 which have raised over £500m in external investment. Some of these businesses are featured in later sections of this report. Licensing income was £6.25m in the year ending March 2013.

ix) The Said Business School was established in 1996 and is one of Europe's youngest business schools, but it has rapidly established a leading reputation. It provides post graduate and executive programmes, of various lengths and levels, as well as a wide range of events targeted at national and local businesses. It pioneered the annual flagship 'Silicon Valley comes to Oxford' event which has also been adopted elsewhere as a programme that brings together leading entrepreneurs and innovators. Some staff also have research interests in entrepreneurship, focused on the Centre for Entrepreneurship and Innovation, and in science and technology studies. These are recent developments for the University and discussions with high technology businesses did not identify close links between them and the Business School. Nevertheless, the Business School could become a valuable component of the research infrastructure over time, including support for local entrepreneurs.

2.8 Data indicate that the University is a UK leader in terms of working with industry and knowledge transfer. However, as an internationally competitive university, global comparisons are important. Differences in higher education systems and economic contexts (and the consequent limitations on data) mean that such comparisons are difficult. For example, the funding regimes for UK and US universities are quite different. In the US, more federal research money is available per capita and it is concentrated in a smaller proportion of its academic institutions; philanthropy funding is far more important than in the UK; and tuition fees are much higher. By contrast, UK universities depend much more on funding allocated through the RAE and external grants.

2.9 Bearing in mind these provisos, we have reviewed AUTM²³ data on Oxford and leading US Universities²⁴. This comparison is indicative only, not least because data on Oxford are only available for 2009 and 2010. We have averaged 2009 and 2010 data and analysis indicates:

- Oxford is significantly smaller than most of the comparators. Average research expenditure over the two years was \$543 million compared with \$1.4 billion at MIT²⁵, the largest. Caltech, the smallest, has approximately the same research budget as Oxford.
- Industry accounts for 8% of total research funding at Oxford. In the US, only Columbia is higher (17%). MIT, John Hopkins and Stanford return similar proportions and Caltech, Cornell and Harvard have around half this proportion²⁶.
- Total licensing income, excluding returns from equity sales, made up around 1% of Oxford's research expenditure; about the same as John Hopkins, Harvard and Cornell. MIT (5%), Stanford (8%), Caltech (9%) and Columbia (23%) were all significantly higher. However, all the US universities date the start of their technology programmes as during the 1970s or earlier²⁷, whereas Oxford's programme dates from 1987. We have no information on the timing of licensing returns, but a substantial proportion is likely to have been generated by deals stretching back some time.

²³ Association of University Technology Managers.

²⁴ Massachusetts Institute of Technology, John Hopkins, Stanford, Harvard, Cornell and Caltech. Some leading US universities, e.g. Yale and Princeton, do not provide data to AUTM.

²⁵ Neither MIT nor Caltech have Medical Schools, which accounts for a significant proportion of Oxford research.

²⁶ The proportion of industry funding is affected by the scale of government funding, which is higher in the US. Actual industry funding for the top universities in the US is also generally higher than in the UK.

²⁷ MIT began its programme in 1940.

It is also the case that high average returns generally reflect a small number of high earning patents²⁸ and the ability to generate such returns is correlated with the overall scale of the research portfolio

- Since the data are limited to only two years they shed little light on start-ups which are defined by AUTM as “companies dependent on licencing the university’s technology for initiation”. Oxford averaged three start-ups per year on this definition; significantly less per dollar of research expenditure than the comparators.

- 2.10 These data are, at best, indicative, and require more analysis than has been possible during this study. They suggest that the University of Oxford may not be performing as strongly as some of the leading US universities, but this may reflect the much later start of its licensing and start-up activities, higher levels of federal and industry research funding, and the better developed innovation ecosystems in many parts of the US.
- 2.11 In all its activities, the University’s outlook is global. It recruits students from all over the world and its research and other collaborations are similarly international. Global connectivity is essential for any university with leading-edge aspirations and is the first priority in the University’s Strategic Plan:
- To develop the University’s position as a global forum for intellectual engagement, through the proactive communication of ideas generated at Oxford and through openness to new ideas generated elsewhere*²⁹.
- 2.12 One consequence is that a relatively small proportion of business-facing activities are with organisations based in the surrounding area. We do not have data on the exact location of partners but Higher Education Business and Community Interaction survey (HEBCI)³⁰ data provide information on interactions with partners in the South East region (excluding Greater London). They show that:
- Foreign firms sponsored more research (£22m) than UK businesses (£17m), although the University was still the second highest generator of research funds from UK businesses.

Some 5% of all business sponsored research was for businesses in the South East.

- Around 6% of consultancy, continuous professional development and the use of technical facilities was for businesses located in the South East.

Oxford Brookes University

- 2.13 Oxford Brookes is one of the leading post-92 universities. It complements the University of Oxford with a greater emphasis on high level training and applied research. Research and knowledge transfer is a key part of Oxford Brookes’ strategy:

Harness the creativity, knowledge, and commitment of the university’s academics, staff and students to benefit urban and rural communities principally within Oxfordshire.

*Further develop mutually beneficial partnerships to facilitate the application of the university’s education, research, and knowledge transfer nationally and internationally and to prepare the university’s graduates to be engaged global citizens*³¹.

- 2.14 Total research grants amounted to around £4m in 2010-11. In the STEM disciplines Oxford Brookes’ strengths are in the life sciences, computer science and engineering. It has developed distinctive expertise in motorsport and provides specialist degrees (BEng and MEng) in motorsport and automotive engineering. These are an important source of skills for the motorsport sector and this aspect is discussed further at paragraph 3.13.
- 2.15 While business engagement is important to Brookes, and it has developed important local relationships, it looks more widely than the county for partners. In 2010/11:
- it generated £2.4m in revenue from continuing professional development, consultancy and the use of its specialist facilities. Around half of these services were for SMEs. Some 5% of the total was for businesses within the South East
 - contract research for businesses was £305,000, 40% in the South East

- income from licensing intellectual property was £1.6m, which was the 10th highest in the UK, 5% from organisations in the South East.

2.16 Brookes is, in many ways, complementary to the University of Oxford. It is active in a number of disciplines in which the University of Oxford is not. These include:

- a range of degree programmes related to the built environment. In 2010-11 there were over 1,600 students in architecture, building, and planning. Architecture was the largest subject area with 700 students
- design studies with 50 students, although much of the work in architecture is also relevant to design. Design clearly has a key contribution to make to the successful introduction of technology-based products.

2.17 Brookes also educates and researches in areas allied to, but complementary with, the University of Oxford's strengths; notably in health care. Brookes does not have a medical school, but in 2010-11 there were approaching 2,600 nursing students and over 450 other subjects allied to medicine. Many graduates are believed to find employment in the county, and they also represent a skilled labour force on which the biomedical sector can draw.

2.18 Knowledge Transfer Partnerships (KTPs) are an important knowledge transfer mechanism for Brookes, which has been the academic partner on 14 projects. KTPs involve one or more graduates undertaking a project within a company under academic supervision. They are employed by the company for the duration of the project – usually one or two years. Some of Brookes' KTPs involve local partners and Brookes considers its work with Webmart to have been especially successful. Webmart, headquartered at Bicester, buys printing services and manages printing projects on behalf its customers.

The project, supervised by Oxford Brookes' Business School, analysed Webmart's position in the print management marketplace, identifying areas for corporate development and investment, and integrating these into Webmart's IT systems. As a result of the project, Webmart's sales are projected to increase by £30 million over two years. In March 2008 the partnership received the highest possible grade of 'outstanding' in a KTP assessment.

2.19 The Department of Mechanical Engineering and Mathematical Sciences at Brookes has a high external profile. There are over 700 engineering students at present and 55 in mathematics. Research is organised into three inter-disciplinary themes: Sustainable Engineering and Innovation (SEI); Advanced Engines, Propulsion and Vehicles (AEPV); and Simulation, Modelling and Systems Integration (SMSI). The department is oriented to real-world problems and has particularly close relationships with the automotive sector. For example:

- Brookes worked with BMW, supported by the Technology Strategy Board, to explore the opportunities and constraints for electric powered vehicles. The work centred on the Mini and involved academics from psychology in order to fully understand the social and psychological aspects of driving electric cars as well as the technical issues. BMW Oxford also provides placements for around 40 engineering students each year.
- The University, via a KTP, is working with YASA Motors³², an Oxfordshire company which is developing an electric motor that delivers four times the performance of current models, in a package that is much lighter and half the size.

²⁸ This is known to be the case with Columbia.

²⁹ University of Oxford Strategic Plan 2013-2018, www.ox.ac.uk/document.rm?id=2971

³⁰ Op cit.

³¹ Research and Knowledge Transfer Strategy 2010-2015 <http://www.brookes.ac.uk/about-brookes/strategy-2020/our-strategy-for-2020/>

³² YASA stands for Yokeless And Segmented Armature.

The Research Institutes

- 2.20 The research institutes to the south of Oxford are an important feature of the research infrastructure. Their main distinctiveness derives from the combination of the Universities and the 'big science' research facilities at Culham and Harwell, although the Centre for Ecology and Hydrology is also significant.
- 2.21 The **Culham Centre for Fusion Energy** is the UK's national fusion research laboratory and the location of the Joint European Torus (JET), the pioneering tokamak facility for fusion research. Construction of the next generation facility (ITER) is underway in France, but JET is still operational in its own right and also contributing to the design and development of ITER. The Centre also hosts a UK funded tokamak (MAST) which is about to undergo a substantial upgrade. Office and laboratory space includes an innovation centre managed by Oxford Innovation, and there are currently 17 businesses, not all technology-based, on site. The design, construction and maintenance of these facilities has resulted in advanced engineering and scientific and engineering skills on-site.
- 2.22 The Culham Centre for Fusion Energy works with businesses in two ways. It can assist companies to secure contracts to supply large scale scientific facilities, including ITER and other facilities, by providing technical advice and advising on contracting processes. Such contracts can be valuable, both for the additional business they generate, but also because some may incorporate new technologies, developed by the facility, which can enable penetration of other markets. The Centre also brings its fusion expertise to bear on business technical problems. It provides a Technical Support Package for businesses located in the innovation centre, providing access to the Centre's mechanical, electrical and electronic engineering skills and technologies. Similar services are available to larger businesses located elsewhere on-site.
- 2.23 **Harwell Oxford** hosts two major facilities: the Diamond synchrotron and the ISIS neutron source. ISIS is long established, and has undergone continual development and upgrading. Construction of the Diamond synchrotron began in 2003 and many beam lines are now operational. In addition to these two facilities, the Science and Technology Facilities Council's (STFC) Rutherford Appleton Laboratory (RAL), which includes the Central Laser Facility, the MRC Mammalian Genetics Unit Biological Solid State NMR Facility, the Satellite Applications Catapult Centre and the European Space Agency Business Incubation Centre, are located on the campus. STFC and MRC have recently established the 'Research Complex' on the RAL site, which houses, among other activities, the Membrane Protein Laboratory. This provides temporary accommodation for research teams from UK universities as well as Diamond and RAL staff. Ten research groups are currently using the facility.
- 2.24 A range of business accommodation, including an innovation centre managed by Oxford Innovation, is available on-campus, and there are plans to develop housing on-site. There are around 150 organisations on the campus and total employment is approximately 4,500 people. The STFC has designated Harwell, along with Daresbury, as a science and innovation campus and STFC Innovations Ltd is responsible for commercialising research emerging from the Rutherford Appleton Laboratory. There are 12 spin-outs associated with Harwell, either on campus or located nearby.
- 2.25 The major facilities at Harwell are available for business use. Business demand for Diamond exceeds availability at present and academic use is protected, although businesses can also access the facility through sponsoring academic research as well as direct use. It provides a means of analysing materials and the intensity of the light source enables smaller samples to be used, a range of operational conditions to be simulated, real time and reduced time measurement and analysis. Diamond has been built to a very high specification and it is achieving very high levels of reliability in comparison with other synchrotron sources. This is of real benefit to businesses since they can book time on the facility with confidence that experiments will be completed when planned.

2.26 Diamond is currently used by 60 companies and some examples illustrate the diversity of sectors and applications:

- GlaxoSmithKline working on the detection limit for the presence of a solvate within a manufactured drug batch
- Rolls-Royce working on the application of surface treatment to fan blades
- Heptares Therapeutics to help develop a treatment for Parkinson's disease
- Hewlett Packard labs to improve the energy efficiency of LCDs
- a consortium wishing to improve the effectiveness of cleaning products
- BP for enhanced oil recovery research
- General Motors working on hydrogen storage.

2.27 The ISIS neutron source enables materials to be studied at the atomic level and a new beam line is under construction for the study of the effects of cosmic radiation which will be mainly for business use. As with Diamond, there is a wide range of sectors to which it is relevant:

- Schlumberger Research examined how asphaltenes behaved in different circumstances allowing more efficient extraction of hydrocarbons
- Orla Protein Technologies used ISIS to ensure their protein surfaces were reliable for manufacturing.
- Powerwave UK used ISIS to recreate the firing stage of ceramic components which has proved significantly more efficient than previous trial-and-error methods
- Airbus investigated the integrity of welds in aluminium alloys.

2.28 As with Culham, there are also opportunities for equipment suppliers to benefit and ISIS has a close relationship with Oxford Instruments, which supplied the magnets for the Second Target Station. Oxford Instruments staff worked closely with ISIS scientists on the contract and the knowledge gained helped it to develop a new system which could be offered to other facilities. The prestige of ISIS has also enhanced credibility in other markets.

2.29 The **Centre for Ecology and Hydrology (CEH)** is an environmental research institute, core funded by the Natural Environment Research Council, with sites at Bangor, Edinburgh, Lancaster as well as the headquarters at Wallingford Oxfordshire. It has global research partners and works with industry through consultancy, training, KTPs and sponsored research. Four spin-out companies have been established by CEH staff. The Centre hosts several large environmental data sets, which are accessible online.

Conclusion

- 2.30 The two universities provide high volume and high level skills for the sub-regional economy. Research outputs, especially from the University of Oxford, are leading edge and of genuine interest to businesses, although academics look nationally and internationally, rather than locally, for partners. The global connectivity of the University is, however, potentially a key strength of the county. The contacts established through research and teaching can promote inward investment and facilitate entry into foreign markets for local businesses.
- 2.31 More generally, the global brand of the University of Oxford raises the international profile of the county. This connectivity is demonstrated by some key data for 2010/11:
- 6,600 students at the University of Oxford were from outside the UK; almost 3,200 students at Oxford Brookes were from abroad
 - £22m was secured in research sponsorship from foreign firms.
- 2.32 The proximity of the major research facilities to the University is unique³³ in Europe and possibly worldwide. Grenoble has a similar clustering of big science facilities but cannot claim the same university standing as the Oxfordshire cluster³⁴. These facilities contribute to the infrastructure in a number of ways:
- direct use by business: for many experiments it is desirable, and sometimes essential, for the researcher to be on-site
 - the transfer of knowledge through supply contracts and direct assistance to businesses
 - the business space and associated innovation support that they provide
 - the highly skilled engineers attracted to design, construct, maintain and operate the facilities
 - more generally, raising the profile of science as a career, and promotion through extensive outreach programmes
 - they further add to global connectivity: ISIS and Diamond, in particular, attract many foreign scientists from industry and academia.

³³ Other universities have clusters of research institutes, but the collection of large scale facilities and the associated engineering and other skills in the Oxford cluster is distinctive.

³⁴ The Université Joseph Fourier at Grenoble was ranked 180th in the THE Rankings op cit.

3. The technology and skills endowment

Technology specialisms

- 3.1 The quality and scale of research and education in STEM subjects in Oxfordshire's universities and research institutions generates cutting edge expertise in a wide variety of science and technology areas. However, within the broad range of expertise, distinctive specialisms have developed which are important nationally and internationally, both in their own right and, equally importantly, in how they interact within the Oxfordshire high tech economy. These distinctive but overlapping technology areas chime well with the UK Government's 'eight great technologies'³⁵, and are shown in **Figure 3-1**.

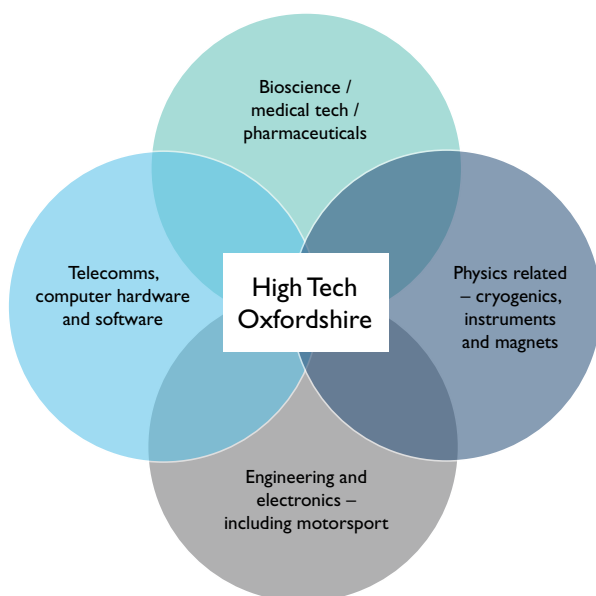


FIGURE 3-1: Understanding high tech Oxfordshire: Core overlapping technologies

But the technologies on which successful high tech businesses draw have become very complex indeed, and virtually impossible to compartmentalise. At least in terms of the technologies, it is arguably the scale and nature of the overlaps that really starts to define the intrinsic potential of high tech Oxfordshire.

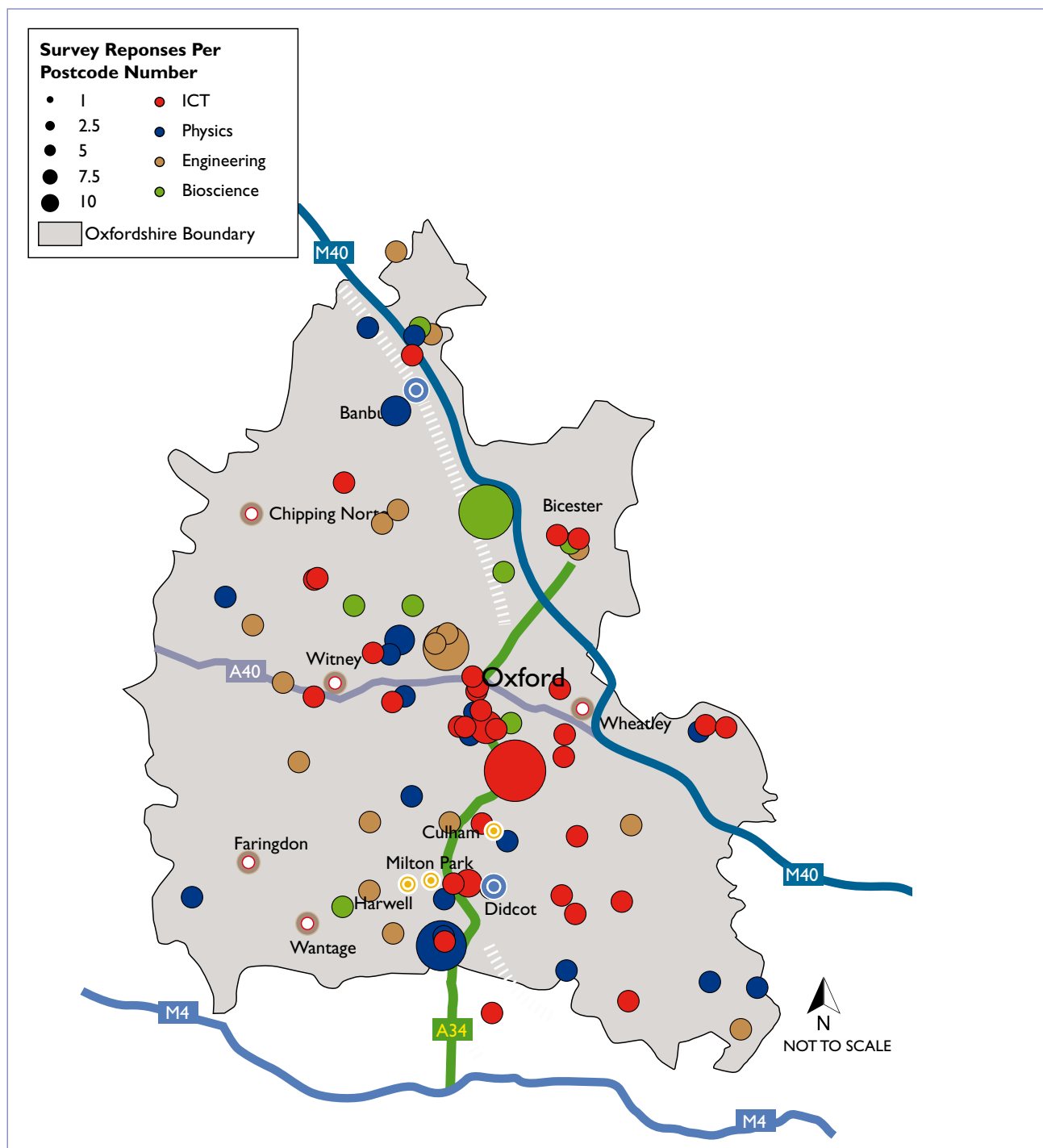
- 3.3 The economic manifestation of these specialisms is hard to evidence through conventional data: they increasingly cut across conventional classification boundaries and in varying combinations. Moreover, their significance rests not only in the scale of employment linked to them directly or the number of identifiable businesses – which include some globally recognisable industry leaders like Oxford Biomedica, Oxford Instruments, Siemens Magnet Technology, Prodrive, and Sophos. It also variously lies in: (i) the strength of linkages between the research base and firms; (ii) the firms' supply chains; (iii) their influence in relation to the evolution of local labour markets; and (iv) their wider, more intangible, impacts in terms of perceptions of high tech Oxfordshire, from internal and external vantage points alike.

- 3.2 Some of the interrelationships are obvious – for example between bioscience and ICT in relation to big data and genomics, and between magnets and medical technology. Others may be less obvious (for example, research collaboration between the McLaren F1 team and the University of Oxford's medical faculty), or are still to be explored.

³⁵ The eight great technologies were identified in a speech by David Willetts, Minister for Universities and Science in the Department for Business, Innovation and Skills, in January 2013 –<https://www.gov.uk/government/speeches/eight-great-technologies>. The technologies are: big data computing; space science and its applications; robotics and autonomous systems; life sciences, genomics and synthetic biology; regenerative medicine; agri science; advanced materials and nano technology; and energy and its storage.

3.4 The four technology groupings in *Figure 3-1* are distinctive and recognisable across the whole of Oxfordshire, as demonstrated in *Figure 3-2*, which shows the distribution of survey respondents across the county and within these four key technology-based groupings. The importance of the north-south axis defined by the A34 and main rail lines through Oxford is reasonably clear – mirroring the spatial pattern that is apparent for the population as a whole (*Figure 4-1*). But beyond that, what is notable from *Figure 3-2* is that there is not a clear spatial pattern in relation to any of these four broad groups.

FIGURE 3-2: Respondents to our high tech firms survey – by broad technology grouping



Source: SQW – based on Oxfordshire High Tech Firms' Survey, 2013

- 3.5 In the paragraphs that follow, we briefly describe the basic dimensions of the four technology specialisms, and the 'soft wiring' within and between them.

Bioscience/medical technologies / pharmaceuticals

- 3.6 The University of Oxford has world class specialisms across the broad fields of medicine and chemistry, in biomedical engineering, and in mathematical / computational biomedicine. The Medical Sciences Division is one of the largest in Europe with 2,500 staff and 800 postgraduate students involved in medical research. Over £1.2 billion has been invested in biomedical academic research in Oxford during the past five years. To a very considerable extent, these outstanding academic credentials underpin the area's profile in the commercialisation of bioscience.
- 3.7 Against this backdrop, the *Biocluster Report 2011: Transition* (published by OBN) identified 163 bioscience firms across Oxfordshire. This represented an increase of 14% since 2008 with most of the growth in stock resulting from new start-ups and spin-outs (rather than company relocations). Across Oxfordshire, the report indicates that distinctive specialisms exist in drug discovery, medical technologies, diagnostics, bioinformatics, contract research and green biotechnology.
- 3.8 Bioscience has been, and remains, a voracious consumer of investment funding. The *Biocluster Report* notes that between 2008 and 2010, the ten largest Oxfordshire-based fundraisers received some \$313 million – approximately one sixth of the total investment in the UK bioscience sector over the same period and testimony both to the strength of Oxfordshire and the implicit potential within the sector for further growth. Many bioscience businesses however remain pre-revenue and in many cases, the business model is long term and very funding-dependent: the imperative, essentially, is to develop technologies/IP as the route to creating value.

