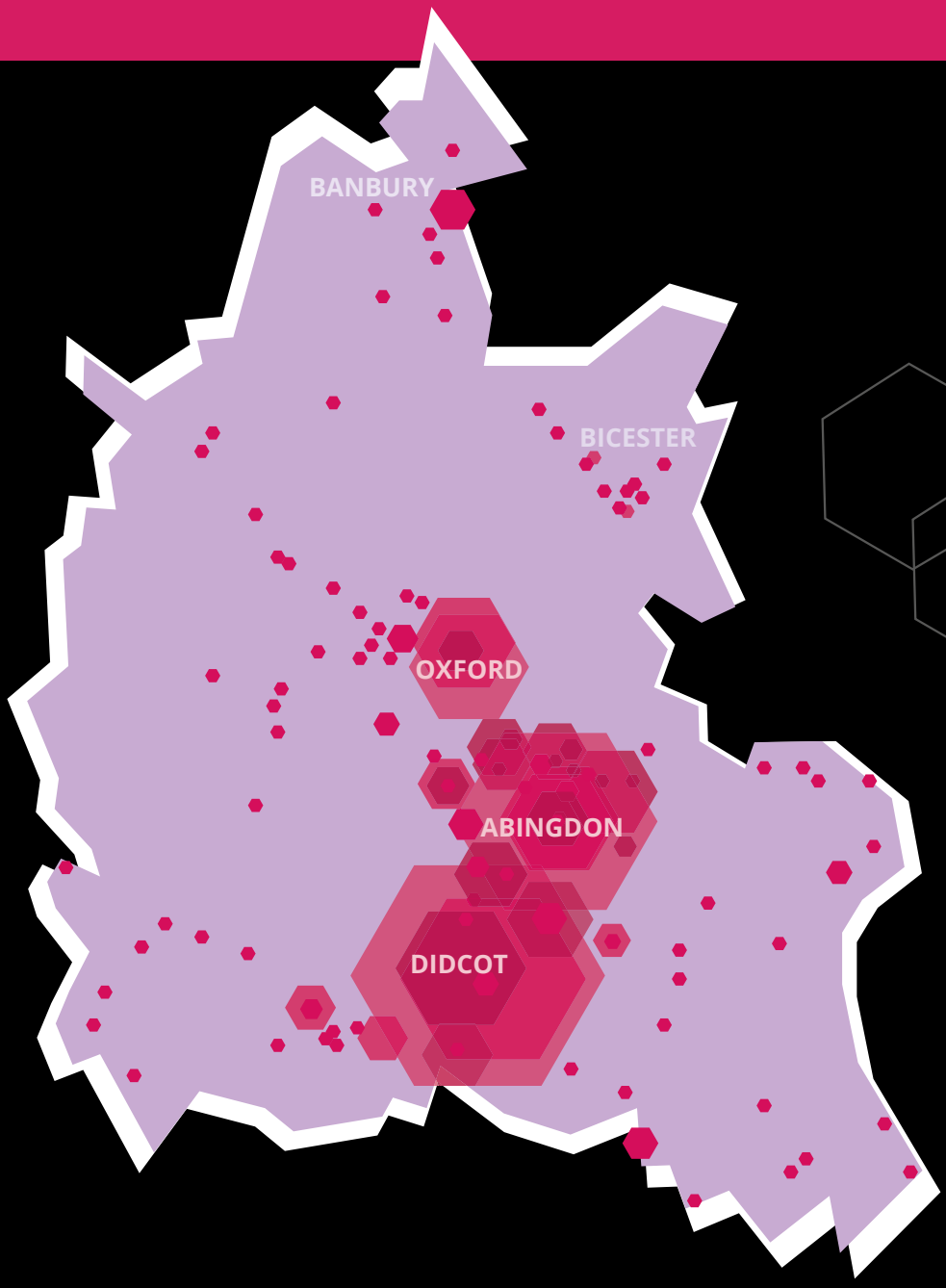
OXFORDSHIRE'S INNOVATION ENGINE 2023

A scientific super-cluster,
looking back, looking forward



Advanced Oxford

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Preface

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The *Oxfordshire Innovation Engine* report was published in 2013, followed by an Update Report two and a half years later. Both assessed the characteristics of the region's cluster of high-tech companies and opportunities for significant societal benefit and impact from the translation and commercialisation of Oxfordshire's scientific research and capabilities. However, the reports also identified constraints which could impede progress and impact the region's growth potential.

The political debate is again focused on economic growth, productivity and jobs, and the Government has set out its plan to cement the UK's place as a science and technology superpower by 2030; so it is timely that this report looks back at what has been achieved in the last decade, but also looks forward.