Physics-related activity – including cryogenics, instruments and magnets

- 3.9 Within Oxfordshire, there is some read-across from bioscience to another group of activities that owes much to its links with the physical sciences – at the University of Oxford but also through the work of the Rutherford Appleton Laboratory at Harwell and energy fusion research at Culham. These institutions define the core of Oxfordshire's 'big science' resource and they constitute a unique asset from which a series of businesses have emerged in the past, and new, more-or-less formally spun off business are continuing to populate the adjacent innovation centres today.
- 3.10 Within this context, cryogenics has (over a period of at least 50 years) established itself as a distinct Oxfordshire-based specialism. Oxford Instruments has been at its core and it has, effectively, created a global industry which continues to grow quickly. For example, Siemens Magnet Technology, formerly part of Oxford Instruments, produces superconducting magnets at its Eynsham factory (seven miles to the north west of Oxford); these magnets are embedded in 30% of the world's MRI scanners, and the link back to an Oxfordshire technology is beyond dispute.
- 3.11 In addition, it is important to note the growing importance of Oxfordshire vis-à-vis space science. The UK Space Agency, the European Space Agency (ESA) and the International Space Innovation Centre and the new Satellite Applications Catapult are all based at Harwell Oxford. Looking ahead, major growth is expected in space satellite technologies in support of developments in telecommunications (particularly in broadband internet from space, internet on the move, 'smart homes' and mobile telephone services as well as HD and 3D TV), navigation systems, earth observation and world-wide security infrastructures. Oxfordshire-based businesses are well placed to both contribute and benefit.

Engineering/electronics and motorsport

- 3.12 There are undoubtedly also links between physics-related activities and the broadly defined engineering / electronics sector. One very distinctive strand within this is motorsport and – located at the heart of the UK's motorsport valley – Oxfordshire occupies a unique position.
- 3.13 Motorsport is different from other high tech sectors, insofar as formal links to the research base are much less apparent. Nevertheless, within motorsport are some of Oxfordshire's largest and most research-intensive businesses and the workforce employed by these firms is among the most highly qualified. A more detailed account of the character of Oxfordshire's motorsport sector is provided in **Box 3-2** below.

BOX 3-2: Motorsport in Oxfordshire

Some of the world's largest and most prestigious motorsport firms are located in Oxfordshire, including Lotus FI, Williams FI and Prodrive. New entrants to motorsport have also chosen to locate in Oxfordshire: Caterham FI was first established in Norfolk but within a year had moved to west Oxfordshire to give it better access to specialist staff and suppliers; and Marussia is in Banbury, having originally been based in Yorkshire.

At the core of the cluster are the firms which produce the race cars. The established teams such as Lotus and Williams each employ around 500 staff and are vertically integrated in order to protect the security of their supplies: for example, Williams arranges all its logistics in-house. They are secretive (mainly based in secluded and secure locations) and intensely competitive, and depend on a highly specialised, capable and dedicated workforce. Despite their secrecy, the teams often share suppliers and facilities (e.g. Caterham use Williams' second wind tunnel and Red Bull gearboxes). FI is highly regulated, and regulatory changes combined with intense competition cause constant modifications to cars. Competitive advantages can be gained by tiny improvements in technology, but these are quickly adopted by competitors ensuring a continual search for improvements.

The intense competition means staff are highly trained and carefully selected. For example, Lotus FI recruited 20 engineering graduates last year from Cambridge, Cranfield and Oxford universities, and at the end of the year, it released 15 and retained the best five. Each of the teams tends to develop relationships with particular universities and colleges, in order to recruit the best students. Some recruit globally, particularly in the areas of greatest shortage such as power electronics, aerodynamic engineering and composites.

The FI firms characterise themselves in different ways. For example, the Managing Director of Lotus FI said that they could be considered with equal validity as an R&D company that produces two race cars, or as a marketing company with two race cars, or simply as an FI team.

All of the motorsport teams are highly focused on competing successfully in the racing season, but some are also diversifying, applying technologies developed in motorsport to other areas and trading on the motorsport brand. For example, Williams is developing an energy efficiency business based on FI hybrid systems, and has also established a technology centre in Qatar. Both Williams and Caterham have simulators which are available for other vehicle manufacturers to use for road safety testing, and Williams has a conference centre on its site which is extensively used by its corporate sponsors and external organisations. Caterham FI is regarded by Tony Fernandes, its owner, as providing the high profile brand for future expansion across a variety of industries in the automotive, composites and media areas.

Links to the wider Oxfordshire economy

Oxfordshire is a rich source of specialist skills and suppliers for the motorsport cluster. There are many small specialist suppliers located mainly in the north and west of the county, as well as the high profile race teams, and a large workforce with specialist engineering, technical and other skills needed by the cluster. The University of Oxford, Oxford Brookes and Oxford and Cherwell Valley College all provide education and training for the motorsport industry, but there are fewer research links.

The major motorsport firms also use local services such as legal, financial, marketing and logistics, catering and security.

Constraints on future growth

The key constraint on future growth, other than self-imposed regulations by the motorsport authorities, is likely to be the availability of specialist skills. At the top end, some expertise is in short supply globally, such as aerodynamic engineering and composites. Motorsport Valley is relatively well placed to compete for this global talent although several firms commented on the complexity of the process for securing work permits for recruits from outside the EU.

Graduate electrical and electronic engineers are also in short supply nationally due to insufficient numbers being trained in the past.

For example, Prodrive commented that their graduate engineers are mainly over 40 or in their early 20s, with a gap in between due to the decline in engineering courses in the 1970s and 1980s.

At skilled technician level there has been a hollowing out of supply. For example, Williams F1 said that in the 1980s they used to employ technicians who had completed apprenticeships at Harwell and Cowley, but this supply dried up and they now do most of their own apprentice training. Prodrive said that competition from Jaguar Land Rover in Coventry has meant they have had to increase salaries to retain their own technicians.

Telecommunications and computer hardware and software

3.14 A fourth sector, which is more difficult to pin down, is that linked to telecommunications and computer hardware and software. On the face of it, this is rather less visible than all three of the groupings outlined above, and at least in part, this may reflect the relatively late arrival of computer science at the University of Oxford; according to one of our consultees, undergraduate degrees were not awarded in this subject until the mid 1980s – which means that the ‘oldest’ members of the graduate community are now still only in their late 40s.

3.15 Despite its apparently late arrival, the University of Oxford’s computer science department was placed in the top five nationally in the 2008 Research Assessment Exercise, and there is much evidence from official data sources regarding the importance of the sector within Oxfordshire. For the county as a whole (and relative to England), the employee jobs location quotient for ‘computers and peripheral hardware’ in 2011 was 10.97 (indicating that there were almost 11 times more employee jobs in the sector in Oxfordshire than would typically be expected across England). Although we can only speculate, this may have owed much to the activities of firms such as RM plc, a major supplier of computer hardware and software to UK schools which is located on Milton Park, and Sophos plc, a creator

of anti-virus and encryption products located on Abingdon Science Park. Whilst less dramatic, it is also notable that the location quotients for ‘communication equipment’ (2.73) and ‘other IT and computer related activities’ (1.30) were also high.

The wider knowledge economy – and the endowment linked to it

3.16 There is, however, a further ingredient that underpins high tech Oxfordshire. It concerns Oxfordshire’s wider ‘endowment’ on which the high tech business community has been able to draw.

The broader knowledge economy

3.17 The wider knowledge economy, beyond the four specialist areas discussed above, is very important to Oxfordshire’s endowment of expertise and skills. Two examples illustrate the point:

- Oxford is one of the world’s leading centres of **academic and scientific publishing**. Several of the leading brands have a strong presence in the county – not least Oxford University Press (OUP), but also Wiley Blackwell, Elsevier, Taylor & Francis and Macmillan. There are also many small supporting companies in the cluster – for example, the Manta Connect website ³⁶ lists 142 printing and publishing companies in Oxford. Publishing is long established in the city: the first book was printed in 1478, and the structure of OUP (which remains

³⁶ http://www.manta.com/world/Europe/United+Kingdom/-/Oxford/printing_publishing--A5/

a department of the University) was established in the mid-17th Century. OUP alone now has a global turnover of £700m and 6,000 employees, of which 1,800 are in Oxford. International markets are increasingly important: 85% of OUP revenues are now derived from outside UK. New skills are required as the old world of print is increasingly being superseded by digital content, with Oxford Brookes being a major provider.

- Engineering skills in Oxfordshire have benefitted from the fact that **motor vehicles** have been manufactured at Cowley since Morris Motors opened a plant there in 1913. After various changes of ownership, BMW acquired the Cowley plant from British Aerospace in 1994, which became the production centre for the new Rover 75 in late 1998. Since 2001, BMW has been producing the MINI at Cowley, and has developed it as a premium brand. In 2011, there were 3,800 employees in Oxford manufacturing over 191,000 customised MINIs at one of the most modern BMW Group production sites. 80% of MINIs are exported to 99 countries worldwide.

The calibre of Oxfordshire's workforce

3.18 The calibre of the Oxfordshire workforce is an important consequence of the diversity of the knowledge economy illustrated above, but also of the excellence of some of the academic and training resources in the county, including Oxford and Cherwell Valley College (OCVC) and some excellent schools as well as the two universities in Oxford. In addition, a University Technical College is to be built at Didcot, specialising in science, engineering and computing, and sponsored jointly by University of Reading, OCVC, BMW, Oxford Instruments, Culham Science Centre and Rutherford Appleton Laboratory (the appearance of Reading University rather than the University of Oxford or Oxford Brookes in this list is interesting).

3.19 In terms of qualification-based proxies for skills, Oxfordshire performs very strongly. Overall, close to 45% of its working age population is qualified to NVQ4 (degree level) or above, and in Oxford itself the figure is 59%; the average figure for England is close to 33% and the difference is therefore substantial. The proportion in southern Oxfordshire is also high, but in north Oxfordshire it is below the national average³⁷.

3.20 However, shortages of scientific and technical skills were identified by most respondents to our business survey as a constraint on growth, and the in-depth interviews generally confirmed this. Concerns were most acute in the engineering, motorsport and physical sciences sectors. For example, motorsport firms expressed concerns about the shortage of highly specialist skills such as aerodynamics engineers and the use of carbon fibre, and also in more general areas such as electrical and electronic engineering. In publishing, there are shortages of digital skills at a time when the industry is changing rapidly. However, these concerns reflect national, and in some cases global shortages, which were addressed in different ways. For those that could afford it, internationally competitive salaries were paid; but in some other cases, there was an increasing trend to expand elsewhere – for example, publishing in the Far East.

3.21 Constraints on commercial and management skills are regarded as far less important by firms in Oxfordshire: identified as a constraint by around 20% of survey respondents, compared to 44% of respondents identifying technical skills as a constraint to growth. This probably reflects the strategic location of Oxfordshire, close to the Thames Valley and London to the south and the West Midlands conurbation to the north. In contrast, surveys for the Cambridge Phenomenon studies identified greater concerns with management and particularly commercial expertise, which was largely attributed to Cambridge's relative isolation from other big employment centres.

³⁷ The proportions of the working age population with qualifications at NVQ4 and above are: Cherwell 31%, South Oxfordshire 45%; Vale of White Horse 48%, West Oxfordshire 37%. APS, ONS, 2012.

4. The dynamics of the high tech business ecosystem

A snapshot from official statistics and other data sources

Employee jobs in the high tech economy

- 4.1 The 'high tech' economy is fraught with definitional challenges – both in aggregate and with regard to component activities within it. Eurostat has developed two definitions – one narrow and one broader, both based on the standard system of industrial classification (SIC 2007). Both definitions include high tech manufacturing (e.g. pharmaceutical preparations, and air and spacecraft and related machinery) and high tech knowledge intensive services (such as telecommunications, and scientific research and development). In addition, the wider definition includes some other knowledge intensive activities which are important in Oxfordshire (e.g. publishing). On the narrow definition, it is estimated that – in 2011 (the latest year for which data are currently available from the Business Register and Employment Survey (BRES)) – **high tech manufacturing accounted for around 4,000 employee jobs in Oxfordshire while high tech knowledge intensive services accounted for a further 16,000.** Overall, these high tech sectors provided **6.2% of Oxfordshire's total complement of employee jobs**; the comparable figure for England as a whole was around 5.1%. On the wider definition, there were **43,000 jobs, including 13,000 in manufacturing and 29,000 in services.**
- 4.2 The spatial distribution of high tech employee jobs across Oxfordshire varies substantially. The highest incidence is seen in the district of Vale of White Horse (in the south); here, high tech employee jobs (on the narrow definition) account for around 13.7% of the total – more than double the Oxfordshire average. Conversely, the most thinly represented district is Oxford itself where the incidence of high tech employee jobs is below the England-wide average (although it has more high tech jobs using the wider definition due to the concentration of publishing and motor manufacturing in the city).

Comparisons with other areas

- 4.3 It is also instructive to consider how high tech Oxfordshire compares with elsewhere. In this context, two key comparators are the Cambridge sub-region³⁸ and Thames Valley³⁹. **Table 4-1** shows that in both absolute and relative terms, and on both narrow and broader Eurostat definitions of high tech sectors, Oxfordshire has fewer high tech employees than either of the comparators. Broadly speaking, Oxfordshire is much closer to the Cambridge sub-region in terms of the scale and pattern of high tech employee jobs (i.e. the balance between manufacturing and services), and also when considering high tech jobs as a proportion of all jobs. This is particularly the case when considering the wider definition of high tech jobs, which includes two sectors which are particularly important in Oxfordshire: publishing and automotive.
- 4.4 In contrast, the Thames Valley has more high tech jobs than either Oxfordshire or the Cambridge sub-region, and these jobs form a higher proportion of the total number of jobs in the Thames Valley. The characteristics of high tech jobs in the Thames Valley is also different: there are far more jobs in high tech services, in both absolute and relative terms, and there are also many more multinational firms with large and diverse workforces (some with substantial sales and marketing operations), attracted by proximity to Heathrow and London. Examples include Vodafone in Newbury, Cisco Systems in Reading, and UCB in Slough.

³⁸ Note this is not the county of Cambridgeshire. Instead, the Cambridge sub-region is defined here as the local authority districts of Cambridge, East Cambridgeshire, South Cambridgeshire, Huntingdonshire, Forest Heath, North Hertfordshire and Uttlesford.

³⁹ Defined here as all ex-Berkshire unitary authorities, plus the local authority districts of Basingstoke and Deane, Hart, Rushmoor, Runnymede, Spelthorne, Surrey Heath and South Buckinghamshire.

TABLE 4-1: Employees in high-tech sectors (Eurostat Definition), Oxfordshire and comparators, 2011 ⁴⁰

	OXFORDSHIRE	CAMBRIDGE SUB-REGION	THAMES VALLEY	ENGLAND
Total Employees (All Sectors)	320,600	351,300	783,900	22,929,600
Number of Employees (narrow Eurostat definition of high tech)				
High-Tech Manufacturing	4,000	8,100	7,600	213,000
High-Tech KI Services	16,000	22,600	95,300	950,600
Total: Eurostat High-Tech Sectors	20,000	30,700	102,900	1,163,600
As % of Total Employees (narrow Eurostat definition of high tech)				
High-Tech Manufacturing	1.2%	2.3%	1.0%	0.9%
High-Tech KI Services	5.0%	6.4%	12.2%	4.1%
Total: Eurostat High-Tech Sectors	6.2%	8.7%	13.1%	5.1%
Number of Employees (broader Eurostat Plus definition including 'medium tech')				
High and Medium Tech Manufacturing	13,100	16,500	26,500	716,800
High-Tech and selected other KI Services	29,900	36,400	114,700	1,524,600
Total: Wider High-Tech Sectors	43,000	52,900	141,200	2,241,400
As % of Total Employees (broader Eurostat Plus definition including 'medium tech')				
High and Medium Tech Manufacturing	4.1%	4.7%	3.4%	3.1%
High-Tech and selected other KI Services	9.3%	10.4%	14.6%	6.6%
Total: Wider High-Tech Sectors	13.4%	15.1%	18.0%	9.8%

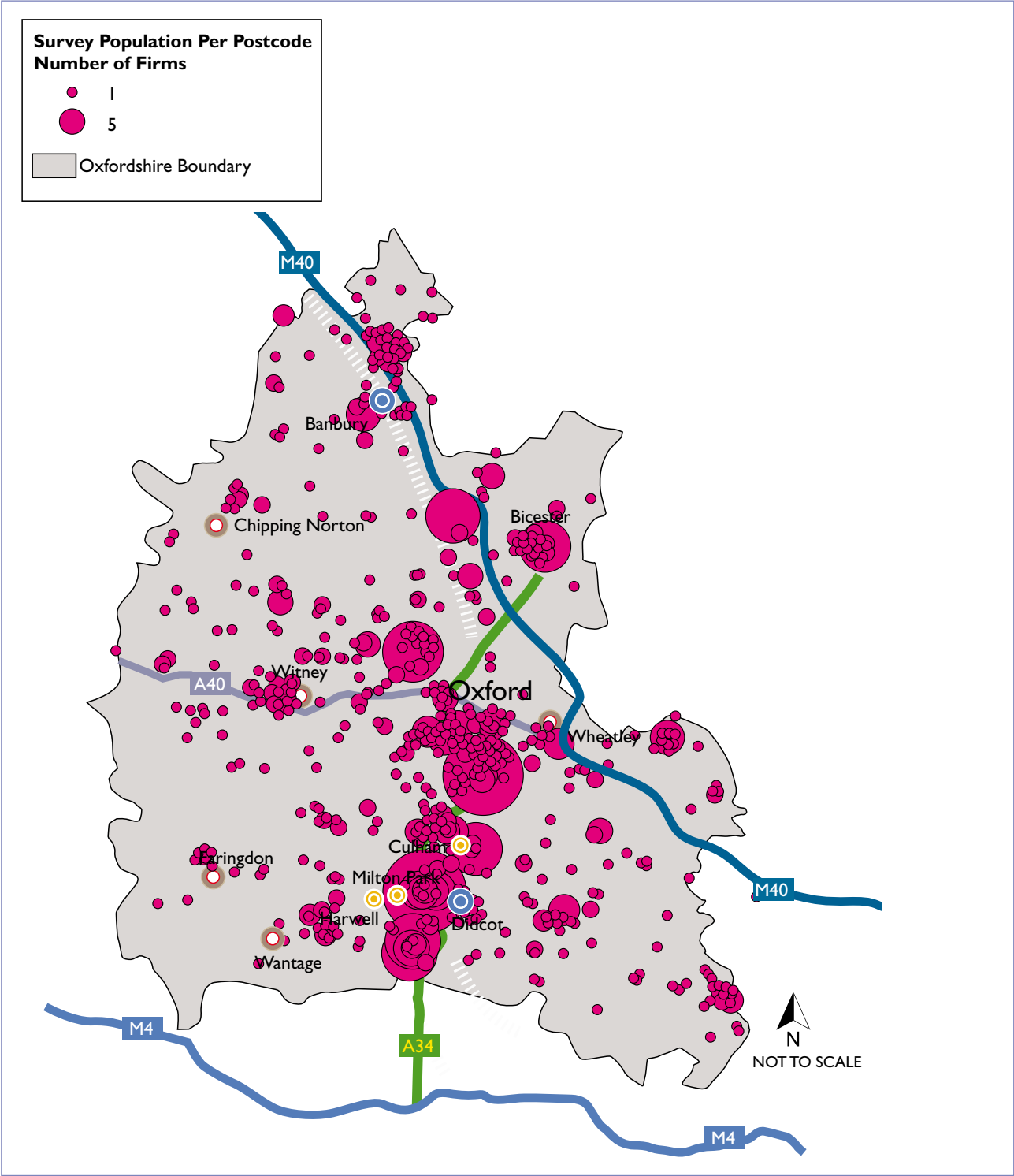
Source: ONS, Business Register & Employment Survey (NOMIS). Narrow Definition – High-tech manufacturing: 2007 SIC 21, 26, 30.3. High-tech knowledge intensive services: 2007 SIC 59-63, 72. Broader Definition – High-tech & medium high-tech manufacturing: 2007 SIC 20-21, 25.4, 26-29, 30 (except 30.1), 32.5. High-tech & selected other knowledge intensive services: 2007 SIC 58-63, 71-72, 74.1, 74.9. Figures for total employees exclude farm-based agriculture (2007 SIC 01000). All figures are rounded to the nearest hundred employees.

- 4.5 In comparison to the major US high tech clusters such as Silicon Valley and Boston/Massachusetts, both Oxfordshire and the Cambridge sub-region are small, and in many respects the whole of the Thames Valley and Oxfordshire (and arguably the whole of the Golden Triangle, also encompassing Cambridge and London) would be seen, from an international perspective, as a single high tech spatial concentration with distinctive but linked component parts. The links that Oxfordshire high tech firms have across this wider area is a topic to which we return in *Chapter 5*.

Business stock

- 4.6 From the inter-departmental business register (IDBR), Oxfordshire's overall stock of (VAT or PAYE-registered) businesses is estimated to be close to 33,500. From this source, it is not possible to derive a reliable estimate of the number of businesses in high tech sectors. Using the narrow Eurostat definition – and assuming the distribution of business stock mirrors the distribution of employee jobs – we might estimate that there are **in the region of 2,000 high tech firms in Oxfordshire**. Other sources point to somewhat higher numbers ⁴¹ – but based on a different, and broader, definition of high tech. Our own review of company databases and various directories has led to a more cautious estimate but one that is still **in the order of about 1,500**; the spatial distribution of these businesses is shown in *Figure 4-1*. As with the distribution of employment, this map points to the significance of the high tech economy particularly in the south of the county and along the A34 corridor; but it also suggests a degree of clustering around each of the principal market towns – and it emphasises that 'high tech Oxfordshire' is a county-wide concern.

FIGURE 4-1: Spatial distribution of high tech businesses identified within Oxfordshire



Source: SQW – based on a review of various company directories and databases

⁴⁰ These data are taken from an Annex to this report, produced by Professor Helen Lawton Smith and colleagues, and available on request from SQW.

⁴¹ See, for example, Waters, R, and Lawton Smith, H (2012) 'High Technology Local Economies: geographical mobility of the highly skilled' Chapter 5 in U Hilpert and H Lawton Smith (Eds) *Networking Regionalised Innovative Labour Markets*, Routledge, pp 96-116.

The high tech firms

- 4.7 Oxfordshire's high tech businesses are extremely diverse. Each one has a different story to tell, both with regard to its past evolution and its future prospects (and constraints). Across these individual narratives, there is, inevitably, a strong element of path dependency: in other words, for individual firms, history matters greatly. But what do these stories tell us about Oxfordshire's high tech businesses as a whole? To generate some insights, individual narratives need to be probed and two sets of crucial questions must be addressed: first, to what extent do the different stories converge on a shared set of contingent circumstances; and second, looking ahead, do these stories provide any hint at future prospects, both for the individual businesses concerned and for Oxfordshire as a high tech economy?
- 4.8 Drawing on the individual stories provided by some of Oxfordshire's high tech businesses – and also on the findings from our wider business survey, our survey of high tech firms' employees and our other consultations – this chapter looks both forward and back to consider extant processes of business formation and growth, and future prospects linked to both.

In the beginning...

- 4.9 If we were to attempt to pinpoint the year in which high tech Oxfordshire came into being – certainly in terms of its business community – then 1959 would be a strong candidate. This was the year in which Oxford Instruments plc, a firm that became totemic in relation to the county's knowledge economy, was first established. Its story is well known: from humble origins in a garden shed, Oxford Instruments grew rapidly in the 1960s and 1970s in the context of advances in superconductivity and by the time the firm was floated in the early 1980s, its turnover exceeded £100m. Between 1990 and 2005 its performance was more erratic, but since then, growth has resumed and in 2011 it entered the FTSE 250 index, and was voted PLC of the year⁴². By 2012, its revenues were well in excess of £300m and Oxford Instruments continues to be a clear Oxfordshire success story.

- 4.10 The importance of Oxford Instruments lay not just in its size but in the fact that it came to define (in very tangible terms) the heart of an inter-connected high tech ecosystem. This included the University of Oxford, the 'big science' facilities in the south of the county, and a number of key individuals; it has been described in fascinating detail through a number of previous studies⁴³ (and for a thorough account of its early development these are well worth reading). Our narrative here is much less comprehensive and is restricted to those elements that appear particularly germane to the high tech sector's current form and future prospects.
- 4.11 Oxford Instruments was founded by Sir Martin and Lady (Audrey) Wood. The business was started while Martin Wood was working in the University of Oxford's Physics Department, where he continued for another 10 years. In the course of growing the firm various businesses were spun-off/divested, not least Oxford Magnet Technology which was acquired by Siemens and today still employs around 500 people in Oxfordshire. The Woods used the wealth they generated to become very significant local philanthropists and investors, forming The Oxford Trust in 1985, and investing actively in close to 50 separate enterprises in Oxfordshire over a period from 1966 to the present; a number of these failed, but some (notably Sophos) grew to become substantial Oxfordshire success stories in their own right and others (for example, Tokamak Solutions) have the potential to do so in the future. Throughout, as investors, the Woods were both actively involved in their businesses' development (often assuming Board positions) and they were committed to this process for the long haul: their exit from Orbit Precision Machining Ltd, for example, occurred 28 years after their initial investment, while Oxford Metrics Group, in which they invested in 1984, was floated on AIM in 2001. Moreover a good proportion of their investments had some kind of relationship to Oxford Instruments and/or the University of Oxford and/or one of the 'big science' institutions in the south of the county.

4.12 Alongside the Oxford Instruments narrative, and to some extent intertwined with it, was a small group of investors-cum-entrepreneurs with a similarly deep commitment to Oxfordshire and the possibilities of high tech business growth within it. This included Nick Cross and Ian Laing, who had generated considerable wealth by securing an equity interest in, redeveloping, and then achieving the staged sale of Milton Park over the decade from 1984. Between 1992 and 2013, Cross and Laing invested in around 15 different technology-based enterprises, some of which – for example, Oxford Asymmetry International plc – proved to be very successful. Like the Woods, the investment approach of Cross and Laing was active (insofar as they invariably assumed board positions); sustained (in that they often provided successive rounds of funding); and patient (with the elapsed time between the initial investment and eventual exit being generally in the order of eight to ten years and sometimes a good deal longer). The local investment community also included a number of individuals who were more formally identifiable as financiers; among these were Lucius Cary, founder of the Oxford Technology VCTs, John Laurie of Oxford Ventures Group, and later Ted and David Mott of Oxford Capital.

4.13 The academic community – and those at the interface between academic institutions and the process of commercialisation (in all its guises) also played a key role. In terms of the former, from the University of Oxford, key individuals included, inter alia, Professor Graham Richards (Department of Chemistry and co-founder of Oxford Molecular Ltd); Professor Sir John Bell (Nuffield Department of Clinical Medicine and with early links to Oxagen, Avidex and Powderject Pharmaceuticals); Professor Sir Mike Brady (Department of Information Engineering, co-founder of Mirada Solutions and board member of Oxford Instruments and Isis Innovation); and Professor Steve Davies (Department of Chemistry and co-founder of Oxford Asymmetry, VASTox and Oxford Diversity).

Amongst those at the interface with the academic community, key players included Dr Tim Cook (who initially worked for Oxford Instruments and subsequently played a pioneering role as Managing Director of Isis Innovation); Paul Bradstock (another Oxford Instruments employee who eventually led The Oxford Trust); and Dr David Kingham (who led Oxford Innovation when it was spun out from The Oxford Trust and subsequently co-founded Tokamak Solutions based at Culham).

The changing networks of inter-relationships

Informal networks and key individuals within them

4.14 The narrative set out above is by no means complete but it points to a density of inter-relationships that has developed over some decades between individuals and organisations linked more or less closely to each other, to the University of Oxford, to the 'big science' institutions in southern Oxfordshire and, in many cases, to Oxford Instruments. But in terms of high tech Oxfordshire as a whole, it is important to consider how important this network of inter-relationships is today, and what it tells us about prospects.

⁴² The PLC Awards event was founded in 1987 to reward excellence in the smaller quoted company sector.

⁴³ See, for example, *"Magnetic Venture, the story of Oxford Instruments"*, Lady (Audrey) Wood (2001), Oxford University Press; *"From Bright Sparks to Brilliant Businesses: Oxford University Spin-Outs and Start-Ups"*, Sir Douglas Hague and Anthea Milnes (2010), AC & Black Publishers: London; *"Oxford Entrepreneurs"*, Douglas Hague and Christine Holmes (2006); and *Enterprising Oxford: The Growth of the Oxfordshire High-Tech Economy – Volumes I and II*, Helen Lawton Smith, John Glasson, James Simmie, Andrew Chadwick and Gordon Clark (2003), Oxfordshire Economic Observatory.

4.15 As part of our business survey, high tech firms were asked which individuals they considered to be the most influential in shaping high tech Oxfordshire, both currently, and looking back over 25 years. At one level, the findings from this exercise are nothing more than the results of a straw poll, but they are intriguing, not least because they are wholly consistent with the insights generated through other strands of work. The survey findings are summarised in **Table 4-2**.

TABLE 4-2: Firms' responses to the question "which individuals do you consider to be most influential in shaping business growth in high tech Oxfordshire both currently and looking back over the last 25 years?"

NAME	BACKGROUND AT DATE OF SURVEY	LOOKING BACK: NO. OF RESPONSES	CURRENTLY: NO. OF RESPONSES
Sir Martin and Lady Audrey Wood	Co-founders of Oxford Instruments and serial entrepreneurs/investors	16	2
Professor Sir Mike Brady	Academic from the University of Oxford, entrepreneur and board member of both Oxford Instruments and Isis Innovation	2	1
Sir Richard Branson	Serial entrepreneur and founder of Virgin who lives in Oxfordshire	2	1
Nick Cross	Developer and subsequently a serial entrepreneur/ investor	2	1
Lord Drayson	Co-founder of Powderject Pharmaceuticals and subsequently a Minister of State	2	
Ian Laing	Developer and subsequently a serial entrepreneur/ investor	2	1
Professor Graham Richards	Academic from the University of Oxford and entrepreneur	2	
Dr Andrew Rickman	Founder of Bookham Technology plc and now a serial investor	2	

Looking back over the last 25 years, individuals mentioned by one respondent as being "most influential" included:

Professor Hagan Bayley (Academic from the University of Oxford and founder of Oxford Nanopore Technologies) • Dr Tim Cook (Former Managing Director of Isis Innovation) • Professor Steve Davies (Academic from the University of Oxford and co-founder of Oxford Asymmetry) • James Dyson (Founder of the Dyson company and Dyson Foundation) • Dr Peter Lammer / Dr Jan Hruska (Co-founders of Sophos) • David Richards (Founder of Prodrive) • Dr Gordon Sanghera (Founder of Oxford Nanopore Technologies)

Currently, individuals mentioned by one respondent as being "most influential" included:

Professor Sir John Bell (Academic from the University of Oxford and supporter of several biotech businesses) • Lucius Carey (Investor and founder of the Oxford Technology VCTs) • Martin Dare-Edwards (Founding chair of Oxfordshire Local Enterprise Partnership) • James Dipple (Managing Director of Milton Park) • Jean-Jacques Dourdain (Director General of the European Space Agency – with links to Harwell) • Sally Ann Forsyth (Director of Science Parks at Goodman – with responsibility for Harwell) • Iain Gray (Chief Executive Officer of the Technology Strategy Board) • Dr Edward Green (Founder and Chief Scientific Advisor of Green Biologics Ltd) • Eileen Modral (Key role at Oxford Investment Opportunity Network) • Dr Jon Rees (Chief Executive Officer of OBN) • Bruce Savage (Founder of Cytocell Ltd and serial entrepreneur) • Adrian Shooter (Chairman of Oxfordshire Local Enterprise Partnership) • Dave Waller (Oxfordshire County Council and Venturefest) • John Wormersly (Chief Executive of the Science and Technology Facilities Council)

Source: SQW – based on Oxfordshire High Tech Firms' Survey, 2013

4.16 From the table, a number of immediate observations can be made:

- Sir Martin and Lady (Audrey) Wood were (by far) the most commonly identified individuals, certainly in relation to the last 25 years of Oxfordshire's high tech business community but also in relation to the current situation
- whereas academics from the University of Oxford and high tech business entrepreneurs featured strongly in the historic list, the balance appears to be different amongst the current incumbents with more public/quasi-public sector interest
- the current list is more disparate than the historic one; indeed, amongst the current 'nominations' only Sir Martin and Lady (Audrey) Wood were mentioned more than once.

4.17 But another observation is just how few of our survey respondents were able to comment at all: looking back over 25 years, 24 (of 142 respondents) identified at least one influential individual and in terms of the current assessment, just 11 firms provided any kind of response.

4.18 Of course, the findings from this exercise should not be taken too far. 'Influence' is nebulous, particularly in the melee of the here and now, and it is much easier to discern with the benefit of hindsight. Equally, the assessment of 'influence' relies on the particular perspective of the individuals completing the questionnaire; it is perfectly possible that their colleagues⁴⁴ (or perhaps predecessors) could have come up with different responses. Yet Sir Martin and Lady (Audrey) Wood aside, through our in-depth consultations, we were also struck by just how fragmented the responses were to the question of who the key individuals are within Oxfordshire's high tech community today. In the words of one very knowledgeable consultee:

"A few years ago, there was a 'formally informal' group of investors who were well-known across Oxfordshire – Martin and Audrey Wood, Ian Laing, Nick Cross and also Tim Cook. Effectively, these people worked together and the consequence was an informal, but very effective, process of due diligence which worked well. Subsequently, these individuals really have not been replaced."

The significance of informal networks in shaping high tech Oxfordshire as a whole

4.19 Although Sir Martin and Lady (Audrey) Wood were undoubtedly at the core of a network that appears to have become more fragmented over time, it is important to avoid simplistic inferences about the overall significance of 'the network' within high tech Oxfordshire: we have observed, for example, that the Woods invested in around 50 start-up businesses but we reported earlier that across Oxfordshire, there are now around 1,500 high tech businesses in total. The firms that grew in and through the informal networks are typically the larger ones in high tech Oxfordshire – and hence their share of employment and GVA will be higher than their representation in the business population – but nevertheless, these metrics suggest that other processes of business growth are simultaneously at play.

4.20 From our business survey, it is possible to derive some insights into the source of company founders across different high tech sectors, and how this has changed over time. From **Table 4-3**, it is apparent that among our 142 respondents, 49 (35%) reported that one or more of their founders had come directly from employment with the University of Oxford, Oxford Brookes, an Oxfordshire-based research establishment or another business in the county. This profile however varies noticeably by sector: for bioscience/medical technology/pharmaceuticals firms and those operating in the physics-related sector (including cryogenics, instruments and magnets) the incidence of local founders is over 50% and it is in these sectors therefore that the importance of the wider network would appear to be greatest. From **Table 4-3**, there is no real evidence to suggest that the incidence of local founders has changed significantly over time.

⁴⁴ In this context, however, the findings from our separate survey of three high tech firms' employees are telling. Across the three firms (one in bioscience, one motorsport and one software), 112 employees (across all occupations) completed our questionnaire. Of these, 100 provided no answer or said that they had no idea and three referred to their own CEO/founder. Among the remainder, the names that were mentioned included: Nick Cross (3); Ian Laing (2); Sir Martin and Lady (Audrey) Wood (1); Paul Drayson (1); Jon Rees (1); Professor Hagen Bayley (1); and Richard Branson (1).

TABLE 4-3: Firms' responses to the question "did any of the business's founders come directly from employment with the University of Oxford; Oxford Brookes; an Oxfordshire-based research establishment; or another business in Oxfordshire", by sector, and by year of establishment in Oxfordshire

YEAR OF ESTABLISHMENT IN OXFORDSHIRE	BIOSCIENCE / MED TECH / PHARMA		ELECTRONICS / ENGINEERING INCL. MOTORSPORT		PHYSICS-RELATED INCL. CRYOGENICS, INSTRUMENTS, MAGNETS		TELECOMMS / COMPUTER HARDWARE / SOFTWARE	
	Yes Ox founders	No Ox founders	Yes Ox founders	No Ox founders	Yes Ox founders	No Ox founders	Yes Ox founders	No Ox founders
Before 1980	1	1	1	5	2	3	1	3
1980-1989	0	0	3	1	2	1	1	2
1990-1999	3	2	0	4	3	1	1	6
2000-2004	2	4	0	3	2	4	2	8
2005-2009	11	9	1	7	8	3	1	13
2010 or later	2	0	0	3	1	3	1	7
Total	19	16	5	23	18	15	7	39

Source: SQW – based on Oxfordshire High Tech Firms' Survey, 2013

4.21 Another important insight can be gleaned from firms' explanations as to why their business was originally established in Oxfordshire (*Table 4-4*). As ever, 'home of founder' features prominently – which begs the question of why the founder was in Oxfordshire in the first place. Beyond this, we can observe that factors relating to networks intrinsic to Oxfordshire feature in 42 (of 142) cases while more generic locational advantages are noted by a further 20 businesses, the majority of which have been established in the county since 2005.

TABLE 4-4: Firms' explanations of their location in Oxfordshire by the year of establishment in Oxfordshire

	BEFORE 1980	1980-1989	1990-1999	2000-2004	2005-2009	2010 OR LATER
Home of founder	11	6	10	19	23	4
Links to University of Oxford: either a spin-out, or softer links, or the founders met there	3	1	6	2	9	4
Links to Harwell / RAL / Culham / ESI / Wallingford / Diagonox					8	2
Acquired or spun-out from Oxfordshire-based business	1	2	1		2	1
Concentration of relevant businesses / specialist labour market			2	2	3	2
Central UK location – good for London and/or airports	1		1		7	2
Other		1		2	1	2
Don't know	1					

Source: SQW – based on Oxfordshire High Tech Firms' Survey, 2013

4.22 In terms of both the previous employment of founders and the explanations given for their Oxfordshire location, the networks of relationships with related firms and/or universities and/or other research institutions in Oxfordshire do then appear to be significant for about a third of our survey respondents. With that context, the growing sense of network fragmentation is noteworthy.

The emergence of more formal networks

- 4.23 As the informal networks have – at least to some extent – dissipated, more formal and managed arrangements have been established. Some, such as OBN (formerly, Oxfordshire Bioscience Network) are sector specific business networks; others (like Oxford Investment Opportunity Network and Oxford Early Investments) are investment networks and focused on a particular stage in the process of business growth; and a third group (including Venturefest) have sought to appeal to high tech businesses and investors more generally.
- 4.24 As part of our business survey, firms were asked to comment on the extent to which they agreed with the statement *“within Oxfordshire, networking groups are useful to us”*: overall, 54 (of 142) respondents indicated that they “totally” or “partly” agreed. Through our employees’ survey, we also tested the importance of different forms of networking. Among 112 respondents, 11 indicated that *“links through formal local networks”* were “very important” while a further 40 suggested that they were “of some use”.
- 4.25 However, particularly amongst the businesses, the pattern of response again varied substantially by sector: in the main, firms operating in the field of bioscience/medical technology/pharmaceuticals were more positive than those in other sectors. This finding links closely to the effectiveness of OBN which was reviewed positively throughout our wider consultations and the leadership of it (by Dr Jon Rees) was widely recognised.
- 4.26 More generally though, formalised networks in Oxfordshire – as indeed elsewhere – have struggled to sustain the role and purpose for which they were intended. Once formalised, they typically rely on intermediaries and/or the public sector for funding, and yet this creates the risk that the high tech entrepreneurs and investors are marginalised as the networks themselves are – as one consultee put it – *“over-run by intermediaries in a feeding frenzy”*. For this reason, the formalised network ecosystem is, in practice, immensely difficult to orchestrate and sustain and, with the exception of OBN, a good number of our consultees questioned the centrality of the principal existing networks vis-à-vis the process of high tech business growth in Oxfordshire.

Implications

- 4.27 There is much evidence to point to the past importance of networks within Oxfordshire in creating and nurturing early stage technology-based businesses. But with the apparent fragmentation of informal networks and the mixed press linked to the more formal ones, the consequence – which was consistently recognised but also a source of some puzzlement – is that high tech Oxfordshire may be increasingly different from some other centres of the knowledge economy. The underpinning paradox is neatly summarised through the (unprompted and verbatim) comments of a number of survey respondents:

“‘High Tech Oxfordshire’ doesn’t exist in any real terms. There are high tech firms here but there is no ‘movement’. This is not Cambridge or Silicon Roundabout.” (Respondent # 32 – Software firm located in Oxford)

“Generally, I don’t feel ‘High Tech Oxford’ exists, though there are large amounts of companies and networks. For example, there aren’t strong links between spin-outs, Said Business School, University careers service, etc., despite obvious overlaps in interest. There appears to be more interest in developing ‘High Tech Oxford’ from a number of parties, though it is not yet clear how influential they are.” (Respondent # 60 – Environmental technologies firm located in Oxford)

“I don’t think of there being a ‘high tech Oxfordshire’ really, it is more like a small band of people. Without having a huge amount of first-hand knowledge, it seems like Cambridge has stolen a march on us in this area.” (Respondent # 69 – Software firm located in the north of the county)

- 4.28 If these observations are accepted, then two very important questions follow in relation to the future of Oxfordshire’s high tech sector: why does this appear to be happening; and does it matter? It is to these questions that we now turn.

Why is the growth dynamic of high tech Oxfordshire apparently changing?

Perspectives from individual businesses

- 4.29 In considering why the nature of the growth dynamic may be changing in high tech Oxfordshire, it is instructive to consider in rather more detail the recent histories of individual firms – including those which were essentially the progeny of the relationship-rich ecosystem described above.
- 4.30 As explained in detail in **Box 4-1**, during the early years of **Oxford Asymmetry's** development, the links to the Oxfordshire ecosystem were crucially important – the scientist co-founder was an academic from the University of Oxford; early stage financing was provided by Nick Cross and Ian Laing; and the early management of the business relied on Dr Tim Cook. Milton Park provided an excellent location: as an employment site it was cheap and it

was also close to relatively affordable new housing which was being built in nearby Didcot at precisely the time Oxford Asymmetry was seeking to recruit large numbers of young, ambitious, scientists. By the late 1990s, Oxford Asymmetry had floated on the London Stock Exchange and employed close to 300 people in Oxfordshire. In 2001, Oxford Asymmetry was acquired by the German biotechnology company, Evotec. Significant restructuring and refocusing followed and today, activities on Milton Park can only be understood as part of a much larger international business. Increasingly, Evotec's business model is defined around relationships, alliances and collaborations with both international companies and research institutions (including the universities of Harvard and Yale). Other than providing a business location, there are now almost no links into the Oxfordshire ecosystem through which Oxford Asymmetry was effectively created, and there are very limited interactions with the University of Oxford.

BOX 4-1: Case Study – Oxford Asymmetry / Evotec

Today, Evotec is a drug discovery alliance and development partnership business focused on progressing innovative product approaches with leading pharmaceutical and biotechnology companies. It is a publically-owned German company (of which Evotec UK Ltd is a wholly owned subsidiary), quoted on the Frankfurt Stock Exchange. The company from which it grew – Evotec BioSystems GmbH – was founded in Hamburg in 1993. Over the last 20 years, the company has acquired various businesses. One of its key acquisitions was that of Oxford Asymmetry International plc in 2000.

Growth of Oxford Asymmetry, 1991-2000

The origins of Oxford Asymmetry can be traced to Oxford Chirality, a venture set up in the late 1980s by Professor Steve Davies (from the University of Oxford's chemistry department) with financial support from BP Chemicals. Despite promising beginnings, BP did not pursue the project (because its own strategy changed). Professor Davies had confidence in the science and therefore established Oxford Asymmetry to pursue the venture, initially with no external funding.

At a Christmas party in 1991, held at Rutherford Appleton Laboratories, Dr David Kingham (then Assistant Director of The Oxford Trust) introduced Professor Davies to Nick Cross and Ian Laing, developers of Milton Park, and Dr Tim Cook. In 1992, Nick Cross and Ian Laing invested in Oxford Asymmetry, and Tim Cook became managing director, quickly building a company with robust business processes. The company moved from Oxford University to Milton Park, in part because Oxford Science Park was considered too expensive; initially it occupied cheap, ex-ordinance, depot sheds on Milton Park.

In the early days, Oxford Asymmetry employed a group of committed and enthusiastic scientists, many of whom were attracted by the link to Prof Davies. Quickly the firm developed from Prof Davies' specialisms in organic chemistry to become a process development and small scale manufacturer. In 1993, Edwin Moses replaced Tim Cook as managing director, and he continued to build up his team; at about this time, 3i also invested in the business. In 1995, there was an important collaboration with Pfizer, focused on combinatorial chemistry; this led to the creation of Oxford Diversity (a subsidiary of Oxford Asymmetry) with a focus on medicinal biochemistry.

In the late 1990s, Oxford Asymmetry grew very quickly to employ 240 people on Milton Park, many of whom were young, well-qualified, science graduates (and 20% were also non-UK nationals). Many were attracted by the pace of growth and the excitement that came with it: there was a very strong work ethic. Also important, however, was the fact that new, young, recruits could afford to buy one of the new houses being built in Didcot.

In 1998, after five years of profitable growth, the company was floated on the London Stock Exchange, raising £20m and valuing the business at £100m. At this time, Oxford Asymmetry employed almost 300 people, all of them based on Milton Park.

Post-flotation, Oxford Asymmetry continued to grow. However, constant public scrutiny was challenging for a strongly knowledge-based business, not least in terms of the metrics that were judged to be important: the City was far more interested in revenue and profit growth than indicators linked to the underlying science. A year or so after flotation, Oxford Asymmetry recognised that it needed to make some strategic choices – either to focus on large scale chemicals production or to pursue the interface between chemistry and biology, with clear links to drug discovery. At the time, the drug discovery route was considered to be the more promising and there were several suitors, one of which was the German company, Evotec. In December 2000, Oxford Asymmetry was acquired by Evotec for £316m.

Growth of Evotec, 2001-date

For the old-Oxford Asymmetry, the period post-acquisition was difficult: Evotec and Oxford Asymmetry were culturally quite different, and the process of integrating two businesses was hard. The challenges were compounded by a global down-turn in the drug discovery sector.

In 2007, Evotec sold the chemical development part of the combined business – originally part of Oxford Asymmetry – for £31.5m to a US pharmaceuticals services company, Aptuit (an operation remains on Milton Park today). At that stage, the company's Oxfordshire footprint declined significantly, to around 230 people and its focus also changed, to medicinal chemistry. However, seven years after the original acquisition, Evotec did start to "gel": a new business model proved more effective and the two key sites (on Milton Park and in Germany) worked much more closely together. At this point, Evotec employed around 400 people globally.

2008 was a difficult year. Two different drugs failed at late stages in their trials, and a US acquisition absorbed significant resources. Following the appointment of a new chief executive, in 2009, Evotec itself changed course: it scaled back its own research significantly and returned to core drug discovery services.

Subsequently Evotec has developed a number of collaborative innovation/research-based alliances with big pharma – including Bayer, Boehringer Ingelheim, Novartis, Genentech and Roche – and with leading academics (notably through Harvard University and, more recently, Yale University), focusing on a wide range of disease areas (diabetes, kidney disease, depression and neurodegenerative/neurological diseases). It has acquired several more businesses which have helped to build its credentials in innovative biology, including: Develogen (Goettingen-based diabetes biotech company), Kinaxo (Munich-based chemicals proteomics company) and the compound management business of Galapagos (based in San Francisco).

Over recent years, its sales have increased significantly (with revenue doubling between 2009 and 2011). Geographically, North America accounts for around 50% of sales, Europe for 40% and Japan for 10%. By focussing on innovation driven outsourcing, Evotec believes it can continue to flourish and grow against the trend of outsourcing to India and China. In 2011, Evotec made profits of around €6 million. Evotec's worldwide workforce numbered around 610 staff, with important sites in Goettingen, Hamburg, Munich, San Francisco and Thane, as well as on Milton Park. Today, Evotec employs just over 200 people at its Milton Park site. It is – genuinely – a global business and its Oxfordshire-based staff work in teams which span its global geography. Its links into local networks and institutions within Oxfordshire are limited.

4.31 Like Oxford Asymmetry/Evotec, **Sophos** (see Box 4-2) was an 'Oxford thoroughbred' – formed by post-doctoral students from the University of Oxford and relying entirely on locally-sourced early-stage financing. Although its growth narrative has been more linear, it too has seen changes of ownership, a series of international acquisitions and an increasing focus on international markets. In this context, its links with the wider Oxfordshire ecosystem also appear to have declined – both absolutely and relatively. In addition, for Sophos, it is important to note that its labour market is increasingly focused to the south of its site on Abingdon Science Park and into the Thames Valley.

BOX 4-2: Case Study – Sophos

Sophos was founded in 1985 by Dr Jan Hruska and Dr Peter Lammer, both of whom were post-doctoral students in the Department of Engineering at the University of Oxford. At the time, both founders were keen to go into business and they pursued a range of early concepts (including the possibility of a portable computer); but the one that attracted most interest was computer encryption. At around the same time, the challenge of computer viruses was emerging and Sophos was approached by potential customers who needed a solution. It was in this context that the company quickly specialised in the development of anti-virus software.

The financing of the early growth of Sophos relied on business angels and the earliest investors were locally-based; Martin and Audrey Wood and Oxford Seedcorn Capital (OSC) Ltd. In 1998, the Thames Valley office of 3i bought out OSC and acquired some of the Woods' holding for £2.5m⁴⁵.

Growth to become a major global player

Over the next few years, Sophos grew quickly, and on an increasingly international basis. Over the three financial years from 1999/2000 to 2001/2002, its turnover increased from £15m to £32m (and pre-tax profits from £4.7m to £9.8m). At about this time, a dedicated sales office was established in Boston (USA); this was crucial in making in-roads into the north American market (which was, and remains, the major market for software firms).

Sophos' physical footprint in Oxfordshire also changed. Initially, the company had been based in the home of one of the founders (in Kennington). It moved to Haddenham, and later to rented accommodation on Abingdon Science Park. In October 2001, Sophos was granted planning permission by Vale of White Horse District Council to build its new corporate headquarters on Abingdon Science Park with the intention of accommodating some 600 staff. The new building provided 145,000 sq ft of accommodation on three storeys; and the construction costs were estimated at £32m⁴⁶. Sophos moved into the new building, which was opened by the Queen in November 2003⁴⁷.