Great progress has been made since 2013, but there is still much to be done if the region is to contribute fully to the global superpower ambition. Just as Government is looking to create a coordinated approach to science and technology, so this region must come together to build on the breadth and depth of science and innovation in Oxfordshire.

We have a phenomenal record of success, but we must use this as a foundation for even greater achievement. As in 2013 and 2016, *Oxfordshire's Innovation Engine 2023* identifies challenges and opportunities. It shines a spotlight on our rich and varied knowledge economy and presents a set of recommendations to guide activity moving forward. I commend Advanced Oxford for the research, analysis and insight this report provides and I particularly welcome the new innovation dashboard that will help us to track key indicators of progress moving forward. I urge government at all levels – local, regional and national – to read this report and to work with the science and technology community to ensure that Oxfordshire remains an engine room for innovation.

Professor Sir John Bell
Regius Professor of Medicine
University of Oxford

Executive Summary

The first Oxfordshire Innovation Engine report, *Realising the Growth Potential*, was published in the autumn of 2013. It was followed two and a half years later by an 'Update Report' that assessed progress against the actions and recommendations proposed in 2013. Ten years on, Advanced Oxford, working with the International Center for the Study of Research at Elsevier, has produced *Oxfordshire's Innovation Engine 2023*, which reassesses the region's science and technology ecosystem, looking forward, but also looking back over the last decade. Has the growth potential been realised – have challenges been addressed and the opportunities pursued?

If the commissioners and authors of the 2013 report had been able to travel forward a decade and assess Oxfordshire's innovation ecosystem as it is now, it is likely that they would have been pleased with what they found. There has been positive progress across all the success measures set out in 2013. They may also have concluded that the challenges and opportunities presented within the report had been considered, and mostly acted upon. Despite some unforeseen and significant events in the last ten years, the Oxfordshire science and technology-related ecosystem has strengthened and is a significant contributor to the UK and to the Government's ambitions for the country as a scientific superpower.

While a number of the recommendations from the original report are no longer relevant, the majority continue to speak to issues that still concern the region's innovation community. They remind us that the region must continue to work together, ensuring that Oxfordshire remains an engine for innovation, but there are also long-term challenges that must be addressed with ambition, with all the actors working in the interests of this region and what it can achieve.

There are many challenges associated with collecting reliable economic performance data at the regional level, but Oxfordshire appears to have a thriving and diverse innovation ecosystem. The region's knowledge economy has grown considerably in the last decade, both the stock of companies and employment. However, high and medium-tech manufacturing has declined, although this may reflect a maturing of the ecosystem, where manufacturing activities move out of the region as companies scale. Equally, the maturing ecosystem is categorised by growth that has a more international outlook. Companies that started in Oxfordshire are trading and expanding internationally – they are inward investors into new territories, reflecting the global markets in which they operate. This is a true measure of success – born in Oxfordshire, translating science and technology ideas into new products and services, resulting in commercial companies that operate in the region and the rest of the world. Collectively these companies provide a blueprint for the rest of the ecosystem.

The region has attracted inward investment, but the strategy needs to be better defined moving forward and whatever the approach, there is an opportunity for organisations and institutions to work together to attract new investors. The region

has a good record on starting and retaining science and technology-focused businesses, but they still tend to be male dominated, in both their formation and leadership. If there is still a long way to go on gender equality, it seems likely that other diversity characteristics also need attention and action.

There have been many positive developments within the local business environment in the last decade. There is a growing stock of innovation space with many new developments in the pipeline which will add much needed capacity into the system in the next five years. Housing and transport continue to be key challenges and need to be addressed. Other infrastructure needs investment too, particularly data connectivity and supply of power.

A healthy innovation ecosystem is dependent upon the supply of risk capital to support our most innovative businesses. There have been developments in the last decade, at a local level, but also in government policy. As the ecosystem matures, the financing environment needs to change too and there is an opportunity to diversify and swell the number of investors operating in the region.

The 2013 report identified 'ambiguous attitudes towards growth' across the region. Oxfordshire is still lacking strong, economically focused leaders, representatives, advocates, and cheer leaders. The innovation community must continue to engage and bring its voice and influence to decision making, planning and make the case for investment – locally and to national government. The benefits that the region's high-tech community can bring in addressing pressing societal, technological, environmental, health and sustainability challenges need to be recognised and celebrated. Oxfordshire is a place that can identify, develop, and provide solutions to the world, but there is a need to be proactive in telling Oxfordshire's innovation story – not everyone knows how rich, varied, and successful this ecosystem is.

What next?

Advanced Oxford intends that this report acts as a stimulus to Oxfordshire's innovation community, to come together, to drive the next decade of prosperity, to build a forward-looking and resilient economy. New mechanisms and structures are needed – Advanced Oxford will play its part – but a collective endeavour is needed if Oxfordshire's innovation ecosystem is to flourish, strengthen and play a pivotal role in making the UK a beacon for science, technology, and innovation. To this end, the following recommendations are being made:

RECOMMENDATION 1 Strengthen leadership across the region in relation to innovation.