In May 2002, US-based investment company, TA Associates, acquired a minority stake in Sophos for £41m (US\$60m); and two TA executives were appointed to the main board (in part to drive forward growth in north America). Subsequently, Sophos used strategic acquisitions as a critical route to growing the business. Some of the principal acquisitions included:

- in September 2003, the acquisition of a Canadian company, ActiveState, which develops anti-spam software
- in January 2007, the acquisition of ENDFORCE, an Ohio-based company with specialisms in endpoint security and policy compliance
- in October 2008, the acquisition of Utimaco, a major German firm with significant expertise in data security.

These, and other acquisitions, were pivotal in broadening and deepening Sophos' software solutions, and enabling the company to extend its global customer base. Another key milestone in this process was the decision, in 2008, that the company's global headquarters should be formally shared between Boston (USA) and Abingdon; this was crucial in the firm's global positioning, particularly vis-à-vis the north American market.

The acquisition of ActiveState was important in another respect. Its president, Steve Munford, subsequently became Chief Operating Officer (April 2005) and then Chief Executive Officer (January 2006) of Sophos. At that point, Jan Hruska and Peter Lammer – the original founders of Sophos – ceased to manage the business on a day-to-day basis, although both still continue to serve as members of the company's main board.

In November 2007, Sophos announced its intention to float on the London Stock Exchange. However in May 2010, Sophos instead agreed to sell a majority interest in the company to Apax Partners, a global private equity and venture capital firm, headquartered in London. The transaction valued Sophos at \$830m⁴⁸.

Subsequently, Sophos has continued to grow rapidly. Its focus remains security for business, but the breadth and depth of its expertise has grown substantially – in part as a result of further acquisitions and their integration into the business. In July 2011, Sophos acquired Astaro (a German-based specialist in network security) and, in April 2012, it bought DIALOGS (another German firm, with specialisms in mobile device management).

In the year to March 2012, Sophos' global billings were \$402.9m, an increase of 17% on the previous year; and geographically (by value), north America accounted for about 30% of billings; western Europe for 50%; and the rest of the world for 20%. In the same year, Sophos' cash EBITDA was \$107.9m, up 14% on the year before. Globally, it employed 1,600 people.

Sophos in Oxfordshire today

Currently, about 480 Sophos staff are based in Oxfordshire (i.e. just under a third of the total). Of these, around half are software developers or malware analysts whose

principal focus is anticipating and responding to emerging viruses. Particularly among this group, Sophos is continually seeking to recruit. Frequently, new recruits come from previous employment in the Thames Valley (Reading, Maidenhead, Newbury) where a labour market (for both software engineers and commercial staff) has been created through the European HQs of major US companies like Oracle and Microsoft. In addition, 15-20% of its Abingdon-based software engineers are recruited internationally (some from elsewhere in the EU).

Around 100 Abingdon-based staff are engaged in UK sales and marketing and a further 100 are concerned with global corporate functions. Sophos' Abingdon site remains its single largest location although as a share of the whole operation, it has declined: ten years ago, Abingdon accounted for well over half of the Sophos' global workforce (which then numbered around 300 staff). In the future, most of Sophos' physical growth is likely to be outside of Oxfordshire.

⁴⁵ Sophos press release dated 8 September 1998.

⁴⁶ Sophos press release dated 9 October 2001.

⁴⁷ Sophos press release dated 3 November 2003.

⁴⁸ Sophos press release dated 3 May 2010.

- 4.32 If both Oxford Asymmetry and Sophos – two of the major success stories of high tech Oxfordshire over the last 20 years – have functionally grown out of, and away from, the Oxfordshire high tech ecosystem that created them, even if they are both physically still located within it, what of the original lynchpin, **Oxford Instruments**? Whilst perhaps not as extreme, its recent history has some similarities (see Box 4-3) and the leitmotiv again is one of ownership changes, international acquisitions and the development of international markets.

BOX 4-3: Case Study – Oxford Instruments PLC (since 2009)

The recent history of Oxford Instruments has been very strong, particularly when seen in the context of the global downturn. In 2009, the company's total revenue was £206m while by 2012, it had increased to £337m; and over the same period, the average number of employees increased from 1,500 to 1,900. In 2012, Oxford Instruments spent over £22m on R&D, almost 7% of its revenue.

Currently, Oxford Instruments is structured into three main operating sectors, each of which includes a number of stand-alone businesses. Nanotechnology Tools focuses on high performance technology products for research and industry, and in 2012, it generated sales of £153m. Industrial Products supplies analytical systems and components for research and industry, and in 2012, it generated sales of £129m. Oxford Instruments Service sector reflects a worldwide network of service, with sales of £56m.

A reading of this list suggests clear continuity in the scientific focus of Oxford Instruments. However, while the commitment to excellence in the application of physical sciences remains obvious, there have also been some major changes.

Changing geographies

Among the most important have been profound changes in the geography of Oxford Instruments' activity. As the table below shows, over recent years, its sales to China have grown substantially: in absolute terms, these increased by over £31m between 2009 and 2012, and by 2012, the firm was selling more in China than in the UK. The geography of Oxford Instruments' operations has also changed, but the pattern has been different. From 2009 to 2012, the overall importance of UK-based activity declined in relative terms while major growth was seen in both USA and Germany. The scale of Oxford Instruments' activity in China remained very small in relative terms but, by 2012, China accounted for five of Oxford Instruments' 14 global dedicated sales/service offices.

TABLE 4-5: *The changing international profile of Oxford Instruments*

COUNTRY	SHARE OF SALES 2009	SHARE OF SALES 2012	SHARE OF PROPERTY, PLANT AND NON-TANGIBLE ASSETS 2009	SHARE OF PROPERTY, PLANT AND NON-TANGIBLE ASSETS 2012	NUMBER OF ADDRESSES (FROM THE OXFORD INSTRUMENTS' DIRECTORY 2009)	NUMBER OF ADDRESSES (FROM THE OXFORD INSTRUMENTS' DIRECTORY 2012)
UK	12%	9%	39%	26%	4, and no separate sales/service offices	4, and no separate sales/service offices
USA	25%	27%	18%	28%	5, and 1 separate sales/service offices	9, and 1 separate sales/service offices
Germany	8%	7%	30%	38%	2, and 1 separate sales/service offices	2, and 1 separate sales/service offices
China	8%	14%	0.3%	0.2%	0, but 4 sales/service offices	0, but 5 sales/service offices

Source: SQW – Based on data from Oxford Instruments plc's annual report and accounts, 2009 and 2012

Changing activities

Another potentially important change has been the balance between production and R&D. A reading of Oxford Instruments plc's Annual Report and Accounts covering the periods from 2008 to 2012 suggests that overall, the number of staff engaged in R&D remained fairly constant between 2008 and 2012 (at about 240, but with year on year variation) and although it increased in absolute terms, as a proportion of revenue, cash spent on R&D declined over this period from 9% to 7%. However, the number of staff engaged in production grew substantially: from under 700 in 2008 to over 950 in 2012.

The process of growth – and the role of acquisitions

This overall growth profile, both in terms of geography and focus, has been driven organically, and through acquisition. Recent acquisitions have all been international, and they largely explain the changing spatial footprint of Oxford Instruments' operations outlined above. They include: WAS Analytical (Germany); Vericold (Germany); TDI (USA); Link Analytical (Sweden); Omicron Nanotechnology (Germany, but also with sites in UK, USA, France and Japan); Omniprobe Inc (USA); Platinum Medical Imaging (USA) and Asylum Research (USA).

As stated in Oxford Instruments' Annual Reports and Accounts (from a number of years), the rationale for these acquisitions has either been to provide a route to new customers (e.g. Platinum Medical Imaging) and/or to deepen Oxford Instruments' expertise and knowledge base in particular sectors (e.g. Omicron Nanotechnology).

Oxford Instruments as an investor

Oxford Instruments' recent history has not simply been about acquisitions, however. The company has also invested in new ventures of many forms.

One recent example is Tokamak Solutions (UK) Ltd which was founded in 2009. Based at Culham Innovation Centre, the company's aim is to create a super compact, but powerful, fusion neutron source. Although in its early stages, the associated technology could potentially provide a cost-effective method to harness fusion energy and generate safe, pollution-free power. Through its first investment round, Tokamak Solutions raised £170,000 of equity; the principal investors included Sir Martin and Lady (Audrey) Wood and Oxford Instruments.

Two subsequent investment rounds have been completed. Oxford Instruments' interest in the venture goes beyond its equity stake; it is, for example, working as a major sub-contractor on the project with a particular focus on magnet design. Sir Martin Wood is a member of Tokamak Solutions' Scientific and Environmental Advisory Board.

Oxford Instruments and Oxfordshire

Oxford Instruments is a global company. Nevertheless its Oxfordshire presence is intrinsic to Oxford Instruments today. It takes a number of different forms:

- Oxford Instruments has three main functions that are physically based at its Tubney Woods site, six miles to the south west of Oxford: its head office function (which employs 35 people); its Omicron Nanoscience activity (part of the Nanotechnology Tools division), which employs 150 people; and its Magnetic Resonance business (part of the Industrial Products division) which accounts for 35 employees. Overall, about 12% of Oxford Instruments plc's workforce is currently based within Oxfordshire
- At the level of Oxford Instruments' main board, there are some significant local links:
 - Nigel Keen (Chairman) is a board member of Isis Innovation, and Bernard Taylor (recently retired Board member) chairs Isis Innovation
 - Professor Sir Mike Brady (Deputy Chairman) is Emeritus Professor in the Department of Oncology and Biology at the University of Oxford; he is also a non-executive director of other technology-based companies in Oxford (e.g. Mirada Medical).
- Oxford Instruments invests in Oxford-based early stage businesses. The example of Tokamak Solutions was outlined above, but there are others; in particular, Oxford Instruments always takes note of the spin-outs emerging through Isis Innovation
- Although informal, Oxford Instruments has close links with Culham and with the Rutherford Appleton Laboratory at Harwell
- Although no longer involved in the management of Oxford Instruments, its co-founders, Sir Martin and Lady (Audrey) Wood, continue to be strong supporters of technology-based start-ups in Oxfordshire, and important investors in technology-based start-ups.

- 4.33 The three case studies of Oxford Asymmetry, Evotec, Sophos and Oxford Instruments, relate to three of Oxfordshire's major high tech success stories. All three can trace their roots deep into the Oxfordshire ecosystem and yet all three, albeit to varying degrees, appear to have loosened their local ties and significantly broadened their canvass to operate on a global stage of relationships, alliances and acquisitions. So what are we observing? Is it a commentary on the maturing of three individual businesses, or is it a comment on the changing nature of the ecosystem as a whole?
- 4.34 Our contention would be that it is, in practice, both. As evidence, we would cite two examples: **Oxford Nanopore Technologies (Box 4-4)** and **Immunocore (Box 4-5)**.
- 4.35 **Oxford Nanopore Technologies** is a relatively young company and – at the time of writing – it remains a pre-revenue R&D business. Although a spin-out from the University of Oxford's Department of Chemistry, from the outset it has focused on the development of international research collaborations at the heart of its business model. As it moves towards production, it has also forged a series of alliances with global electronics companies.
- 4.36 The imperative for internationalisation did not come later for Oxford Nanopore Technologies: it was there right from the start. And it is, fundamentally, this international perspective that is causing the Oxfordshire high tech ecosystem to evolve and change. It is, perhaps, a particular challenge – and opportunity – for Oxfordshire given a location that lends itself to international business (much more so than in Cambridge), irrespective of its high tech pedigree and credentials: a location within an hour of both a major hub airport and a global city provides a pretty compelling offer for any internationally-minded business.

BOX 4-4: Case Study – Oxford Nanopore Technologies

Origins of Oxford Nanopore Technologies

Oxford Nanopore Technologies was formed in 2005, based on nanopore research conducted by Professor Hagen Bayley (from the Chemistry Department at the University of Oxford). From the outset, equity in the new company was shared between the founders, the University of Oxford and IP Group; the latter partly reflected its commercialisation agreement with the Chemistry Department (through which it received half of the university equity in chemistry spin-outs for 15 years in return for £20m up-front investment) but also some direct investment. IP Group initially provided £500k of seed funding, and Dr Gordon Sanghera was appointed as CEO to set up and run the new venture. Previously, Dr Sanghera had been Research Director at Medisense Inc (both before and after its acquisition by Abbott Laboratories) and prior to that, he had been a post-doctoral student in the University of Oxford's chemistry department.

The importance of global academic collaborations

Since its formation, Oxford Nanopore Technologies has sought to achieve a position of 'the nanopore company' globally. Whilst it recognised the excellence of research at the University of Oxford, it also acknowledged that nanopore science (and its application) is evolving quickly and hence Oxford Nanopore Technologies needed a portfolio of academic relationships to complement its internal R&D in order to be the technical leaders in all nanopore sensing.

As well as collaborations, it needed to have an intellectual property portfolio that secured this position. It therefore sought to develop collaborations with leading academics around the world and it now has 12 collaborations of this nature – including with Harvard University, Stanford University, University of California (Santa Cruz), Brown University and the University of Cambridge. In these departments, Oxford Nanopore Technologies funds post-doctoral students to undertake genuinely 'blue sky' research; in return, Oxford Nanopore Technologies develops its patent portfolio – which now numbers well over 300 individual patents across over 80 patent families.

Developing products

Oxford Nanopore Technologies has a team of electronics and mechanical engineers who have led the process of designing its products in-house. However, for some parts of the technology, the firm also partners with major electronics companies, all of which are global players. The technology is modular, designed for manufacturing scalability and also for scalability in the hands of the customers: examples include, MinION (R) a device for DNA sequencing that has the appearance of a pen drive/USB device, and GridION (R), a sensing instrument that clusters like computers. Although still a pre-revenue R&D business, the launch of Oxford Nanopore Technologies' first product is imminent.

Oxford Nanopore Technologies in Oxfordshire... and Cambridge

Currently, Oxford Nanopore Technologies employs about 145 people, of whom around 130 are based on Oxford Science Park. Some 85% of the Oxford staff are technologists/scientists who come from a wide range of scientific disciplines – informatics, electronics, biology, etc. – and currently, some 18 different nationalities are represented: in terms both of the science and the staff, Oxford Nanopore Technologies is therefore a genuine "melting pot" defined around convergent technologies that have a wide range of potential applications. At an appropriate time in the company's development, Oxford Nanopore Technologies is likely to open a manufacturing facility in Oxfordshire which may start by employing 50-100 people.

Over the last year, Oxford Nanopore Technologies has established a presence in Cambridge (UK): currently the Cambridge office is relatively small although it is set to grow. The Cambridge operation (located to the south of Cambridge at Chesterford Research Park) focuses mainly on bioinformatics and in that domain, the Cambridge labour market and opportunities for collaboration are especially strong (given the work of the Sanger Centre, the European Bioinformatics Institute at Hinxton, etc.).

- 4.37 **Immunocore (Box 4-5)** provides another example of a business whose origin can be traced back to technology developed in the University of Oxford – in this case, spun out in 1999. However, its continued links with Oxfordshire are largely due to the long term involvement of two of the early angel investors, Nick Cross and Ian Laing, including successive rounds of re-investment and hands-on management support (Nick Cross remains Chairman). The original business, Avidex, was acquired in 2006 by a German biotech company, MediGene AG, but a subsequent review led to the disposal of Avidex's pre-clinical assets. Immunocore was formed in 2008 to take over and develop some of these assets, with re-investment by the original angel investors. Five years later, following further rounds of investment, Immunocore has concluded two major research and licensing agreements – one with Genentech, part of Roche Group, and the second with GlaxoSmithKline. This should ensure that the firm continues to grow in Oxfordshire, but its further development is essentially dependent on working through international partners.

BOX 4-5: Case Study – Immunocore

Introduction

Immunocore and Adaptimmune (the Companies) are sister companies which together aim to develop entirely novel therapies for cancer and viral disease using engineered T cell receptors (TCRs). The principal focus of current research is on cancer. Clinical trials are in progress in the UK and USA with encouraging results. There is potential for the technology to have a major impact on cancer and other serious diseases such as viral and autoimmune diseases.

Origin of the Companies

The Companies both derive from Avidex, a 1999 spin-out from Oxford University established by Dr Bent Jakobsen to further develop and commercialise his breakthrough work on TCRs. Avidex was backed by a mixture of angel and venture funding and was acquired in 2006 by the German biotechnology company, MediGene AG.

In 2008 MediGene agreed to licence certain gene therapy applications of the Avidex technology to Adaptimmune, a new company established by the original management, James Noble and Bent Jakobsen, with two of the original angel investors, Nick Cross and Ian Laing, in order to fund the first clinical trials in this field.

Later, following a strategic review in 2008, MediGene AG elected to focus on development of its late stage assets and divest its preclinical assets. Immunocore was formed to take over and develop the TCR technology with investment from a consortium comprising MediGene and a number of angel investors.

Today, Adaptimmune and Immunocore continue to exploit the same technology platform in different ways and are pioneering breakthrough therapies for serious diseases particularly cancer.

Technology

The Companies aim to utilise the body's own machinery (the TCR) to target and destroy cancerous or infected cells. Using TCRs engineered to have increased affinity for markers on the surface of diseased cells the patient's own immune system is able to recognise and kill cancer or viral cells. Adaptimmune uses the patient's own T cells in to which genes for the increased affinity TCRs have been transplanted as the therapeutic agent. Immunocore's products are wholly synthetic, biological drugs called ImmTACs (Immune mobilising mTCR Against Cancer) able to treat large sections of the population with a given tissue type.

This immunotherapeutic approach is a major breakthrough in the treatment of serious diseases.

There are essentially two ways to strengthen the immune system to fight disease: (i) monoclonal antibodies (or biological scaffold or fragments) derived from the humoral or extracellular immune system, which now comprise a £50 billion market, and (ii) through the cellular immune system.

The cellular immune system is stimulated by vaccines, but no-one has so far managed to mobilise it to fight disease by harnessing the T cells (TCRs can access many more targets than monoclonal antibodies). Adaptimmune and Immunocore are attempting to do this. If successful, it will provide a much more targeted way to fight diseases such as cancer because it provides the ability to treat only the diseased cells, avoiding damage to the healthy cells. The potential is enormous.

The Companies undertake their own R&D using proprietary TCR engineering technology and have clinical trials in progress for multiple cancers in the UK and USA.

Development

So far it has taken 20 years of research, including 14 years since the spin out from Oxford University, and approximately £75 million, to develop the TCR technology which is protected by multi-layered structural, tool and process patents. After two decades of pioneering work, Immunocore has signed major partnership agreements with two leading pharmaceutical firms, partly attracted by encouraging results from an early clinical trial in melanoma. Immunocore also has strong interest to partner from a number of other pharmaceutical companies.

In June 2013, Immunocore entered a research collaboration and licensing agreement with Genentech, a member of Roche Group, for the discovery and development of multiple novel cancer targets using Immunocore's ImmTAC technology. Under the agreement, Immunocore will receive an initiation fee of \$10 to \$20 million per programme and is eligible to receive in excess of \$300 million in development and commercial milestone payments for each target programme and significant tiered royalties.

In July 2013, Immunocore announced a research and licensing agreement with GlaxoSmithKline to discover ImmTACs against novel targets. Under the agreement, Immunocore will receive up to £142 million in pre-clinical milestone payments and for each product that reaches the market, up to £200 million is due in development and commercial milestone payments, plus royalties.

The Companies now employ over 75 staff between them. Post MediGene the two firms have received investment of around £35 million, often in annual tranches, from the three 'founder' angel investors and (since 2010) other private investors.

The Companies' business model is to develop and licence to 'big pharma' their considerable number of 'drug candidates' aimed at particular targets, rather than commercialise the products themselves. Hence the strategy is to concentrate on the inventive end of the business where the human capital requirements are high but the financial capital needs relatively low and to licence products to interested pharmaceutical companies, who will conduct the expensive late stage trials, manufacture and market the drugs. The licensing model will generate a revenue stream based on achieving an upfront fee, development and sales milestones and earning royalties on product sales.

Links within Oxfordshire

There are two essential links with Oxfordshire: the University of Oxford was the source of the original technology and the funding has been provided by Oxford based angel investors. The technology is a prime example of ground breaking research undertaken in the University and with long term commercial potential. The investment is an excellent example of mature angel investment by individuals with a long term perspective and with deep pockets to support multiple funding rounds as the potential new drugs are developed through clinical trials over many years.

Constraints on growth

The main constraint on the commercial exploitation of the technology platform now being developed by the Companies has been the availability of investors willing and able to take a long term view. Fortunately the two locally based investors who supported the early stage exploitation of the technology have stuck with the founding scientist and management through successive stages of platform development. In contrast, the original VC consortium pulled out after five years and as a consequence nearly destroyed the value of the core IP.

The length of time and cost of developing new drugs acts as a severe constraint on investment, which in turn hinders technology commercialisation and business growth. In general, VCs have time horizons which are too short to support adequately major innovation and, in the current economic climate, they are, despite the name, also risk averse. They often force a biotech company to identify a clinical candidate too early and focus all their resources on forcing it through clinical trials at the expense of building a sound technology base and product pipeline. This puts all the investment eggs in one basket – if the first candidate fails, the company fails. Platform technologies such as that being developed by the Companies are abandoned as too complex, but can provide far more opportunities.

Currently the Companies have a growing portfolio of validated targets to support development of a wide range of unique clinical biotherapeutics.

Perspectives on the internationalisation of high tech Oxfordshire

- 4.38 From the different strands of work completed in the course of this study, there is ample evidence of the increasing internationalisation of high tech Oxfordshire in all its different guises.

Labour market

- 4.39 One key dimension relates to the labour market. Across the 112 individuals (from three firms) who completed our employees' survey, 11 different nationalities were represented. Some 79 of these staff were graduates, and among these, non-UK university degrees included 12 first degrees, 12 masters' degrees and 5 PhDs. Among the 76 employees that had had a previous job, 11 people had worked for an employer abroad.
- 4.40 Whilst not without challenges – especially in relation to visas (**see Box 4-6**) – many high tech businesses in Oxfordshire rely on an increasingly international workforce. The case studies cited above bear this out: Oxford Nanopore Technologies talked in terms of 18 different nationalities among its staff while Sophos explained that 15 to 20% of Abingdon-based software engineers are recruited internationally. Immunocore and Adaptimmune have 75 employees with 15 different nationalities.

BOX 4-6: Comments on international recruitment by a consultee business

Oxford has excellent international connections. It is a very multicultural place, and this is hugely valuable to making connections anywhere in the world. Many high tech Oxford firms employ people of many nationalities, partly because of their skills but also because of their international networks. Therefore, a strength of Oxford is the ability to build multicultural teams which are capable of supporting business expansion anywhere in the world.

However, a key concern identified repeatedly by firms is the difficulty in getting work permits for international staff, as illustrated by the following example.

Firm X recruited a Chinese investment associate following completion of his PhD in Engineering from Queen Mary College, University of London.

The intention was to use him to assess potential markets for investee companies as well as investment targets in China. An essential part of his role is regular travel to China. However, he was prevented from leaving the country for a year while the Borders Agency processed the work permit application. "It was very frustrating and the delay was totally unnecessary. The number of very bright foreigners being educated in the UK is a huge asset, but the government seems to regard them as a problem".

Firm X also recently had another application for an eastern European appointment turned down on incorrect grounds and were forced to reapply. "It's a huge waste of senior management time"

Source: SQW interview

Sources of technology and innovation

4.41 Overall, from our business survey, 36 (of 142) firms described international collaboration as “crucially” or “very” important for their business (**Table 4-6**). Specifically, as an external source of technology and innovation, 17 firms considered international universities and/or research institutes and/or companies to be “crucially important” and a further 52 judged them to be “important”. There were, again, sectoral differences in these assessments and the grouping that really stood out was bioscience / medical technologies / pharmaceuticals; it is perhaps noteworthy that this was also the sector in which the incidence of company founders from inside the ecosystem was greatest (see **Table 4-3** above).

TABLE 4-6: Firms’ assessments of “the importance of universities/research institutes / technology oriented companies from **outside the UK** as a source of external technology and innovation for your business”

	BIOSCIENCE / MED TECH / PHARMA	ELECTRONICS / ENGINEERING INCL. MOTORSPORT	PHYSICS-RELATED INCL. CRYOGENICS, INSTRUMENTS, MAGNETS	TELECOMMS / COMPUTER HARDWARE / SOFTWARE
Crucially important	8	3	2	4
Important	17	4	16	15
Not important	5	17	10	16
No opinion / No response	5	4	5	11

Source: SQW – based on Oxfordshire High Tech Firms’ Survey, 2013

Sales and markets

4.42 In relation to sales and markets, a proportion of firms within high tech Oxfordshire remain pre-production and whilst – as Oxford Nanopore Technologies demonstrates – these firms may rely on international collaborations, they will not, by definition, translate this into a high level of exports. For revenue-generating firms, however, the level of export was generally high – although this did vary by sector: businesses in telecoms/computer hardware/software were less likely to focus on export markets than those in other sectors, particularly bioscience/medical technology/pharmaceuticals (see **Table 4-7**).

TABLE 4-7: Proportion of sales (by value) earned outside the UK

EXPORTS AS A PROPORTION OF SALES	BIOSCIENCE / MED TECH / PHARMA	ELECTRONICS / ENGINEERING INCL. MOTORSPORT	PHYSICS-RELATED INCL. CRYOGENICS, INSTRUMENTS, MAGNETS	TELECOMMS / COMPUTER HARDWARE / SOFTWARE
Less than 10%	5	5	5	19
10-79%	7	12	11	10
80% or more	7	6	6	4
[Pre-production – so no sales or revenue]	[10]	[1]	[9]	[5]
No response	6	4	2	8

Source: SQW – based on Oxfordshire High Tech Firms’ Survey, 2013

Ownership and finance

4.43 Finally, it is important to consider issues relating to ownership and finance and here, we can draw on perspectives from both the demand and supply side. In terms of the latter, it is notable that 12 firms from among our survey respondents (of which five were within the broadly defined physics-related sector) had external investors defined as “overseas corporates”, and this pattern – particularly in the context of growing high tech businesses – was borne out through our case studies. More generally, consultees talked in terms of a new wave of international investment into high tech Oxfordshire; and in at least one (recent) case, this relied significantly on Russian capital with the links traced back to the student days of both the investor and the high tech entrepreneur within the University of Oxford.

4.44 In parallel, it is important to consider where Oxfordshire’s investment community is currently investing. We observed earlier that over the last

50 years, Sir Martin and Lady (Audrey) Wood have been prolific investors, mainly in Oxfordshire-based high tech businesses – and hence the relationships have been local. Today, one of the most active angel investors is Dr Andrew Rickman (founder of Oxfordshire-based Bookham Technology which had early links to the Rutherford Appleton Laboratory and was subsequently floated on the London Stock Exchange and NASDAQ). Like his forbears, Andrew Rickman is a very hands-on investor, devoting significant amounts of management time to his investees and often assuming the position of chairman. But unlike his forbears, it is apparent that through his company (Rockley Group), the US and China feature very strongly indeed in his investment portfolio, as **Box 4-7** below bears out. However, this strategy also represents a significant opportunity for Oxfordshire technologies as Andrew Rickman plays a key role in introducing growing technology firms to major international markets, particularly in China and the USA.

BOX 4-7: The current Rockley Group investment portfolio

The website of the Rockley Group lists eight investee companies of which Andrew Rickman is chairman. These are:

- **Green Biologics** – This firm is based on Milton Park with operations in the US. It is concerned essentially with environmental technologies and, particularly, the production of renewable chemicals and biofuels. It has established production partnerships and collaborations in China, South Africa, Brazil and India
- **Intelligent Sensor Systems** – This firm is based on Brunel Science Park (west London) and it is concerned with optical fibre sensor systems and services for the energy sector (China). It has partnered with the Shandong Academy of Sciences and its customers include major coal, oil and power producers in China
- **Kotura** – With an HQ in Monterey Park, California, Kotura is concerned with silicon photonic chip design and manufacture which have applications in communications and sensors. It is a leading development and manufacturing partner for high speed next generation low energy consumption servers. Kotura was acquired by Mellanox Technologies Ltd (Nasdaq: MLNX), a producer of infiniband and Ethernet networking equipment for approximately \$80 million in August 2013: a very successful investment exit for Rockley and their associated investors.

- **Laihe Rockley Biochemicals** – Located in Jilin Province, China, this is a joint venture company that was established by Songyuan Laihe Chemicals Co.Ltd with Green Biologics and Rockley China Fund. It is seeking to produce green chemicals such as butanol to replace petrochemical alternatives
- **Oxitec** – Based on Milton Park, this is a biotech company which is focused on controlling insects that spread disease and damage crops.
- **Oxsensis** – Formed in 2003 as a spin-out from the Rutherford Appleton Laboratory (and located at Harwell Oxford, this firm is focused on optical instrumentation and sensor systems for high efficiency aero and car engines
- **Simgui** – Based in Shanghai, this firm is China’s leading supplier of epitaxial and silicon on insulate wafers for the domestic semiconductor industry. These products are crucial in the growing market for energy efficient semi-conductor devices
- **Spikes Cavell** – Based in the Thames Valley and also the US, this firm is a leading provider of spend intelligence solutions to UK public sector procurement organisations.

Does the changing growth dynamic of high tech Oxfordshire matter?

- 4.45 The sociology and dynamics of high tech Oxfordshire in 2013 are different from those which characterised the county 25 or more years ago. From 1985 onwards, The Oxford Trust (which also uses the public facing brand of Science Oxford) played a significant role in promoting networks, and they were typically deep/dense/rich, and strongly Oxfordshire-centric. Today, networks of key inter-relationships still exist at the heart of the high tech business growth model, but some are more formalised and many are increasingly fluid: the international dimension features much more strongly, as do links into London and the Thames Valley (which will be considered in more detail in **Chapter 5**), and the extent to which they are 'contained' within Oxfordshire is very much reduced. But, apart from a nostalgic lurch into history, does this change really matter? What does it mean for the course of path-dependency and for Oxfordshire as a location for the formation and growth of technology-based businesses? And does it imply that Oxfordshire's future prospects as a focus for high tech business excellence are damaged – or are they actually enhanced?
- 4.46 Our strong sense is that for Oxfordshire, this transition is double-edged. There are certainly some risks implicit within it. Uppermost within these is the concern that as the international dimension holds sway, the pattern of 're-investment' in the underlying ecosystem starts to wane. This 're-investment' takes a number of forms. The most obvious is the financial one. Previously, the capital that was realised through the exits of high tech entrepreneur /investors was visibly re-invested in subsequent companies – and with this re-investment came a good deal of insight, know-how and networks that quite probably assisted the growth path of the next investee company.
- 4.47 Today, the evidence for this on-going process of re-investment is much less clear. In the course of our consultations, different explanations were offered as to why this might be the case, for example:
- In recent years, high tech entrepreneurs, even the successful ones, have simply made less money: over the last decade, there have been relatively few sizeable flotations and/or acquisitions of Oxfordshire-based technology businesses
 - Where money has been made, the strong inclination of would-be investors has been either to look further afield for investment opportunities – perhaps because the quality of investment opportunities in Oxfordshire is less distinctive, but also because their surrounding knowledge networks are more spatially extensive; or simply to do other things altogether.
- 4.48 There is a second challenge to 're-investment' that is more nebulous but equally important: it concerns the process of 're-investment' in relationships within Oxfordshire. Particularly in talking to the more established high tech business leaders, we were struck by just how much of their time/energy is, literally, sucked out of Oxfordshire. Much of it is drawn in the direction of London, particularly for listed companies and those with institutional shareholders and/or London-based venture capitalists, both of whom appear to have an insatiable appetite for time and attention. For those in businesses whose ownership is international, it was also clear that the principal lines of communication are now outside Oxfordshire – and in many cases also outside the UK. In these scenarios, which are increasingly commonplace, there simply is not time or resource to devote to sustaining soft networks in Oxfordshire, however important they might once have been. For this reason too, there was a consistent sense that many high tech businesses – including those that owe their origins to the University of Oxford and/or one of the 'big science' facilities and are still in a pre-revenue phase of development – are increasingly 'in' but not 'of' Oxfordshire.

- 4.49 If these are the downside risks, what about the significant upside opportunities? The most obvious relates to the fact that technology-based economies are increasingly global. It is sobering to reflect that the early (and rapid) growth of Oxford Instruments occurred in a world that was essentially pre-EU, pre-Thatcher, pre-liberalised capital markets, pre-BRIC, and pre-internet: Sir Martin and Lady (Audrey) Wood faced a quite different set of circumstances and opportunities from the entrepreneurs of today. Now, and undoubtedly looking ahead too, markets for technology, money, labour and products /services are global; and overall, the evidence suggests that Oxfordshire's high tech businesses are well tuned into them. Equally, it is important to reflect on the changing nature of the technologies that underpin tech-based businesses. Increasingly, these are multi-layered and premised on flexible convergence across a wide range of disciplines and specialisms. The imperative for creative alliances in their development and application is overwhelming, and to be viable, this too needs a global canvass and mind set. Again, we have seen a good number of Oxfordshire's high tech businesses engaging actively in this process. For both reasons, then, we might conclude that Oxfordshire's technology-based businesses (and their staff, their collaborators and their investors) should, collectively, face the future with some underlying confidence.
- 4.50 But there is a further challenge, and perhaps paradox, at the heart of this, and we reflect on it briefly by way of conclusion. As Oxfordshire's high tech businesses, and the networks of inter-relationships that underpin them, become increasingly outward-facing, is Oxfordshire losing its distinctive comparative advantage? Is it becoming indistinguishable from any other location that is within an hour of a hub airport and a global city?
- 4.51 There is certainly some risk of Oxfordshire becoming indistinguishable from elsewhere. Talking to individual firms, there was a sense of some becoming increasingly disconnected from Oxfordshire. In discussion, several were asked *"if they could put their firm on a magic carpet, where would they like to see it land?"* However, while a few mentioned Cambridge or London or Silicon Valley, for the most part, firms seemed perfectly content with Oxfordshire.
- 4.52 Underpinning this response was a recognition of the value of proximity to Heathrow and London, but also an acknowledgement that Oxfordshire provides a very pleasant place for people to live and for businesses to be formed and grow. There was also recognition that skilled people could be persuaded to build their careers in Oxfordshire, and in this regard, the links back to the University of Oxford and/or one of the 'big science' facilities were generally strong. Firms also mentioned the power of the Oxford brand – and the paradox is that 'Oxford' is considered to be parochial vis-à-vis UK audiences but absolutely compelling in relation to (increasingly important) international ones. The cost of living and working in Oxfordshire was a concern – and this is something that the local planning authorities will need to watch. But the overall conclusion is that while the behaviour of Oxfordshire's high tech businesses may be increasingly indistinguishable from that of their peers elsewhere, the resources and assets on which they are able to draw remain really quite special.

4.53 Finally, and as an aside, we will make some comparative comments in relation to Cambridge as there were a number of comments from Oxfordshire businesses which contrasted the strength of the high tech 'movement' in Cambridge with its apparent absence in Oxfordshire. More generally, many consultees noted that compared to Oxfordshire, Cambridge retains a strong, identifiable core of investors-cum-entrepreneurs, many of whom are locally visible, prominent and well-networked Cambridge Angels⁴⁹. In the bioscience sphere – as one major Oxford-based firm commented – “*Oxford does not have an Andy Richards*⁵⁰”; while another consultee noted that today Oxfordshire suffers from “*having neither Herman Hauser*⁵¹ *nor Alex Plant*⁵²”.

4.54 Today the Cambridge ecosystem is – we would conclude – *locally* stronger and more coherent than that we have observed in Oxfordshire. But as a location for *international business* and networking, Oxfordshire undoubtedly has the edge. Looking ahead, we can only speculate as to which of these two cocktails might ultimately prove most effective: both are very potent, but they are different.

⁴⁹ See <http://cambridgeangels.com/>

⁵⁰ Cambridge-based serial entrepreneur in bioscience.

⁵¹ Entrepreneur and investor, and co-founder of both Amadeus Capital and the Cambridge Network.

⁵² Previously Chief Executive of Cambridgeshire Horizons (which focused strongly on delivering the infrastructure commitments linked to the growth of Cambridge); and now Executive Director at Cambridgeshire County Council (Economy, Transport & Environment Services).

5. The innovation ecosystem – finance and professional services

- 5.1 The relationship between Oxfordshire's evolving high tech business community and the growth of the financial and professional services sector has, genuinely, been one of symbiosis: in principle, these service providers both facilitate and enable high tech business growth, but they are also hugely dependent on it and as commercial businesses in their own right, they must continually adapt and evolve in response to market demand. For these reasons, they have a unique perspective on the changing dynamics of high tech business growth more generally and they make a distinctive contribution to it.
- 5.2 Overall, and on a reasonably tight definition, we estimate that there are in the order of 6,200 jobs in Oxfordshire in related activities such as banking, legal activities (including patent attorneys) and accountancy. Compared to England as a whole, and on a jobs measure, these activities are under-represented in Oxfordshire. Through an analysis of employment data and the use of location quotients, it is possible to draw parallel insights from comparator areas:
- analysis suggests that the pattern of employment in these sectors in the Cambridge sub-region is very similar – in relative terms – to that in Oxfordshire
 - patterns of specialisation across the Thames Valley, however, are different. The Thames Valley has a relatively strong concentration of jobs in activities linked to some professional and financial services, particularly accounting.
- 5.3 Nationally, the financial and business services sector is dominated by London. A study by GLA Economics provides rather stark reading in this context: drawing on data from the ONS Regional Accounts, it reports that between 1997 and 2010, London's share of headline GVA in "financial and insurance" activities rose from 41% to 47% of the UK total, while that in "professional, scientific and technical" activities increased from 32% to 36%⁵³. For Oxfordshire, and most other local economies in the UK, the implications are profoundly important; the growing influence of London is a recurring theme within this chapter. Our view, borne out by our consultations, is that the relative concentration of related employment in the Thames Valley owes much to its functional connectivity and physical adjacency with London, and it is this that sets it apart from both Oxfordshire and the Cambridge sub-region.
- 5.4 Against the backdrop of London's rapid growth in financial and business services over the last 15 years, this chapter considers the nature and process of early stage finance and investment within high tech Oxfordshire today. It then describes and examines the changing role and character of wider related professional service functions.

Early stage finance

- 5.5 Within **Chapter 4**, some attention was paid to the crucial role of entrepreneurs-cum-investors in fuelling the early growth of Oxfordshire's high tech business community: the reinvestment cycle was immensely important and many of the successful firms within high tech Oxfordshire today can trace their early growth to it. Yet we also observed that the early generation of entrepreneurs-cum-investors does not appear to have been replaced – or at least not in a form that is visible and widely recognised. Within Oxfordshire today, there are certainly individual angel investors. However, a consistent comment from our consultees was that compared to their forebears, these are less well networked locally, “less serial” and less patient – due in no small measure to the simple fact that *“their pockets are far less deep”*. In addition, the view expressed by a number of consultees was that these investors typically had made their money elsewhere: they generally live in the county and therefore have some commitment to it, but the emerging “process of investment” is residentially driven and therefore quite different from that of the past.
- 5.6 Across Oxfordshire, as the informal networks arguably have waned, a number of more formal ones have emerged. In respect of spin-out businesses from the University of Oxford, Isis Angels Network has played a key role in relation to early investment rounds for some companies, although it has found it more difficult to establish relationships with investors who can also bring management expertise to build new businesses. The IP Group has also been important in a number of cases, including Oxford Nanopore Technologies (which was discussed in **Chapter 4**). The University struck a pioneering deal with the IP Group in 2000 under which the University received up-front funding of £20 million to part-finance a new chemistry laboratory in return for a 50% share in the equity of Chemistry Department spin-outs and licensing returns. The Group has also invested in spin-outs. In 2011, IP Group acquired a strategic stake in Teknikos, a specialist medical technology fund under a similar agreement with the University's Institute of Biomedical Engineering.
- 5.7 It is notable also that Imperial Innovations is a very active investor in technology-based businesses in Oxfordshire – albeit businesses whose technology generally derives from Imperial College, London (see **Box 5-1** for an example).

⁵³ Regional, sub-regional and local gross value added estimates for London, 1997-2011 | Melissa Wickham (January 2013): GLA Economics, Current Issues Note 39.

BOX 5-1: Case Study – Nexeon

Introduction

Nexeon is a battery materials and licensing company developing silicon anodes for the next generation of lithium-ion batteries. Nexeon's silicon anodes enable significantly greater Li-ion battery capacity to be achieved, providing lighter batteries with more energy and longer lifetime between charges. Applications of this technology include consumer electronics, electronic vehicles, sustainable energy, aerospace, medical and defence industries.

Origin of the company

Nexeon was founded as a spin-out in 2005 as a result of work done by Professor Mino Green, Emeritus Professor at the Department of Electrical Engineering at Imperial College London. The proof of concept work, which started in 2004, was funded by Imperial Innovations and supervised by Dr Paul Atherton. In April 2006 Dr Atherton made a major investment in Nexeon and became Executive Chairman. He describes himself as an "investing chairman", taking significant control of the companies in which he invests.

Nexeon has developed proprietary processes and equipment for producing the material and for making electrodes. The firm has over 40 patent families with a wide territorial coverage and more than 100 grants to date. The portfolio includes patents on highly structured silicon materials, their methods of manufacture and their use in applications including lithium ion batteries, together with filings on composites, binders, electrolytes and electrochemical cell designs.

Nexeon's technology has won recognition and various awards, including being named in the prestigious 2012 Global Cleantech 100, and in 2013 winning the 5th annual Rushlight Award for Energy Efficiency.

The application for the technology is mainly in consumer devices – laptops, notebooks, phones, cameras etc. However, there is also an application in medical e.g. emergency lighting, defibrillators, pace makers where batteries are needed that can still work even if the device has been on standby for a long time. Electric vehicles are also a potential application.

Development of Nexeon

The A round investment in Nexeon was in July 2007. £4.25m was raised from three sources: Imperial Innovations (£1.95m), PUK Ventures and Tudor, a hedge fund. This was followed by a £10m fund raising in February 2009 led by Imperial Innovations, and most recently in August 2011 a Series C investment round of £40m, including £15m from Imperial Innovations. Invesco Pension Fund was a major investor in the last two rounds.

Nexeon is currently loss making, with a 'burn rate' of £5m per year, but expects to be at break even in two years.

Following the first round investment, Nexeon moved to the former Atomic Energy Authority (AEA) Technology Battery Research & Development facility at Culham in southern Oxfordshire. AEA had used these facilities to research high performance batteries for the defence and aerospace industries. The move saved Nexeon an estimated £10m in investment in specialist fit-out and equipment. The other advantage of the Culham location was access to staff with specialist skills, including some who had previously worked for AEA.

By early 2009 Nexeon had established a fully operational pilot plant, producing sufficient material to make high volumes of cells on a daily basis. In mid-2010, Nexeon moved to a facility released by AzkoNobel at Milton Park, again making use of existing specialist equipment. The move was to create expansion space and in particular to establish a second pilot plant capable of higher production volumes. The proximity of Milton Park to Culham meant that Nexeon was able to retain its staff. The funding secured through the round in 2011 will support the establishment of a larger manufacturing facility, which is likely to be located elsewhere in the UK at a site with the required chemical industry infrastructure.

The company has a strategic partnership agreement with WACKER Chemie AG to obtain expertise in the scale-up of Nexeon's silicon anode technology to commercial volumes. In parallel, WACKER has also become a strategic investor in Nexeon. A collaboration has also started with a global tier one automotive OEM, with a view to optimising the company's technology for electric vehicle applications.

Nexeon now has a fully professional management team, including some who are ex-Cambridge Display Technology, ex-Dow Corning and ex-Oxford Instruments. The firm employs nearly 50 staff, virtually all of whom are qualified scientists and engineers, including 30 PhDs. Many of the workforce live locally, but others commute from as far afield as Cambridge and Malvern.

Links within Oxfordshire

The most significant local links are with the specialist workforce based in south Oxfordshire. Also, in addition to the original link with Culham, Nexeon has links with the Chemistry and Materials Departments of Oxford University and uses the analytical services at Begbroke. Nexeon also uses local engineering contractors and builders. Its accountants are Deloitte in Bristol, and it uses Manches in Oxford for legal advice (IP and commercial).

Constraints on growth

Nexeon is positive about growth prospects. However, the key constraint identified relates to securing highly skilled industrial chemists. Most experienced industrial chemists are located in the north west, where the chemical industry was based, and they are reluctant to move. In contrast, overseas nationals are generally

pleased to relocate to Oxfordshire, though the process of securing working visas is extremely tedious and irritating. Dr Atherton considers that, in comparison with places like Silicon Valley, the UK is “shooting itself in the foot” with its attitude towards in-migration by people with specialist skills.

- 5.8 More broadly, the well-established business angel investment networks are now Oxford Investment Opportunity Network (OION) and Oxford Early Investments (OEI). In securing early stage investment, consultees considered that these networks are playing a useful role, although not, perhaps, an absolutely central one. Moreover, the spatial reach of both the investor members of the networks and of the businesses seeking early stage investment is a good deal further than Oxfordshire.
- 5.9 Similar observations need to be made with regard to the professional investment sector. Oxfordshire can claim a number of early stage investment and/or venture capital funds. The role of Lucius Cary in setting up the Oxford Technology VCTs, and now known as ‘Oxford Technology Management (OTM)’, has already been mentioned. OTM is the longest-established of

the Oxford-based investment firms, and it manages a number of venture capital funds. Whilst Oxfordshire-based enterprises feature within its portfolio, OTM has invested across a much broader geography; examples from its website include technology-based businesses in, inter alia, Towcester, Guildford, Cambridge, Birmingham, London and Winchester. Another Oxfordshire-based investment group is Oxford Capital (formerly known as Oxford Capital Partners). Its own growth narrative is summarised in **Box 5-2** below and again, it is striking how its spatial footprint extends well beyond Oxfordshire to locations “within a couple of hours’ drive”. What is also apparent from **Box 5-2** is an increasingly international dimension – and in this respect, the growth narrative of Oxford Capital mirrors exactly that of the technology-based businesses in which it is seeking to invest.

BOX 5-2: Case Study – Oxford Capital

The origins of Oxford Capital can be traced to a series of angel investments in spin-out companies from a number of different universities in the late 1990s. Some of these were very successful and through one particular investment – a spin-out from the University of Manchester – the value of the original investment was returned many times over.

This early success led to the establishment of a more formal investment fund with the intention, initially, of investing in early stage technology-based companies. Significant funds were successfully raised in the early 2000s, but the market itself proved to be difficult as an investment proposition: early stage technology-based businesses frequently proved to be high risk in relation to both their markets and technologies. Hence by the mid 2000s, Oxford Capital changed its strategy to focus more on providing growth capital once the underlying technology was essentially proven and the business was looking either to scale up its activity and/or to roll it out internationally.

Today Oxford Capital has over £150m of assets under management. It has a “live” portfolio numbering over 20 businesses (and in total, it has invested in about 40 companies), and its focus is on rapidly expanding industry sectors (e.g. communications, healthcare and sustainability) and infrastructure investments (particularly energy efficiency, power generation and renewable energy). Its strategy embraces both proactive and reactive elements.

It receives over 1,000 business plans each year from firms seeking investment, but it also works its own networks hard and creatively to identify emerging opportunities. It has deep relationships within the investment community and it works with both early stage investors and entrepreneurs to develop and nurture opportunities, sometimes over a number of years prior to investment. Within this context, the various networks in and around Oxford – notably Oxford Investment Opportunity Network (OION), Oxford Early Investments and Isis Angels Network – all play a useful role.

In addition, more informal 'syndicates' are also important: through these, 'angels' and 'super angels' work together.

Of Oxford Capital's investments, about a third relate to Oxfordshire businesses. Around a quarter have some kind of link to the University of Oxford – some are spin-outs (or spin-outs from spin-outs) and many are operating in the field of life sciences. Of the remainder, most are headquartered within a couple of hours' drive of Oxford, which is seen as an excellent location, given the density of knowledge-based businesses within this radius.

Oxford Capital currently has a team of 26 staff based at its offices on the edge of Oxford. However, it would be misleading to conclude therefore that the firm is narrowly focused on local opportunities; instead, much of its work is increasingly internationally focused.

Oxford Capital has offices in Oxford, London, Geneva and Hong Kong to service an international base of investors to support the development of its portfolio companies.

Increasingly, Oxford Capital's portfolio has a strong international dimension. Whilst the companies in which it invests typically have UK headquarters, the vast majority are operating internationally and generating an increasing proportion of their sales from non-EU sources; indeed, it is estimated that some 70% of the revenues of Oxford Capital's portfolio companies are generated from export earnings.

Oxford Capital's own commitment to its international presence, whether directly or through an increasing network of international co-investor, is intended to support the growth of businesses within its portfolio by identifying local investment partners and "opening doors" through this route. Hence Oxford Capital, as an investor, is playing a role in supporting the internationalisation of Oxfordshire's science and technology-based companies.

5.10 From individuals, through the networks to the locally-based funds, these investors are playing an important role. However, overall, their scale is relatively modest – as, in general, are the sums invested. More sizeable investments generally rely on local investors investing alongside London-based finance, although in recent years the decline of venture capital has affected the high tech community in Oxfordshire as elsewhere. Nevertheless, links between Oxfordshire and Mayfair/Green Park – the epicentre of the UK's venture capital and private equity industry – are considered to be strong; and in explaining the strength of these ties, the strong correlation with the home addresses of London-based investors is, it seems, no coincidence. Hence, in driving the investment process, relationships do still matter profoundly; but the character, and geography, of these is vastly different from those which underpinned the early growth of Oxfordshire's high tech economy.

Banks, accountants, lawyers, patent attorneys within the supporting infrastructure

5.11 Alongside the equity investors, the wider cadre of professional service providers also plays a formative role. Oxfordshire has a complement of mainly medium-sized professional service providers which include, inter alia, lawyers (such as Manches, Blake Lapthorn and Morgan Cole); accountants (such as James Cowper and Critchleys); and patent attorneys (including Marks and Clerk, JA Kemp, and Dehns). For the most part, these firms operate through a series of local offices in a geography that typically stretches from Oxford, through the Thames Valley (defined more or less broadly) to London: Manches, for example, has three main offices (London (HQ), Reading and Oxford) while James Cowper has six (Henley, London, Newbury, Oxford, Reading and Southampton). As well as the medium-sized independents, a number of major players have a significant Oxford presence – including, for example, Grant Thornton, HSBC and Barclay's.