RECOMMENDATION 2 The City Council and the County Council need to work together to develop a much needed, future-looking transport system, which is Oxfordshire-wide, not just focused on the City of Oxford.

RECOMMENDATION 3 Grow and diversify the number of risk capital investors operating within the region.

RECOMMENDATION 4 Develop a new, clear, strategy, with collective buy-in, for inward investment into the region. Different players within the ecosystem need to work together to ensure that Oxfordshire is open, coherent and can respond to potential investors.

RECOMMENDATION 5 Join up nodes of innovation across the region and help internal and external stakeholders to navigate the landscape through better defined pathways and connectors.

RECOMMENDATION 6 Develop a suite of communications tools and assets, tailored to the needs of different audiences, which can be used by all players, to tell Oxfordshire's innovation story.

Advanced Oxford invites individuals and organisations to come together, to work with us and with colleagues from across the region, and beyond, to respond to these recommendations for action.

This report is published alongside a new 'innovation dashboard' for the Oxfordshire region. By drawing together a set of indicators that attempt to characterise the ecosystem, Advanced Oxford intends to give stakeholders a timely and relevant picture of the knowledge economy across the region. It is intended that this dashboard will be enhanced and developed as new data inputs become available. **The dashboard can be found on Advanced Oxford's website (www.advancedoxford.com).**

Introduction

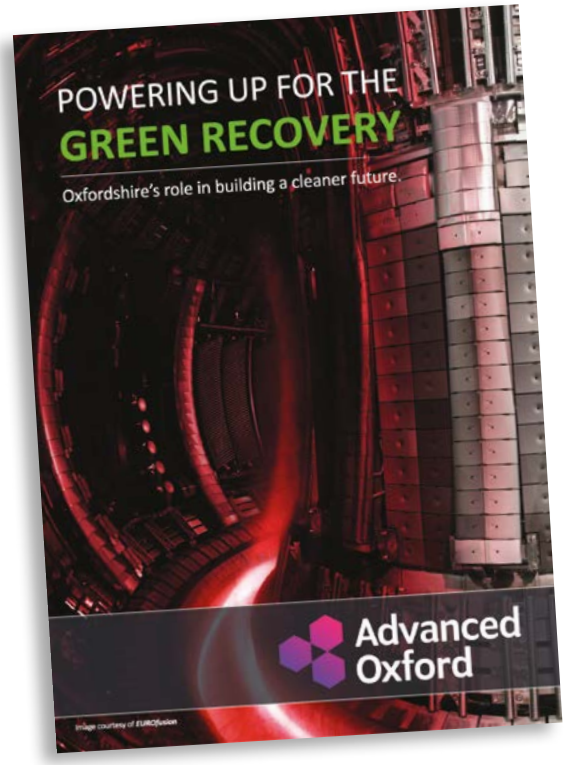
The Oxfordshire Innovation Engine – Realising the Growth Potential **report, was published in the autumn of 2013. The report was commissioned by The University of Oxford and The Oxford Trust, with support from the Oxfordshire Local Enterprise Partnership (OxLEP). In his foreword, Lord Paul Drayson, at the time Managing Partner, Drayson Racing Technologies, wrote the report** *"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"*. **Ten years on, the role of science and technology in fuelling economic growth and new jobs is still as important as ever. The ambition to place the UK at the forefront of science and technology is now embodied in the Government's concept of the UK as a 'Scientific Superpower'.**

PURPOSE OF THE ORIGINAL REPORT

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.

Extract from *The Oxford Innovation Engine – Realising the Growth Potential* (2013)

2013's *The Oxford Innovation Engine – Realising the Growth Potential* was followed, in 2016, by *The Oxfordshire Innovation Engine Update*. The update report considered changes and constraints which had been identified in the original report, asking whether these were being addressed. Although there have been other studies and reports in the intervening period, including *A Science and Innovation Audit for Oxfordshire* published in 2017[1] and the *Oxfordshire Local Industrial Strategy* (2019)[2], there has been no assessment of progress against the issues and recommendations that were made a decade ago since 2016. This report considers whether the constraints and challenges identified in 2013 remain, whether progress has been made, and whether there are new issues which require action. Of course, in the last decade, many things have happened that were not foreseen in 2013, including Brexit and a global pandemic. The reports of 2013 and 2016 were light on key issues such as the skills agenda and the climate emergency. Advanced



Oxford has published research reports on both of these areas subsequently – *Powering Up for the Green Recovery*[3] (2020) and *Attract, Retain, Grow*[4] (2021).