5.12 Overall, the findings from our business survey (*see Table 5-1*) suggest that the quality of professional service provision within Oxfordshire is judged in quite variable terms. Generally, accountants and lawyers are reviewed quite positively. However, the same sentiment is not expressed with regard to clearing banks; whether this reflects the national mood or specific, local, issues is impossible to discern from the survey findings.

TABLE 5-1: Firms' assessments of key financial and professional services within Oxfordshire

STATEMENT	TOTALLY AGREE	PARTLY AGREE	DISAGREE	NO OPINION	NA/NO RESPONSE
Within Oxfordshire...					
...clearing banks provide specialist support	7	22	35	31	47
...specialist legal advice is available	45	43	2	19	33
...accountants are providing specialist support	52	46	10	11	23

Source: SQW – based on Oxfordshire High Tech Firms' Survey, 2013

5.13 Our detailed discussions with technology-based businesses however provided some rather more useful insights into how they work with these professional service providers. Specifically, there was consistent evidence that as technology-based businesses seek to internationalise and/or approach flotation, the benefits of London-based providers become compelling. One firm, for example, explained how it had gradually moved from an Oxford-based law firm to a first, and then a second, London-based alternative, describing the latter as *"rottweilers when it comes to aggressive litigation"*. Whilst very much more expensive, the London-based firms appeared to provide two advantages that the local firms simply could not match: international gravitas coupled with the experience/confidence/ knowledge to define *"where the line is"*. Another firm made very similar comments and it explained that as it grew, and particularly as it faced the scrutiny of City-based financiers, it increasingly needed *"the protection of the big names"*. From amongst our consultees, this generally meant a London-based provider; sometimes, it was possible to achieve the attributes of London provision from a Reading office (with some cost savings in the process); but never did this appear to be this achievable within Oxfordshire.

5.14 The strong sense, then, was that as firms internationalised and grew, they increasingly needed the type of support that the local providers often struggled to generate. Frequently this was much less to do with the quality of the advice than the brand power of the corporate envelope in which it was delivered, but this does in itself signify an important change in the dynamics of the wider ecosystem.

5.15 However, as alluded to in paragraph 5.1, professional service providers are nothing if not adaptable. Whether accountants or lawyers or patent attorneys, the loss of the more demanding/complex clients to London (and sometimes Reading) providers has created the same commercial challenge: the composition of the Oxfordshire market has *de facto* changed in favour of smaller, and far more fragmented, pieces of work at lower fee rates. For the professional service firms, the signals are not difficult to read: while most retain a strong local allegiance, the Oxfordshire market is seen as relatively static and many are looking elsewhere to drive their own business growth.

5.16 Most of the long-established Oxfordshire firms have identified the same opportunity. The Thames Valley is recognised as having its own technology-based economy, albeit with a different sectoral structure (more ICT, less bioscience) and, most importantly, a different type of client base. Overall, Thames Valley clients are at once larger and often less complicated; and in straightforward commercial terms, for professional service providers, the Thames Valley opportunity is currently more lucrative than that which exists in and around Oxford. This assessment constitutes a fundamental change which has been observed over the last five years or so. Two consequences appear to follow:

- First, whilst none of the professional services firms we spoke to are threatening to close their Oxford offices, most are indicating that the balance of growth will continue to shift with the Thames Valley becoming the principal future focus
- Second, in many cases, the apparent level of 'fluidity' between individual firms' Oxford and Reading-based practices has increased substantially: previously, the Oxford/shire market was relatively insular and self-contained, but now individual partners are tending to work the whole patch.

5.17 Alongside this structural change, we observed another – perhaps surprising – process at work. For the most part, Oxford's professional service providers are not located in Oxford city centre. Over the last decade or so, most have gradually moved out either to Oxford Business Park at Cowley or to Seacourt Tower on Oxford's Botley Road; both locations are directly next to the Oxford ring road, and while Seacourt Tower is only one mile from Oxford railway station and the city centre, with excellent bus links, the Oxford Business Park is several miles away and really only accessible by car. Conversely, for the most part, professional services firms in Reading are located in the town centre and within walking distance of the railway station, which of course brings with it easy access to London. The Oxford sites are recognised as being good for car parking and for access to clients across the county, but arguably they are contributing further to a sense of dispersal/fracturing across a professional services business community *writ large*.

Two quotes – from two partners from two different professional services firms (in different sectors), both of whom were observing the growth of Reading at first hand – summarised the issues and the implications:

“In Reading, the professional service firms are located in the town centre – as are a number of private equity firms. There is a much stronger sense of “community” and “critical mass”: if you go to Carluccio's in Reading at lunchtime you meet people you know from other professional services firms and this is useful in terms of finding out what is going on. There is nothing like this in Oxford”.

“In Reading, there is a strong, tightly knit, community – and different deals seem to involve the same groups of lawyers, accountants and banks. The professional services community in Reading is strongly clustered in the town centre, and close to the railway station. It functions as a coherent single community. It is stronger than Oxford already and likely to become stronger still”.

Conclusions

5.18 For the Oxfordshire high tech ecosystem, the dynamics of the financing of technology-based business growth and developments across a wider group of supporting professional service providers are changing profoundly, and quickly. Although highly interconnected, these changes should not be conflated.

5.19 With regard to investment finance, it appears that, other than perhaps in relation to first round seed corn funding, technology-based businesses in Oxfordshire are increasingly drawn into the London financial scene, whether through venture capitalists in the West End or the City. There is also some evidence that technology-based businesses in London are drawn physically into Oxfordshire. But, as demonstrated in **Chapter 4**, even the smallest and newest technology-based businesses are increasingly international and with the process of internationalisation comes the demand for a genre of professional service advice that medium-sized Oxford-based practices find difficult to satisfy; hence the more dynamic of the technology-based businesses quickly look to London providers or, on occasion, to the Reading office of a London-based firm.

- 5.20 For technology-focused professional service firms in Oxfordshire, the Thames Valley is also proving attractive. In part, this is because the client mix is commercially more viable, particularly as the more ambitious of the Oxfordshire-based businesses turn to London. But, it is also because Reading appears to be providing a more stimulating and coherent backdrop for professional services providers. Over time, Reading-based practices appear progressively to have commanded higher fees, secured higher incomes and sustained stronger professional networks; the fact of a medium term competitive advantage for Reading vis-a-vis Oxford therefore seems difficult to dispute.
- 5.21 Finally, it is worth reflecting again on the observations made in paragraph 5.2. This chapter has considered in some detail the similarities and differences between Oxford/shire and Reading/Thames Valley, but it has paid very little attention to the Cambridge sub-region; yet we noted that in relative terms at least, the scale of financial and professional services employment in the Cambridge sub-region is actually very similar to that in Oxfordshire. What then of the changing dynamics in and around Cambridge?
- 5.22 Although difficult to evidence, our suspicion is that the broad structural changes described in this chapter are actually quite similar: Cambridge technology-based businesses are seeking to internationalise and in the process, the comparative advantage of local vis-à-vis London-based provision will shift. However, comparing Oxford to Cambridge, there is one really quite fundamental, if mundane, difference and it concerns the capacity and willingness to accommodate medium-sized financial and professional service providers within the two city centres. As we have seen, for Oxford this appears to be impossible – and indeed, we were told that even with regard to edge-of-Oxford sites in the middle of a recession, there are actually very few options available. In Cambridge, conversely, substantial office provision has been made available in the CBI area, close to the railway station and the financial and professional services sector has wasted no time in taking advantage.
- 5.23 In 2011, Oxford accommodated about 30% of the county's jobs in key professional and financial service sectors; at the same time, Cambridge accounted for over 40% of the Cambridge sub-region's jobs in the same sectors. Hence the spatial distribution was rather different. With the CBI development now substantially on-stream, we could reasonably infer that the relative importance of Cambridge within its sub-region is likely to grow over the years ahead. Within the professional and financial services sector, the implication is that Cambridge is far more likely than Oxford to benefit from the type of clustering advantages that were described above vis-à-vis Reading; and in terms of long term competitiveness, these subtle shifts and opportunities could be quite important. Some of this is structural, but some relates just as much to the more mundane issues surrounding the use of city centre space and the wider physical infrastructure; it is to these issues that we now turn in **Chapter 6**.

6. The innovation ecosystem – specialist property and infrastructure

Specialist property

- 6.1 Oxfordshire is well endowed with specialist property for new and small high tech firms, but less so for larger firms. There are eight innovation centres in the county⁵⁴ providing over 10,000 sqm of flexible business space and related support services. They enjoy high levels of occupancy and there is a waiting list at some⁵⁵. Two important proposals will add to this supply: the Magnet Centre, promoted by Science Oxford, will provide a new visitor attraction focused on scientific discovery and an expanded innovation centre in Oxford city centre (the proposals were awarded £3m from the Regional Growth Fund in July 2013); and a 5,500 sqm bioescalator is proposed for the Churchill Hospital site in Oxford, which will provide links between medical research and new and established bioscience businesses.
- 6.2 The county also has around 500,000 sq m of floorspace already developed on six science and technology parks⁵⁶, and a total of 385,000 sq m available for development on these schemes⁵⁷. Four fifths of the space available for development is in the south of the county at Harwell and Milton Park (see Box 6-1), and only just over 60,000 sqm is available in Oxford, all of it around the periphery (Begbroke, Oxford Science Park and Oxford Technology Park).

BOX 6-1: Case Study – Milton Park and Harwell Oxford

Milton Park and Harwell Oxford are located 15 miles south of Oxford, close to the A34 and Didcot station, which provides fast rail connections to London, Bristol, Oxford and beyond. They are the two largest science and business parks in Oxfordshire, comprising in total 226ha of commercial space, and located just a few miles apart. Key statistics are provided below:

	Harwell Oxford	Milton Park
Business area	125ha	101ha
Developed area	55,000 sqm	250,000 sqm
Available for development	99ha	28ha
Amount with Enterprise Zone status	64ha	28ha
No of organisations on site	150	165
No of employees on site	4,500	6,500
Owner/Developer	UKAEA/Goodman	Hermes/MEPC

The two schemes form the main business space offer of Science Vale. In 2011 the Government awarded 92ha on the two sites Enterprise Zone status, which provides exemption from business rates of up to £275,000 per business over a five year period, simplified planning processes and guaranteed access to high speed broadband.

Milton Park

Milton Park provides a mix of office, industrial and science park space. It began life as a railway supply depot for military supplies in the 1930s, and then as an industrial estate. In 1984 it was acquired by MEPC (Milton Estates Property Company) and grew rapidly after the revision of the Planning Use Class Orders in 1987 (B1-Business Use), which allowed a mix of research and commercial /industrial activities within a single planning consent. The wide range of buildings and allowable activities, flexible leases, a substantial land bank, an excellent strategic location and proactive management have combined to ensure the success of the scheme, both in attracting inward investment (20% of tenants are foreign-owned, including companies that have been acquired by overseas interests) and in anchoring tenants to the site once they have located there. The latter is facilitated by on-site business incubation facilities including, since 2008, a purpose-built innovation centre providing high quality offices and business support for up to 60 small and growing companies.



AERIAL VIEW OF MILTON PARK, OXFORDSHIRE — COURTESY OF MEPC MILTON PARK LTD

Major companies on Milton Park include RM plc (largest UK manufacturer of IT equipment for the schools sector), Taylor and Francis, Evotec, PV Crystalox and LTi Metaltech. Demand for space has remained strong even through the tough recession years, with office occupancy running at 98%. Since 2007, there has been an additional 15,000 sqm of new floor space built, representing a 6% increase in a time of prolonged recession.

Harwell Oxford

Harwell Oxford was a military airbase in the Second World War and in the 1950s became the centre of the UK's civil nuclear programme under UKAEA, with over 6,000 people working there. It is now being developed as a major science park by a public/private sector joint venture between the UK Atomic Energy Authority (the Authority), STFC and Goodman, the international property company. The site provides employment for over 4,500 people working in 150 organisations, including major research facilities, large companies and start-ups in sectors including healthcare, medical devices, space, detector systems, computing, green enterprise and new materials.



AERIAL VIEW OF THE DIAMOND LIGHT SOURCE ON THE HARWELL OXFORD CAMPUS — COURTESY OF DIAMOND LIGHT SOURCE LTD

The research facilities are of international significance and an increasing attraction for firms. Opportunities for interaction with these facilities has been enhanced by construction of the Research Complex at Harwell (RCaH), a new building and equipment designed to accommodate research teams temporarily located on the campus. Some of the companies created by the Authority's research still operate from the campus: for example, Accentus Medical is the global leading supplier of gas plasma spray coatings to the orthopaedic industry, using technology which was developed as part of the civil nuclear programme.

Most recently, a 5,000 sqm building has been completed for Element Six, the world's leading supplier of synthetic industrial diamonds, and opened by David Willetts. The Electron, a 3,000 sqm building developed as the International Space Innovation Centre, now accommodates the Satellite Applications Catapult Centre. Harwell Innovation Centre provides 3,000 sqm of space for small firms on flexible terms.

The site includes new housing: 125 homes have been built, and up to 500 will eventually be provided. There are plans to build 100,000 sqm of business space for science and technology related firms, but as with much of the development industry in the UK at present, pre-lets are required before new build will commence.

Issues

Both sites have a superb strategic location, but local access is problematic for Harwell. The capacity of the A34 is also a major issue, as is the fact that housing supply in the area has lagged behind commercial development.

⁵⁴ Begbroke, Cherwell, Colin Sanders Innovation Centre (Banbury), Culham, Harwell, the Magdalen Centre, Milton Park and Oxford Centre for Innovation. Bicester and Witney are classified as business and innovation centres.

⁵⁵ Begbroke and Oxford Centre for Innovation.

⁵⁶ Abingdon, Begbroke Science Park, Grove Technology Park, Harwell Oxford, Milton Park, Oxford Science Park.

⁵⁷ In addition to the existing six specialist schemes, this figure also includes Oxford Technology Park at Kidlington, which has planning permission but has not yet been developed.

- 6.3 High tech firms also occupy space in a variety of non-specialist business space throughout the county, but again the supply of accommodation in Oxford is limited, with the Oxford Business Park at Cowley the only existing scheme with significant space for development (around 27,000 sq m, with 90,000 sq m already developed). Office space in the city centre is scarce and ageing: there have been only two small developments in the last 20 years. In a 2012 business survey, 53% of respondents identified the lack of suitable business premises as the greatest barrier to location/relocation to Oxford⁵⁸.
- 6.4 There are plans to address these issues, including a proposed business park at Oxford's northern gateway (Peartree) and in Bicester (a 60,000 sqm office development has planning permission), and office space is expected to be provided as part of the proposed mixed use development around Oxford station (the West End/Oxpens area). However, the limited scale and, in particular, spatial distribution of specialist property is likely to lead to a strong focus of high tech businesses in the south of the county.
- 6.5 The mix of types of space in southern Oxfordshire is particularly valuable to growing firms: **Box 5-1 (in Chapter 5)** provides one example of a firm that was able to move between Culham and larger premises on Milton Park; the managing director of another firm which has moved to Milton Park commented that it provides an environment in which firms of all sizes feel "at home", and likened it to some of the large high tech property schemes in California. There is also a strong relationship between some angel funders and flexible property arrangements – in particular, Nick Cross and Ian Laing have based all of their investee companies on Milton Park, which was originally their property scheme but continues to provide relatively low cost, flexible terms for fast growing firms.

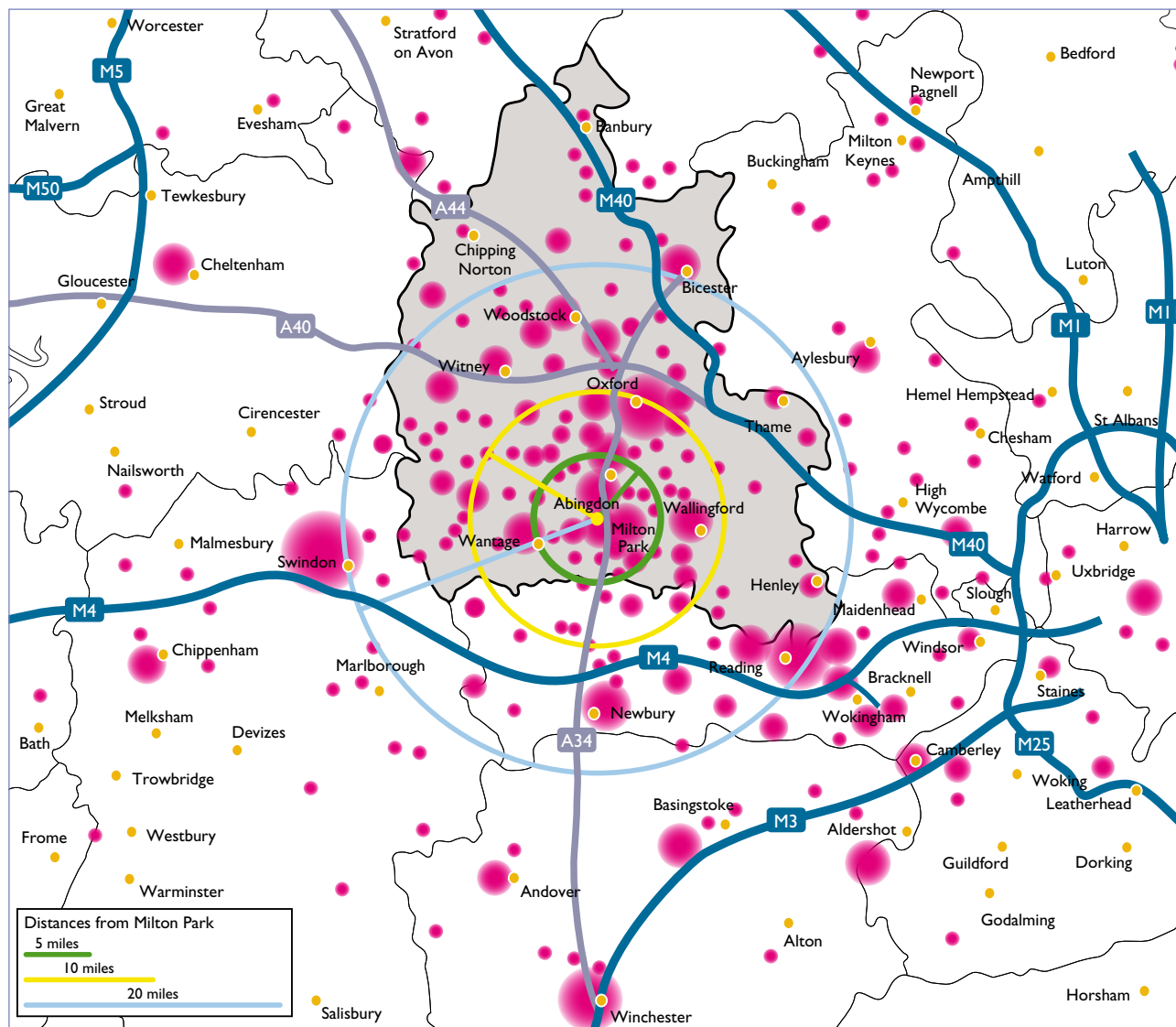
Housing and workforce

- 6.6 The south of Oxfordshire and Oxford city have both suffered for many years from a shortfall in housing supply relative to demand, which has led to high prices and limited affordability, particularly in Oxford. House prices in the city are the highest

in the country relative to average incomes⁵⁹. The constrained housing supply and high costs in Oxford affect both residents and students. More generally, almost a third of firms responding to the survey identified a shortage of housing as a constraint on recruitment.

- 6.7 One consequence of insufficient housing is the relatively slow growth of Oxfordshire's working age population. Between 2001 and 2011, it grew by 6.7%, compared to the national average of 8.3%. There were considerable variations within the county, with Oxford's working age population growing by 12.2% over the period (largely due to increasing multi-occupancy), compared with 1.9% in South Oxfordshire⁶⁰.
- 6.8 High house prices may be a cause of the fact that Oxfordshire's workforce is also ageing more quickly than the national average, again with considerable variations within the county. The city has a young working population, but in the south of the county the main increases during 2001-11 were in the over 60 age groups. In the peak working age group of 30-39 years, there was a decline of 11% in Oxfordshire over this period, much higher than the England average (7.9%) or in the Cambridge sub-region (3.7%) or the Thames Valley (4.6%).
- 6.9 These data are concerning, particularly when related to the main future focus of high tech growth, which given the availability of specialist business space is likely to be in the south of the county. The causes are likely to be a combination of high house prices and limited housing supply. Substantial housing development underway and proposed at Didcot, Grove and Wantage will go some way to addressing these issues, but there is already evidence that firms in the south of Oxfordshire recruit from a wide labour catchment, including north Oxfordshire, the Thames Valley and Wiltshire (see **Figure 6-1**, which shows the catchment for employees of firms based on Milton Park), and that most of these work journeys are by car (the 2012 travel survey for Milton Park showed that 75% of those surveyed travelled to work by car). Unless there is a substantial rebalancing of housing and employment growth, this situation is likely to persist, which will in turn increase commuting and congestion.

FIGURE 6-1: Milton Park – daily travel to work pattern 2012



Source: Milton Park Travel Survey, MEPC (Based on response from 134 companies on site in Winter, 2012.)

⁵⁸ Business Barometer (Commercial Property Focus), Withy King, July 2012.

⁵⁹ The 2013 Lloyds TSB's annual Affordable Cities Review the least affordable city in the UK is Oxford where the average property price (£299,459) is nearly ten times (9.66) gross average earnings in the area.

⁶⁰ MYPE, ONS, 2012.

Transport

- 6.10 Although Oxfordshire has a superb strategic location – 40 miles from Europe's premier hub airport, 50 miles from the heart of a world city, and with excellent strategic road and rail connectivity – road congestion is a major issue for firms: 23% of those responding to our survey identified it as a constraint on growth, and most of those interviewed expressed concerns, particularly in relation to the A34 and congestion in and around Oxford.
- 6.11 The A34 acts as a major national route between the south coast and the Midlands, a bypass for Oxford, and the main road artery linking the principle growth centres in Oxfordshire: Bicester, Oxford and Science Vale. Its overall capacity through Oxfordshire has not been significantly increased since it was turned into a dual carriageway in the 1980s, although some junction improvements have been completed and others are planned. Notwithstanding these improvements, its capacity remains insufficient to fulfil its multiple roles.
- 6.12 Congestion in the city of Oxford is an inevitable consequence of its historic street pattern, but it is exacerbated by the fact that many of the high tech jobs are on the periphery of the urban area (on Oxford Science Park, Oxford Business Park and at Begbroke). In the absence of good rail and bus links, most people commute by car.
- 6.13 Major rail improvements are underway or planned, including: electrification of the west coast mainline; two good routes from Oxford into London (via Didcot to Paddington, and via Bicester to Marylebone); station improvements at Bicester, Didcot and Oxford; the creation of a rail station at Water Eaton Park & Ride (planned for 2015) with a link to Oxford and London Marylebone; and (in prospect) increased capacity on the rail link between Oxford and Didcot, and a direct link between Oxford and Heathrow.
- 6.14 These rail improvements will greatly improve point to point connectivity between the main growth centres in Oxfordshire and also rail links to London and Heathrow. They also provide opportunities for high density development of business space around the improved stations, which, along with the main strategic road junctions, are the most accessible nodes in the county.

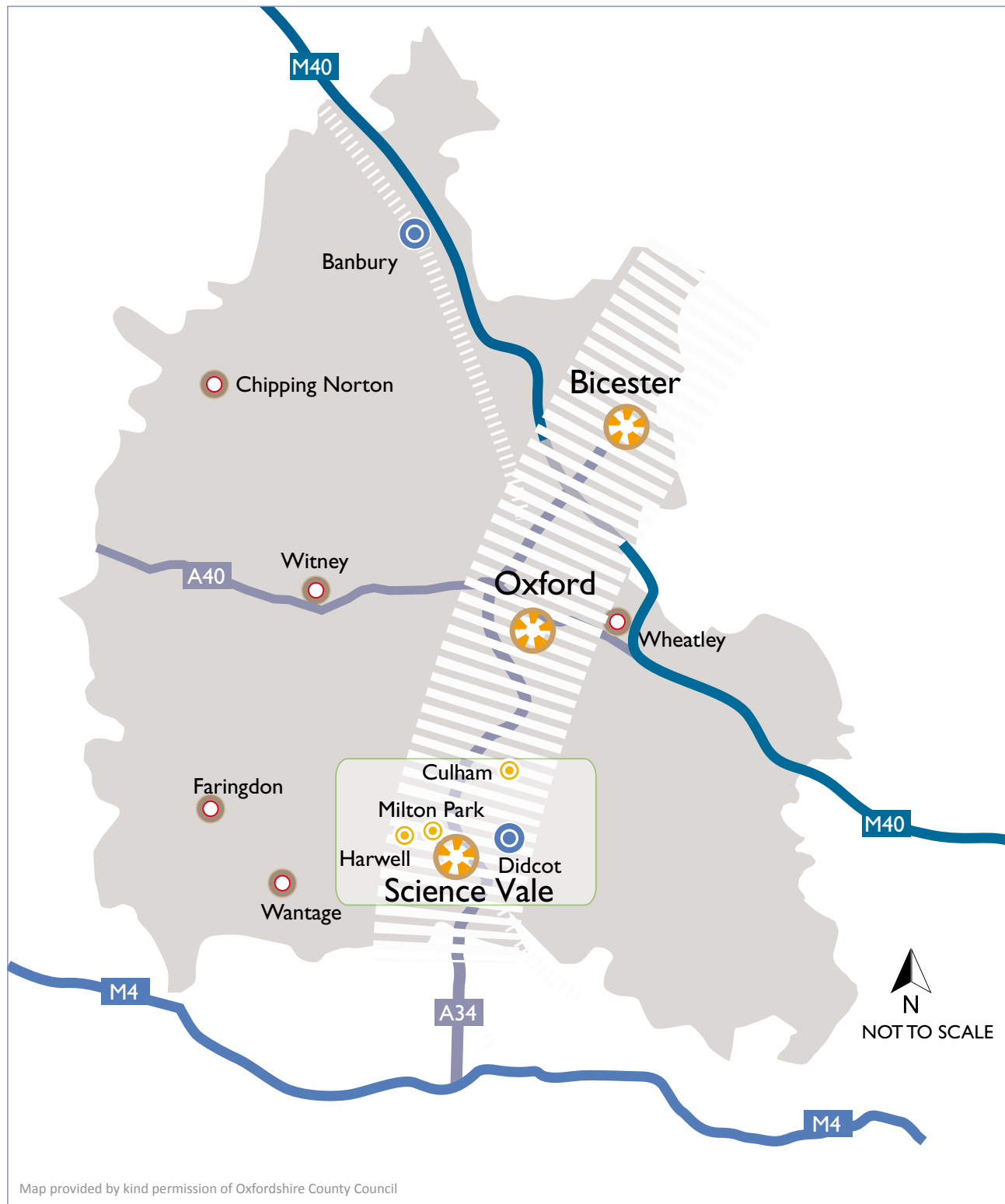
Broadband

- 6.15 Oxford is one of 12 UK cities which the Government announced in December 2012 will share a £50 million Super-Connected City fund set up to provide homes and businesses with ultrafast broadband (at least 80-100Mbps) and high speed wireless internet access⁶¹. However, approximately 40% of the county is not currently served by superfast broadband. Improvements being implemented by BT will bring this down to 30%, but this remains high for a county with a strong, and widely dispersed, high tech economy (the current figure for Berkshire is 16% without access). Almost one third of firms responding to the survey identified broadband as a problem, most of them located in rural areas, with those in telecoms and IT sectors particularly affected.

Planning and development

- 6.16 The current spatial strategy for high tech Oxfordshire focuses growth on three main areas – Bicester, Oxford and Science Vale, each with distinctive attributes, and linked by high capacity road and rail routes:
- Bicester has substantial planned housing and employment growth, including the Graven Hill development and the North West Bicester eco development – the latter will generate green construction jobs and could stimulate development of a broader green economy. Bicester also offers lower cost residential and business accommodation than the other two centres
 - Oxford has two universities, a substantial number of high tech firms within and around the city (including two existing science parks), major growing firms (eg BMW), financial, professional and business services, and an attractive lifestyle which attracts a young, highly educated, international and growing population as well as a wealthy older generation of successful entrepreneurs and investors
 - Science Vale includes the 'big science' research centres at Culham and Harwell, major employment sites with Enterprise Zone status at Milton Park and Harwell, and substantial planned housing development at Didcot, Grove and Wantage.

FIGURE 6-2: The three main areas in the growth strategy for Oxfordshire



Source: 'Knowledge economy spine' map from the Oxford & Oxfordshire City Deal submission, Draft August 2013.

⁶¹ <https://www.gov.uk/government/news/ultrafast-broadband-for-12-uk-cities>

- 6.17 The growth strategy is intended to address the problems concerning the supply of housing and specialist space for high tech firms. It is dependent on the success of each place and good communications between them. However, the main road infrastructure is operating above capacity much of the time and Oxford's growth is constrained by public policy: its outward expansion is limited by Green Belt, and intensification of development within the city is limited by a need to preserve the historic city centre (including height restrictions to maintain views of the historic city from surrounding hills). This combination is likely to constrain growth of the whole area: if Oxford cannot expand, house prices in the city will continue to rise, and more people will have to live elsewhere and commute into the city to work. Much of the new business space is on the periphery, so a high proportion will commute by car, even if the rail improvements are fully and rapidly implemented. Consequently congestion will increase.
- 6.18 There must also be doubts about the scale of provision for business development compared with the scale of opportunity. Three examples illustrate the point:
- Harwell is the main UK centre for space science research and its commercial applications in satellite telecommunications. The Government estimates that space science will grow from a £9bn industry now to one worth £40bn by 2030, generating 100,000 new jobs⁶². If just one tenth of those jobs are based in and around Harwell, this sector alone will use much of the site's capacity for commercial development, and take up much of the planned housing supply in southern Oxfordshire. Yet space science is just one of the high tech sectors with significant growth potential in Science Vale
 - Astra Zeneca's decision to move its main European research activities from Cheshire to Cambridge generated demand for land to accommodate a 40,000 sqm new building.
- Five sites in and around Cambridge had sufficient capacity at short notice to be able to compete for the investment. Oxfordshire was not considered as a possible location by Astra Zeneca, and even if it had been, there was only one site which could have accommodated that scale of inward investment
- Despite growth aspirations, Bicester actually has had very little land or premises available for business expansion for many years. There is an outstanding planning permission for a 60,000 sqm business park, which has not been implemented, and most of the existing commercial space is relatively old and tired. Several firms which wanted to expand in Bicester have been unable to do so and instead have expanded elsewhere. This is not what would be expected of a high tech growth area.
- 6.19 The strategy is also dependent on the commitment and wherewithal to implement it, and these factors have not always been evident in the past. There have been well publicised differences between Oxfordshire local authorities regarding the scale and location of growth around Oxford, frustratingly slow progress on approving local plans for housing and employment growth throughout the county, and a surprising ambivalence about the major infrastructure investments that the high tech business community repeatedly says it needs – most notably, improvements to the A34, but also more local public transport improvements in Oxford and Science Vale.
- 6.20 However, there is evidence of a greater willingness than in the past to support economic growth and manage its consequences more positively. This is particularly so in relation to the City Deal process, which has brought together public sector organisations, the universities, and the Oxfordshire Local Enterprise Partnership to provide a persuasive argument for greater devolution of funding decisions to Oxfordshire.

⁶² "UK space industry set to rocket with £240 million of investment": press release from the Department for Business Innovation and Skills, 9 November 2012.

7. Opportunities, constraints and recommendations

7.1 Drawing on the different strands of evidence and argument presented earlier in this report, this Chapter considers – in broad terms – the opportunities and constraints facing high tech Oxfordshire and it outlines a series of recommendations (summarised in **Table 7-1**). The chapter is divided into three sections which consider in turn high tech Oxfordshire's three main infrastructures: the research-based institutions; the 'soft' infrastructure to support the growth of technology-based businesses; and issues relating to the county's physical infrastructure and its future spatial development. It concludes with comments relating to strategic direction and leadership, and next steps.

The research infrastructure

7.2 Across its research infrastructure, Oxfordshire has massive assets for the high technology economy. But there are also constraints restricting them from realising their full potential. The University of Oxford is a key factor here. Throughout this report, we have talked about 'the University', but in reality it is far more complex than a single organisation. The Colleges have considerable power and autonomy, and also financial resources, although there are substantial differences between them in this latter respect. This complexity means that strategic opportunities which in other universities of a similar scale would be relatively easy to exploit, can take longer, and demand substantial management time. This inevitably means that some of the constraints identified are not easily solvable. As at Cambridge, sustained high tech development will require College engagement, given their land and financial resources as well as their academic role within the University.

7.3 Engineering at Oxford is significantly smaller than at the other institutions mentioned. There were almost 100 FTE academic staff⁶³ in all engineering cost centres in 2010-11. This compares with 200 at Cambridge and 310 at Imperial. As mentioned in **Chapter 2**, this was reflected in the 2008 RAE submissions. Oxford submitted 120 staff compared with 210 (Cambridge) and 300 (Imperial). We do not have any direct evidence that this has impacted on growth in the county, but it is noticeable that most high tech clusters around the world have substantial academic engineering capacities.

7.4 To be effective, the University's capabilities need to be accessible and some of the companies we interviewed commented that it could be difficult to identify and establish relevant contacts within the University. This, in part, reflects the increasing internationalisation of these businesses, and their associated technology sources, discussed elsewhere in this report. But the main outward facing parts of the University are the Departments and these tend to be organised along traditional subject lines, rather than as interdisciplinary centres which align with current and evolving business needs. The issue is recognised by the University and a key component of its research strategy is to encourage interdisciplinary research. For example, the University has identified a large number of researchers concerned with energy issues, and provided external links to this broad research portfolio by means of a web page (<http://www.futureenergy.ox.ac.uk/>). This approach could be further developed and extended to other research themes relevant to industry. The University is also developing a long-term estates strategy for the Science Area which will lead to co-location of cognate disciplines and additional space in new buildings in order to encourage such working.

⁶³ Based on HESA data. "Research only" staff have been excluded from these numbers as these include many post doctorates. However, their inclusion does not alter the overall picture significantly.

- 7.5 Shortage of space in central Oxford is a recurring theme in this report. Most recent, and planned, University developments are within the ring road and this is constraining growth in some cases. The move of the Medical School to Headington demonstrates what is possible. Senior academics consider this to be one of the most important steps for the School and, since the move, it has benefitted from relatively unconstrained growth opportunities. The Science Area estates strategy will partly address this issue, as well as the fact that much research activity is currently located in inappropriate buildings. Space will, however, remain at a premium and it is unlikely that there will be sufficient accommodation for businesses to locate adjacent to, or be embedded within, University laboratories. There are some current examples, such as the Rolls Royce UTC and developments around the hospitals and biomedical research, but it is difficult to see how these could be extended to other areas in central Oxford on any scale. This kind of university-business interaction is potentially very important and is, for example, the original reason for Microsoft Research locating in Cambridge.
- 7.6 If Oxford is to host more of such activity, it will need to be based at non-central locations. Several research groups are already located at Begbroke, and Harwell has similar potential, but there are real challenges for the University in moving academic activity from the city centre because of the difficulties in transport between these sites and the central University area. The expansion of Begbroke is also constrained by the Green Belt designation on surrounding land. However, these challenges need to be overcome if the potential for co-location of university and corporate research activities at both Begbroke and Harwell is to be realised.
- 7.7 Closer working between Harwell and the University could be highly mutually beneficial given the factors discussed in **Chapter 2**. There are already several joint staff appointments and Oxford researchers are the most numerous users of the Diamond synchrotron, but these impacts could be extended through the location of academic activities on-campus and close working with existing and new businesses.
- 7.8 We consider that the single most important *long-term* development of the research infrastructure would be to establish more academic activities on the Harwell Campus. There are some joint appointments between the University and research organisations at Harwell but this arrangement could be extended to facilitate a greater University presence for mutual benefit, and could include, for example, joint research teams. The site has a unique collection of scientific facilities on campus and large groups of highly skilled scientists and engineers as well as the capacity to accommodate a wide range of company types and sizes. Co-location of globally leading academic researchers would prove extremely attractive to UK and foreign businesses which, we believe, could also generate academic benefits. This is, however, only feasible if transport links to central Oxford are radically improved. It would also challenge university academics to work in new ways.
- 7.9 We do not regard expansion at Harwell as an alternative to the aspirations for Begbroke Science Park. Together with the surrounding area (much of it in University and College ownerships), Begbroke offers tremendous potential to create a dynamic interface between University and corporate research facilities and creative new businesses. It could enable the expansion of engineering and other applied sciences, and also provide much needed University-related housing. The area also benefits from improving connectivity due to its proximity to Oxford Airport and a new railway station planned to open at Water Eaton in 2015 that will connect to Oxford, Bicester, Science Vale (Didcot) and London. The realisation of this potential will require changes to Green Belt boundaries, but this could involve adjusting both inner and outer boundaries to avoid reducing the overall extent of the Green Belt. There could be some competition between Begbroke and Harwell, but the potential for technology development in the county is more than sufficient to sustain both developments.

RECOMMENDATIONS:

- Improve visibility of inter-disciplinary research at the University of Oxford, signposting for firms to relevant research and staff, and retention of links with firms as they grow.
- Increase the involvement of the University of Oxford with the public and private sector research facilities at Harwell. This should go beyond the existing joint appointments to establishing academic activities there, such as joint research teams.
- Develop proposals for a major long term expansion of university and corporate research and other related facilities in the Begbroke area, involving the University, its Colleges, other landowners, local government and transport operators.

The soft infrastructure

- 7.10 Of the three key infrastructures that are likely to shape the future of high tech Oxfordshire, the 'soft' infrastructure is the one that is most ethereal and least spatially grounded within the county. Overwhelmingly, it is defined and driven by the private sector and changes within it are generally a straightforward response to shifting market signals.
- 7.11 Two overarching points, observed throughout this study, need to be made in this context. The first is that through the 'soft' infrastructure, the high tech economy is increasingly a product of 'flows' – of capital, of people, of technologies, of markets. These 'flows' ignore administrative boundaries (certainly those within the UK, and usually national borders too). But increasingly, they are also expansive in defining functional ones: international air travel (which is relatively easy in relation to Oxfordshire), the possibilities of internet connectivity and the scope for going viral through social networking are progressively changing the ground rules. Historically, there have been many examples of technology-based businesses in Oxfordshire which were founded through personal friendships/acquaintances that were initially forged by undergraduate, postgraduate or post-doctoral students at the University of Oxford; today, these same relationships are likely to be between people of different nationalities, hence another fillip to the intrinsic and deep-seated shift to far more global networks and alliances.

The Oxfordshire 'innovation engine' needs to embrace these changes fully, recognising the underlying strengths that it can bring to bear.

- 7.12 The second overarching comment has to relate to the changing role and significance of London. Both functionally, and in absolute terms, London is far more significant now than it was a few decades ago; and indeed there was a time when its population and its economic muscle appeared to be waning. Today, it is a thriving global city on Oxfordshire's doorstep and inevitably this too is changing the opportunities and imperatives in relation to much of the 'soft' infrastructure on which Oxfordshire's technology-based businesses both contribute and draw.
- 7.13 Against this most challenging backdrop, this study has pointed to a number of constraints linked to the 'soft' infrastructure. Some of these can be addressed locally, but others require national or international solutions and interventions, and both the fiscal and regulatory systems have a role to play.

Improving access to risk capital

- 7.14 Uppermost among these constraints is a chronic shortage of early stage investment capital and increasing exasperation with the structure and timescales of conventional venture capital investments: neither of these observations is specific to Oxfordshire or its high tech businesses, but both are biting hard. In response three potential solutions have been identified.
- 7.15 Currently, incentives for individual investors work well by de-risking investments, and R&D tax credits and the proposed 'patent box' are good for both companies and investors. However, with the decline, increasing conservatism and short time horizons of venture capital funds, there is a need for measures at a national scale to attract institutions, such as pension funds, insurance companies and others with a long term perspective, to invest directly in high tech firms – a move which could also increase the alignment of timescales between investors and managers. Another possibility is to stimulate greater involvement and investment in SMEs from major corporates.

7.16 More locally, improved early stage funding is important. Potentially, various national sources (such as devolved funding from the National Innovation Fund, part of the Business Bank) could be used to match funds from individual investors channelled through the existing business angel investment networks. This would both increase the availability of early stage funding and could help strengthen the business angel networks in Oxfordshire by providing more resources for investment in firms that they showcase⁶⁴.

7.17 Several consultees contrasted the prominence of the Cambridge business angels, and their tendency to meet regularly and to co-invest, with the lower profile and individualistic character of the Oxford angels. In part this perception is misplaced: there are well established angel networks in Oxfordshire such as Oxford Investment Opportunity Network, Oxford Early Investments and the Isis Angels Network, and co-investment is common. However, the argument is that deal flow would increase, to the benefit of both firms and investors, if angel activity in Oxfordshire had a higher profile and was more coordinated, in particular including the largest investors. This may be impractical, particularly if the largest investors do not want to be 'coordinated', but finding ways to ensure their experience is shared with the next generation of investors could be invaluable to the future of Oxfordshire's high tech business community.

RECOMMENDATIONS:

- Lobby Government to develop measures to encourage institutional investors with a long term perspective, such as pension funds, to invest in high tech firms.
- Develop proposals to increase the supply of early stage investment capital by matching local business angel investment networks funds with national sources of funding.
- Encourage the most experienced angel investors in Oxfordshire to pass on their know-how to the next generation of investors, using the existing networks as a vehicle and strengthening those networks in the process.

Improving access to scientific and technical expertise

7.18 Notwithstanding the strength of Oxfordshire's labour market, a chronic shortage of skills – particularly amongst highly qualified scientists and engineers – was identified as another cross-cutting challenge. Part of the solution to this rests with the physical infrastructure (and is considered in detail below); but part of it is tied up with the fluidity (or otherwise) of international labour markets, and here, UK government could play a role.

7.19 Public opinion and political reality suggest that the rules concerning immigration to the UK are unlikely to be loosened. However, the findings from this study indicate that the processing of work permit applications for high tech firms must be dramatically improved. Throughout this study, we have gathered a range of evidence which has demonstrated just how multi-national Oxfordshire's high tech firms are, both in their employment and their business activities; they, the research institutes and the universities depend on recruiting the best scientists and engineers in the world. A system which operates – whatever the underlying intentions – to dissuade talented foreigners from working in Oxfordshire's high tech community, or from applying to its universities, will be disastrous for the UK's economic performance: it needs to be fixed. We recommend that a lobbying exercise is undertaken to seek government agreement to decentralise the approval process for work permit applications made by Oxfordshire high tech firms.

RECOMMENDATION:

- Lobby Government to improve, and in particular dramatically speed up, the processing of work permit applications for foreign nationals. As part of this lobbying process, seek Government agreement to decentralise the approval process for work permit applications made by Oxfordshire high tech firms.

Information on the high tech community

- 7.20 An issue we have faced in undertaking the research for this report is the paucity of data. It is very difficult to identify high tech firms and activities from standard data sources, therefore there is a need for better local sources. In particular, we recommend that a database of high tech firms is maintained (probably by the County Council), and that the University of Oxford should systematically collect information on its interactions with high tech businesses. To be useful, both data sources will have to be updated regularly and should be linked. This would also facilitate benchmarking against other areas and institutions, and provide evidence of change over time which can be used to promote Oxfordshire and to celebrate its successes.

RECOMMENDATION:

- **Maintain better information on the high tech community in Oxfordshire. Specifically, this should include a database of high tech firms, and more comprehensive information on interactions between the University of Oxford and high tech businesses.**

Networks in Oxfordshire

- 7.21 There are various networks relating to the high tech business community in Oxfordshire, including the business angel networks and sector specific networks such as OBN⁶⁵. However, our research suggests that the high tech community is less networked within Oxfordshire than, say, its equivalent in the Cambridge area. Although we would not want to promote inward looking networks, the success of Venturefest and also of the workshops and networking events held in the process of undertaking this study suggest there is a continuing desire for opportunities for representatives from across the high tech community to meet and discuss common issues and opportunities.

It would be particularly valuable to bring together more frequently people working in Oxfordshire's distinctive technology areas, which tend currently to act in isolation from each other. Networks also help to develop common agendas and to promote strong messaging about investment and other priorities. Historically, The Oxford Trust played a crucial role in supporting business networking and innovation, and although in more recent years its focus has switched more to promoting science education, a revival of its networking role could be timely.

RECOMMENDATION:

- **Increase networking events and activities in Oxfordshire, to support improved linkages across all areas of the high tech community and with the government, research, financial and professional services communities, and to promote strong and consistent messaging regarding priorities.**

The physical infrastructure

- 7.22 The high tech growth strategy for a 'Knowledge Economy Spine' in Oxfordshire, articulated in the City Deal submission, is a significant step forward. However, in our opinion it does not place sufficient emphasis on the crucial economic role of Oxford, instead focusing most attention on growth of Bicester and in Science Vale. The three areas provide complementary resources and opportunities, and all three need to grow. Oxford is the service centre for the wider economy, it has the fastest growing, best educated workforce, and it is the main centre of research and spin outs in the county. Most of the employment growth in the county between 2001 and 2011 was in the city. It is also where many high tech firms choose to locate: 30% of survey respondents are located in the city (including Begbroke and Oxford Science Park), including six of the 17 firms employing over 100 people (and this excludes the major publishing houses).

⁶⁴ In 2008 Oxford Investment Opportunity Network (OION, run by Oxford Innovation) created a co-funding programme with Bank of Scotland. This enabled a substantial increase in the number of firms funded, and the scale of funding made available, though OION in that year.

⁶⁵ OBN was formerly known as Oxfordshire Bioscience Network.

7.23 Oxford has to grow to fulfil its role within the high tech economy. Specifically, we recommend that the long term growth of the city should entail:

- Further development of housing, accommodation for university and corporate research, and supporting activities, beyond existing plans, to the north and south of the existing urban area. The greatest potential for sustainable growth is to the north of the city around Begbroke, the new northern gateway (Peartree) and the planned new rail station at Water Eaton Park & Ride. Begbroke has limited potential for expansion within its existing site, but the University of Oxford owns 170ha adjacent to the park. This provides the opportunity to develop an 'R&D village', including an expansion of research facilities for engineering and other applied science departments, corporate research areas, affordable housing and hotel and recreation facilities. The new access road to the park has capacity to serve a larger area, Oxford airport is within a mile, and the new rail station at Water Eaton, planned to open in 2015, is easily accessible. If complemented by development around Water Eaton, this provides a substantial development opportunity which would be well served by the improved rail infrastructure.

To the south it is likely that Oxford Science Park will need to be expanded beyond its existing capacity once more of the site is occupied. In addition, the Grenoble Road area could be developed to provide housing to meet the needs of the high tech cluster. Much of the infrastructure is already in place, and Oxford City Council and Magdalen College own the land.

These decisions to expand both north and south of the city will be controversial, and will require adjustments to the Green Belt (which could involve additions to the outer edge as well as limited changes to the inner boundary, in order to preserve its overall extent), but without them Oxford will be unable to provide for firms that want to locate and expand there. For firms which want to work closely with one of the universities or other Oxford based research facilities, the choice is likely to be between locating in Oxford itself or alongside another world class research centre outside of Oxfordshire. They are unlikely to locate elsewhere in the county.

- Oxford needs more office space within the city, including (but not limited to) more incubator space. Oxford Centre for Innovation, in the city centre, and two small serviced office facilities, are fully occupied and have waiting lists. The historic central area and land ownerships constrain what can be done, but in the short term the main opportunity is in the West End/Oxpens area around Oxford station. This has been planned for many years, and needs to be progressed as soon as possible to include office space as well as new housing and redevelopment of the station to increase capacity. In addition, funding is needed to support the implementation of the Magnet proposals (a science discovery centre and innovation centre in Oxford city centre) and a 5,000 sqm bioescalator facility on the Churchill Hospital campus, which would link biomedical research and business, and greatly improve the supply of specialist and novel types of incubation space for bioscience firms.

7.24 To enable the Knowledge Economy Spine to function as an integrated whole, strategic and local transport improvements are essential. The capacity of the road and rail links between the three centres (Oxford, Bicester and Science Vale) – and their wider regional and national connectivity – needs to be improved. Superfast broadband is also essential, and access to it needs to be extended.

7.25 Whilst significant rail improvements are planned or underway, and are greatly welcomed, these need to be complemented by fast and frequent local public transport links between the rail stations at Bicester, Water Eaton, Oxford and Didcot, and the main employment areas. This is a particular problem in Oxford, because of the concentration of high tech employment to the north and south of the city, well removed from the city centre and Oxford railway station. The poor links between the main centres within Science Vale also need to be addressed.

7.26 However successful these public transport measures are, there will continue to be a large number of car users, and there is a pressing need to improve the strategic road network – particularly the A34, which is the highest priority for the high tech business community.

The A34 acts as the main road artery for the 'Knowledge Economy Spine', and it is heavily congested. A concerted campaign is needed to secure major improvements, building on recent signs of coordinated local action⁶⁶.

- 7.27 Our survey of high tech firms identified broadband as a problem in rural areas of Oxfordshire, and particularly affecting firms in the telecoms and IT sectors. The OxOnline project, operating through the Oxfordshire Local Enterprise Partnership, has made progress in securing improvements, but even after they are implemented around 30% of Oxfordshire will remain without superfast broadband. We would encourage the Oxfordshire Local Enterprise Partnership to continue to work towards achieving its objective of implementation of superfast broadband across the whole of Oxfordshire by 2015.

RECOMMENDATIONS:

- Implement proposals for a 'Knowledge Economy Spine' for Oxfordshire, by supporting housing and high tech employment growth in the three main foci: Bicester, Oxford and Science Vale. In particular, additional provision for growth to accommodate high tech businesses and employment needs to be made in and around Oxford, including to the north of the city (Begbroke, Water Eaton and the Northern Gateway/Peartree) and to the south (Oxford Science Park and Grenoble Road).
- Provide additional office space (including business incubator provision) in Oxford city centre, particularly by implementing the proposals for the West End/Oxpens area, a bioescalator incubator on the Churchill Hospital campus, and for the Magnet science discovery centre and expanded Oxford Centre for Innovation.
- Improve the capacity and connectivity of strategic and local transport infrastructure within the 'Knowledge Economy Spine', particularly the A34, the main north-south rail links, and fast bus services between the rail stations and main employment centres. Implement superfast broadband proposals.
- Implement superfast broadband across the whole of Oxfordshire by 2015.

Strategy and leadership

- 7.28 The recommendations made above will need vision and leadership to implement and promote. Many are already flagged, or implied, in various documents, for example the City Deal, but there will be a need for coherent and forceful leadership to push them through. A frequently expressed concern in our consultations has been that Oxfordshire has lacked the strong leadership and consistent messaging that have benefited some competitor locations, not least Cambridge. That is not to say there are no strong leaders in the high tech community: clearly there are, and some of them have very considerable influence in government and financial communities. However, the perception of Oxfordshire – both from within the high tech community and from outside – has been of a reluctance to embrace growth and to manage it for the benefit of future generations.

- 7.29 In some ways, the situation is improving: local organisations have agreed to work together to enable growth under the remit of the City Deal process, and a Strategic Economic Plan is being prepared. It is well-recognised that both the track record of delivery and also perceptions need to be changed, if Oxfordshire is to attract the scale of investment it merits from both public and private sectors. Various organisations could take leadership roles, including both universities, the Oxfordshire Local Enterprise Partnership and The Oxford Trust. But strong leadership still needs to be demonstrated in practice. It is particularly important that debates among the local authorities about whether and how to accommodate growth are resolved, and that the University of Oxford and its Colleges agree a long term development strategy which the relevant planning authorities endorse.

RECOMMENDATION:

- Provide strong public and private sector leadership and consistent messaging to realise the growth potential of Oxfordshire's 'innovation engine'.

⁶⁶ http://www.oxfordtimes.co.uk/news/yourtown/oxfordshire/10317904.No_promise_to_solve_county_s_A34_chaos/

What will success look like?

- 7.30 Assuming these issues are addressed, and that there is strong leadership and consistent messaging about Oxfordshire's strengths, growth potential and investment requirements, Oxfordshire's high tech economy will significantly increase its contribution to national economic growth in future, and provide many more high value jobs for future generations of local residents. Indicators of success will include:

INDICATORS OF SUCCESS

- an additional contribution to the national economy of at least £1 billion in GVA (at constant prices) within 10 years, representing a 30% uplift on current projections
- stronger and more productive relationships between Oxfordshire's high tech companies, the universities and research institutes
- substantially higher levels of private and public investment in Oxfordshire
- a perception of Oxfordshire, both internally and externally, as a place which is committed to sustainable growth, and which reflects the scale and success of the high tech community, and its potential to generate greater local and national benefits whilst also achieving global impact.

Next steps

- 7.31 The sponsors of this report are committed to providing ongoing support for implementation of the recommendations, working collaboratively with other parties in the private and public sectors.
- 7.32 They are also committed to ensuring that the Oxfordshire 'innovation engine' plays its part in national economic growth, and that its role should be seen within the context of a 'golden triangle' which also includes the Thames Valley, London and Cambridge. On a global scale, this wider geography is the comparator, and true competitor, with areas such as Silicon Valley and San Francisco, Boston and Massachusetts, and greater Shanghai. Further work is therefore planned to examine the growth potential and respective economic roles and complementarities of other parts of the golden triangle.

TABLE 7-I: Summary of recommendations

PARA	RECOMMENDATION
RESEARCH INFRASTRUCTURE	
7.4	Improve visibility of inter-disciplinary research at the University of Oxford, signposting for firms to relevant research and staff, and retention of links with firms as they grow.
7.8	Increase the involvement of the University of Oxford with the public and private sector research facilities at Harwell. This should go beyond the existing joint appointments to establishing academic activities there, such as joint research teams.
7.9 & 7.23	Develop proposals for a major long term expansion of university and corporate research and other related facilities in the Begbroke area, involving the University, its Colleges, other landowners, local government and transport operators.
SOFT INFRASTRUCTURE	
7.15	Lobby Government to develop measures to encourage institutional investors with a long term perspective, such as pension funds, to invest in high tech firms.
7.16	Develop proposals to increase the supply of early stage investment capital by matching local business angel investment networks funds with national sources of funding.
7.17	Encourage the most experienced angel investors in Oxfordshire to pass on their know-how to the next generation of investors, using the existing networks as a vehicle and strengthening those networks in the process.
7.19	Lobby Government to improve, and in particular dramatically speed up, the processing of work permit applications for foreign nationals. As part of this lobbying process, seek Government agreement to decentralise the approval process for work permit applications made by Oxfordshire high tech firms.
7.20	Maintain better information on the high tech community in Oxfordshire. Specifically, this should include a database of high tech firms, and more comprehensive information on interactions between the University of Oxford and high tech businesses.
7.21	Increase networking events and activities in Oxfordshire, to support improved linkages across all areas of the high tech community and with the government, research, financial and professional services communities, and to promote strong and consistent messaging regarding priorities.
PHYSICAL INFRASTRUCTURE	
7.22 & 7.23	Implement proposals for a 'Knowledge Economy Spine' for Oxfordshire, by supporting housing and high tech employment growth in the three main foci: Bicester, Oxford and Science Vale. In particular, additional provision for growth to accommodate high tech businesses and employment needs to be made in and around Oxford, including to the north of the city (Begbroke, Water Eaton and the Northern Gateway/Peartree) and to the south (Oxford Science Park and Grenoble Road).
7.23	Provide additional office space (including business incubator provision) in Oxford city centre, particularly by implementing the proposals for the West End/Oxpens area, a bioescalator incubator on the Churchill Hospital campus, and for the Magnet science discovery centre and expanded Oxford Centre for Innovation.
7.26	Improve the capacity and connectivity of strategic and local transport infrastructure within the 'Knowledge Economy Spine', particularly the A34, the main north-south rail links, and fast bus services between the rail stations and main employment centres.
7.27	Support the implementation of superfast broadband across the whole of Oxfordshire by 2015 through the Oxfordshire Local Enterprise Partnership.
STRATEGIC DIRECTION AND LEADERSHIP	
7.28 & 7.29	Provide strong public and private sector leadership and consistent messaging to realise the growth potential of Oxfordshire's 'innovation engine'.

Appendix 1:

Steering Group, advisory working groups, consultations and discussions

The following section lists the members of the Steering Group for the project together with members of the advisory working groups, people who participated in formal consultation interviews and those who provided input through formal and informal discussions, meetings and other comments and support.

All positions shown are those held by the individuals as at the date of the consultation, discussion, meeting or other input.

SQW would like to thank everyone who supported this project through their involvement at various stages.

Steering Group

NAME	POSITION	ORGANISATION
Professor Sir John Bell <i>Steering Group Chairman</i>	Regius Professor of Medicine	University of Oxford
Dr Paul Brankin	Chairman	Science Oxford
Lord (Paul) Drayson	Founder & Managing Partner	Drayson Racing Technologies
Ian Laing	Chairman	Oxford Innovation & SQW Group
Councillor Keith Mitchell	Councillor for Bloxham Division	Oxfordshire County Council
Adrian Shooter	Chairman	Oxfordshire Local Enterprise Partnership
Bernard Taylor	Chairman	Isis Innovation
Professor Ian Walmsley	Pro-Vice-Chancellor Research, Academic Services & University Collections	University of Oxford

Advisory Working Group – Business, networks and services

NAME	POSITION	ORGANISATION
Dr Paul Brankin <i>Working Group Chairman</i>	Chairman	Science Oxford
Robert Campbell	Senior Publisher	Wiley-Blackwell Publishing
James Dipple	Managing Director	MEPC Milton Park
Daniel Kindness	Head of Customer Relationship Management and Business Development	Siemens Magnet Technology
Ian Laing	Chairman	Oxford Innovation & SQW Group
David Mott	Managing Partner	Oxford Capital
John Neill	Chairman & Chief Executive	Unipart Group
Peter Nolan	Executive Director & Senior Vice President Commercial Development	Oxford BioMedica plc
Dr Mario Polywka	Chief Operating Officer	Evotec
Dr Allyson Reed	Director of Enterprise & Communications	Technology Strategy Board
Dr Jon Rees	Chief Executive	OBNI
Robert Rickman	Partner	Rockley Group
Ben Sayer	Public Relations Manager	Prodrive
John Shaw	Vice President, Product Management	Sophos
Susan Shayler	Chief Operating Officer	Numerical Algorithms Group
Dr Andrew Sowerby	Group Business Development Manager	Oxford Instruments plc
Mike Watkins	Senior Manager for Retail Services	Nielsen Group

Advisory Working Group – Research

NAME	POSITION	ORGANISATION
Professor Ian Walmsley <i>Working Group Chairman</i>	Pro-Vice-Chancellor Research, Academic Services & University Collections	University of Oxford
Dr Maxine Allen	Head of Business Development & Partnering, Medical Sciences Division	University of Oxford
Professor Mark Bailey	Director	NERC Centre for Ecology & Hydrology, Wallingford
Dr Tim Bestwick	Executive Director, Business & Innovation	Science & Technology Facilities Council
Professor Steve Brown	Director	MRC Harwell
Dr Phil Clare	Associate Director, Research Services & Head of Knowledge Exchange	University of Oxford
Professor Steve Cowley	Chief Executive	UK Atomic Energy Authority & Culham Centre for Fusion Energy
Richard Cutler	Partner	Bloombridge Development Partners
Professor Peter Dobson	Academic Director	Begbroke Science Park
Dr Sally Ann Forsyth	Director of Science Parks	Goodman
Christopher Goard	Non-Executive Director	Oxford University Hospitals NHS Trust
Tom Hockaday	Managing Director	Isis Innovation
Eric Hollis	Chief Financial Officer and Director Support Division	UK Atomic Energy Authority & Culham Centre for Fusion Energy
Paul Inman	Pro-Vice-Chancellor & Dean of Faculty of Technology, Design and Environment	Oxford Brookes University
Professor Gerhard Materlik	Chief Executive Officer	Diamond Light Source Ltd
Dr Nanda Rodrigues	Head of Scientific Business Development	MRC Harwell
Dr John Stedman	Chief Executive	NHS Innovations South East
Dr Nick Wells	Head of Knowledge Transfer	NERC Centre for Ecology & Hydrology, Wallingford
Charles Young	Investment Bursar, Magdalen College	The Oxford Science Park

Advisory Working Group – Local government

NAME	POSITION	ORGANISATION
Councillor Keith Mitchell <i>Working Group Chairman</i>	Councillor for Bloxham Division	Oxfordshire County Council
Calvin Bell	Director of Development	Cherwell District Council & South Northamptonshire Council
Councillor Dorothy Brown	Vice-Chairman	South Oxfordshire District Council
Councillor Yvonne Constance	Cabinet member for Legal and Democratic Services, and HR, IT and Customer Services	Vale of White Horse District Council
Councillor Ann Ducker	Leader	South Oxfordshire District Council
Councillor Ian Hudspeth	Leader	Oxfordshire County Council
Councillor Bob Price	Leader	Oxford City Council
Adrian Shooter	Chairman	Oxfordshire Local Enterprise Partnership
Joanna Simons	Chief Executive	Oxfordshire County Council
Andrew Tucker	Strategic Director – Development	West Oxfordshire District Council

Advisory Working Group – Skills, labour, infrastructure

NAME	POSITION	ORGANISATION
Adrian Shooter <i>Working Group Chairman</i>	Chairman	Oxfordshire Local Enterprise Partnership
Kate Allen	Founder & Managing Director	Allen Associates
William Barton	Business Development Officer	West Oxfordshire District Council
Jonathan Black	Director of Careers Service	University of Oxford
Richard Byard	Service Manager – Economy & Skills	Oxfordshire County Council
Adrian Colwell	Head of Strategic Planning & the Economy	Cherwell District Council
Michael Crofton-Briggs	Head of City Development	Oxford City Council
Sally Dicketts	Principal & Chief Executive	Oxford & Cherwell Valley College
David Edwards	Executive Director for Housing & Regeneration	Oxford City Council
Tom Flanagan	Service Manager – Planning and Transport Policy	Oxfordshire County Council
Ben Jackson	Vice Chairman	Federation of Small Businesses, Oxfordshire
Adrian Lockwood	Chairman	Oxfordshire Skills Board
Councillor Keith Mitchell	Councillor for Bloxham Division	Oxfordshire County Council
Anna Robinson	Strategic Director	South Oxfordshire District Council & Vale of White Horse District Council
David Waller	Enterprise & Innovation Team Leader	Oxfordshire County Council
Nigel Wild	President	Oxfordshire Chamber of Commerce

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NAME	POSITION	ORGANISATION
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Dr Paul Atherton	Chairman	Nexeon Ltd
Joe Barclay	Non-Executive Director	Venturefest Oxford Ltd
William Barton	Business Development Officer	West Oxfordshire District Council
Professor Sir John Bell	Regius Professor of Medicine	University of Oxford
Dr Tim Bestwick	Executive Director, Business & Innovation	Science & Technology Facilities Council
Dr Stephen Blake	Associate (Patent Attorney)	Marks & Clerk
Natalie Blaken	Head of Planning & Sustainable Communities	West Oxfordshire District Council
Dr Kate Bingham	Managing Partner	SV Life Sciences
Dr Paul Brankin	Chairman	Science Oxford
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David Brooks	Chief Executive Officer	RM plc
Professor Alastair Buchan	Head of Medical Sciences Division	University of Oxford
Alex Burns	Chief Executive	Williams FI
Tony Butcher	Managing Director	Prodrive
Michael Butler	Senior Partner	Dehns
Robert Campbell	Senior Publisher	Wiley-Blackwell Publishing
Dr Phil Clare	Associate Director, Research Services & Head of Knowledge Exchange	University of Oxford
Phil Clement	Inward Investment Specialist	Invest in Oxfordshire
Dr Tim Cook	Non-executive director	Oxford Gene Technology Ltd
Professor Steve Cowley	Chief Executive	UK Atomic Energy Authority & Culham Centre for Fusion Energy
Michael Crofton-Briggs	Head of City Development	Oxford City Council
Nicholas Cross	Chairman	Immunocore Ltd
Richard Cutler	Partner	Bloombridge Development Partners
Andrew Davies	Corporate Relationship Director	Barclays Bank plc
John Dawson	Chief Executive Officer	Oxford BioMedica plc
Sally Dicketts	Principal & Chief Executive	Oxford & Cherwell Valley College
James Dipple	Managing Director	MEPC Milton Park
Professor Peter Dobson	Academic Director	Begbroke Science Park
Lord (Paul) Drayson	Founder & Managing Partner	Drayson Racing Technologies
David Edwards	Executive Director for Housing & Regeneration	Oxford City Council
Dr Nicholas Edwards	Director	Medinnovate Ltd
Jody Egginton	Operations Director	Caterham FI

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NAME	POSITION	ORGANISATION
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Dr Sally Ann Forsyth	Director of Science Parks	Goodman
Dr Matthew Frohn	Director	Oxford Technology Management
Christopher Goard	Non-Executive Director	Oxford University Hospitals NHS Trust
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Professor Chris Grovenor	Head of Department of Materials	University of Oxford
Professor Alex Halliday	Head of Mathematical, Physical and Life Sciences Division	University of Oxford
Professor Andrew Hamilton	Vice Chancellor	University of Oxford
Dr Chris Harris	Chief Executive Officer	Yasa Motors
Wendy Hart	Corporate Finance and Strategic Advisory Partner	Grant Thornton UK LLP
Margaret Henry	Company Secretary & PR Director	Oxford Innovation & SQW Group
Tom Hockaday	Managing Director	Isis Innovation
Professor Guy Houlby	Head of Department of Engineering Science	University of Oxford
Paul Inman	Pro-Vice-Chancellor & Dean of Faculty of Technology, Design and Environment	Oxford Brookes University
Ben Jackson	Vice Chairman	Federation of Small Businesses, Oxfordshire
Daniel Kindness	Head of Customer Relationship Management and Business Development	Siemens Magnet Technology
Dr David Kingham	Chief Executive Officer	Tokamak Solutions (UK) Ltd
Ian Laing	Chairman	Oxford Innovation & SQW Group
Alex Lewis	Director of Corporate Activities	Oxford BioMedica plc
Dr Robert Lind	Partner (Patent Attorney)	Marks & Clerk
Patrick Louis	Chief Executive	Lotus FI
Ian Macpherson	Business Development Manager	Oxford Science Park
Professor Gerhard Materlik	Chief Executive Officer	Diamond Light Source Ltd
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David Mott	Managing Partner	Oxford Capital
Dr Raj Parekh	General Partner	Advent Life Sciences
Dr Mario Polywka	Chief Operating Officer	Evotec
Dr Jon Rees	Chief Executive	OBN

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NAME	POSITION	ORGANISATION
Dr Andrew Rickman	Chairman	Rockley Group
Robert Rickman	Partner	Rockley Group
Professor Bill Roscoe	Head of Computer Sciences Department	University of Oxford
Dr Gordon Sanghera	Chief Executive Officer	Oxford Nanopore Technologies Ltd
John Shaw	Vice President, Product Management	Sophos
Susan Shayler	Chief Operating Officer	Numerical Algorithms Group
Dr Andrew Sowerby	Group Business Development Manager	Oxford Instruments plc
Sue Staunton	Partner, Business Services	James Cowper
Dr Daniel Talbot-Ponsonby	Partner (Patent Attorney)	Marks & Clerk
Bernard Taylor	Chairman	Isis Innovation
Professor Peter Tufano	Dean and Professor of Finance	Saïd Business School
Richard Venables	Director	VSL & Partners
David Waller	Enterprise and Innovation Team Leader	Oxfordshire County Council
Professor Ian Walmsley	Pro-Vice-Chancellor Research, Academic Services & University Collections	University of Oxford
Mike Watkins	Senior Manager for Retail Services	Nielsen Group
Ian Wenman	Deputy Chairman	Oxfordshire Local Enterprise Partnership
James Went	Senior Associate	Manches
Lady (Audrey) Wood	Co-founder and Patron	Science Oxford
Sir Martin Wood	Co-founder and Patron	Science Oxford

Individuals who have contributed through attendance at advisory working group meetings, to represent their organisations, or through other meetings, discussions and comments

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Ruth Collier	Head of Press and Information Office	University of Oxford
Professor David Clary	President, Magdalen College	University of Oxford
James Francis	Corporate Communications Manager	Williams FI
Jim Hall	Executive Director, Oxford Centre for Entrepreneurship & Innovation	Saïd Business School
Margaret Hewitt	Director, Oxford Centre for Innovation	Oxford Innovation
Max Hobbs	Principal	Mahler Ventures
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Dr Caroline Livingstone	Manager	Begbroke Science Park
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Lynn Shepherd	Group Director of Communications	Oxford Instruments plc
Paul Slater	Senior Planner (Policy)	West Oxfordshire District Council
Mairi Smith	Assistant Principal Curriculum	Oxford & Cherwell Valley College
Charles Swingland	Deputy Chairman	Circassia Holdings Ltd
Nigel Tipple	Chief Executive	Oxfordshire Local Enterprise Partnership
Martin Tugwell	Deputy Director for Growth & Infrastructure	Oxfordshire County Council
Bruce Usher	Partner	Bloombridge Development Partners
Dr Stuart Wilkinson	Knowledge Exchange Manager	University of Oxford
Pete Wilton	Press Officer – Mathematical, Physical and Life Sciences and Spin-outs	University of Oxford

About the authors:

Chris Green – Chief Executive Officer, SQW Group

Chris Green has been chief executive officer of SQW Group since 2006, and was previously managing director of subsidiary company, SQW. He negotiated a merger with Oxford Innovation (OI) in 2006, which brought OI into the SQW Group.

Chris has substantial experience of economic development and planning work. He has directed a range of projects throughout the UK and internationally on technology-based development, urban and regional regeneration, research and industry links, business growth, tourism and institutional development.

Examples of projects include: economic development strategies, assessments of high technology clusters, innovation policies for universities, proposals for the re-use of major employment sites, economic assessments for eco developments, action plans for small business development, finance initiatives for small firms, feasibility plans for incubators and science and business parks and inward investment proposals.

Clients include public and private sector organisations operating within the UK and internationally, in Africa, Asia, Europe, Latin America and the Middle East.

Prior to joining SQW in 1987, Chris worked for ten years in local government and economic development.

Dr Christine Doel – Director & Head of Markets, SQW

Christine Doel is a Director of SQW and Head of Markets. She joined SQW after completing a PhD in economic geography at the University of Cambridge.

Christine has worked as project director on a wide range of local, sub-national and national economic development projects across the UK – from research-based exercises, through strategy development and action planning, to delivery and evaluation.

She has developed three broad specialisms: area-based strategy, partnership, delivery and governance; rural development within national and local policy frameworks; and spatial development, focusing particularly on the interface between economic development/regeneration and spatial planning.

Clients include local authorities, local enterprise partnerships, universities, property developers and central government.

Robin Brighton – Director, SQW

Robin Brighton specialises in higher education, research policy and innovation. He has worked on all aspects of higher education including teaching and learning, student demand, research and knowledge transfer.

Robin has extensive experience in programme evaluation and feasibility studies and has also undertaken organisational and strategy reviews for public bodies and research and higher education institutes.

Clients include government departments, the higher education funding and research councils and individual higher education institutions, and he has undertaken higher education and research related assignments for regional agencies, and other local bodies. Robin is an economist by training and his initial career was as a university lecturer.

SQW

SQW is a leading provider of research, analysis and advice on sustainable economic and social development for public and private sector organisations. Founded in Cambridge in 1983 by Nick Segal, Roger Quince and Bill Wicksteed, the firm now operates from offices across the UK.

SQW offers services in a diverse range of fields, from innovation and spatial development to the personalisation of public services. In all of its work, the firm employs the principles of rigorous analysis, collaborative working, commitment to quality and independence of thought.

SQW's staff bring extensive experience to their assignments, with backgrounds in academia, national and local government, and industry. Clients include government departments and agencies in the United Kingdom and overseas, devolved administrations, local authorities and partnerships, higher education institutions, charities, energy and infrastructure providers, investors and developers, and service providers.

SQW is part of SQW Group. Its sister firm is Oxford Innovation, which provides premises and business support services to innovative start-up and high growth companies. The Group also includes SQW China, headquartered in Hong Kong, which undertakes international research and analysis.

www.sqw.co.uk

To download a pdf copy of this report, visit:
<http://www.sqw.co.uk/publications>

BACK COVER IMAGES:

1. **An IT specialist demonstrates Sophos Unified Threat Management complete network security.** *Courtesy of Sophos.*

Sophos is focused on delivering industry-leading IT security and data protection solutions. Headquartered in Abingdon, Oxfordshire and Boston, USA, the company was founded in 1985 by two post-doctoral students in Oxford University's Engineering Department and began producing anti-virus and encryption products during the 1980s. Today, Sophos helps to secure the networks used by 100 million people in 150 countries and 100,000 businesses.

2. **Aerial view of the Diamond Light Source on the Harwell Oxford campus.** *Courtesy of Diamond Light Source.*

Diamond Light Source is the national synchrotron facility. By accelerating electrons to near light-speed, Diamond generates brilliant beams of light from infra-red to X-rays and over 2,000 researchers use the beamlines for experiments in disciplines including structural biology, health and medicine, solid state physics, materials & magnetism, nanoscience, electronics, earth & environmental sciences, chemistry, cultural heritage, energy and engineering. Diamond increasingly supports industrial research and development and is working with over 60 companies including Rolls Royce on aerospace and energy applications, GlaxoSmithKline on drug discovery and development and Johnson Matthey on improved emissions control catalysts.

3. **MRI service and refurbishment.** *Courtesy of Oxford Instruments plc.*

Oxford Instruments was founded by Sir Martin and Lady (Audrey) Wood as one of the first spin-out companies from the University of Oxford in 1959, and was a pioneer in the development of the MRI scanner. Today, Oxford Instruments is a leading provider of high technology tools and systems for industry and research around the world. The company prides itself on using innovation to turn smart science into world-class products. Oxford Instruments has discrete business groups operating in three sectors: Nanotechnology Tools, Industrial Products and Service and employs around 1,900 staff. The image is from its service centre in California, USA, where CT and MR scanners are refurbished and serviced.



*This report was commissioned by the University of Oxford and Science Oxford
with support from the Oxfordshire Local Enterprise Partnership.*



This report was prepared by SQW in consultation with representatives from the research, government, financial and business communities of Oxfordshire:
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The Oxfordshire Innovation Engine

REALISING THE GROWTH POTENTIAL



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