This report is published alongside a new 'innovation dashboard' for the Oxfordshire region. Rather than providing a snapshot limited to a single report, the dashboard will be updated on a regular basis. By drawing together a set of indicators that attempt to characterise the ecosystem, Advanced Oxford intends to give stakeholders a timely and relevant picture of the knowledge economy across the region. It is intended that this dashboard will be enhanced and developed as new data inputs become available. The dashboard can be used for data relating to Oxfordshire and the innovation ecosystem, and it is hoped that this will allow people to understand the composition and dynamics of innovation activity across the region.

The dashboard can be found on Advanced Oxford's website (**www.advancedoxford.com**).

This report is published alongside a new 'innovation dashboard' for Oxfordshire... to give stakeholders a timely and relevant picture of the knowledge economy across the region

SUCCESS MEASURES OUTLINED IN THE ORIGINAL REPORT

The Oxfordshire Innovation Engine report identified opportunities, constraints and provided a set of recommendations for action. The recommendations covered a range of issues under the themes of Research infrastructure, Soft infrastructure, Physical infrastructure and Leadership and messaging. What is more, in 2013, a set of four success measures were set out:

- 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.

Extract from *The Oxford Innovation Engine – Realising the Growth Potential* (2013)

1. Science and Innovation Audit, Oxfordshire Transformative Technologies Alliance, 2017 https://www.advancedoxford.com/project/oxfordshire-transformative-technologies-alliance-science-innovation-audit-2017/
2. Oxfordshire Local Industrial Strategy 2019 https://www.oxfordshirelep.com/publications
3. https://www.advancedoxford.com/green-recovery/
4. https://www.advancedoxford.com/project/skills-and-talent/

Measures of success and the 2013 recommendations

A decade of progress?

The Oxford Innovation Engine – Realising the Growth Potential **report (2013) identified four measures of success that would help to determine whether Oxfordshire, when viewed in the future, had built on its position as a leading high-tech cluster and had fulfilled its potential for growth. The report also set out recommendations for action, which were intended to generate greater economic benefits from Oxfordshire's assets, in ways that would enhance, rather than detract from, the attractions of the place. These recommendations for action were considered to be both in the interests of Oxfordshire and the UK. A decade on, have these measures of success been met?**

Consideration is also given to the recommendations that were set out in 2013 (the full set of recommendations from 2013 is available on page 64). However, in so doing, the relevance of the recommendations must also be assessed, when viewed from the vantage point of 2023.

What did success look like in 2013?

The four measures of success were:

1. A positive contribution to the national economy of at least £1bn Gross Added Value at constant prices within 10 years.
2. Stronger and more productive relationships between Oxfordshire's high-tech businesses, the universities and research institutions.
3. Substantially higher levels of private and public investment in Oxfordshire.
4. 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 local and national benefits, whilst also achieving global impact.

> "Some of the recommendations are still very topical, others more anachronistic"
>
> **Advanced Oxford member**

Of course, in assessing these measures, a starting point is the question, *how do you measure success?* Both the 2013 and 2016 reports were silent on this point and indeed, even where there is opportunity to take a quantitative approach – with the first and third measures – no baseline was provided in 2013, and no proposed methodology was captured. The measures on 'relationships' and perceptions of the 'commitment to growth' are subjective. Consequently, the approach taken has been to look for data that can help determine the level of progress where it is available, but otherwise to gather views on the subjective measures.

1 At least a £1bn Gross Added Value within 10 years

Gross Value Added (GVA), which is the value generated by any unit engaged in the production of goods and services, is estimated at a regional level by the ONS on an annual basis.

No baseline was provided in 2013, nor was there any attempt to determine how this would be measured or assessed. In attempting to answer the question as to whether this measure has been achieved, ONS estimates of balanced gross value added (GVA) have been used, allocated to local authorities in the UK. These data are classified as National Statistics, according to the Code of Practice for official statistics.

The most recent available data has been used for each year from 2013 up to 2020.[5] As a consequence, there are only 8 years of data to draw upon; therefore an attempt has been made to determine how well we are doing so far.

GVA estimates are calculated on a workplace basis, allocated to the location where the economic activity takes place. ONS presents GVA estimates in "real" terms, with the effect of inflation removed, referred to as chained volume measures (CVM). Due to the geographical focus and industry breakdown presented in these statistics, some of the figures can be rather volatile and there may be erratic movements in the time series, therefore caution should be used in interpreting the data. Consequently, as well as comparing the most recent data (2020) with data for 2013, the cumulative GVA (summed across years) is also presented. It should also be noted that the latest year's data (2020) are provisional.

A further complication when trying to assess the GVA contribution of Oxfordshire's innovation businesses is associated with data being broken down by industrial groupings, not to individual standard industrial categories of economic activities (SIC) codes.[6] Three groups have been used as proxies for the knowledge economy: telecommunications and information technology (codes 61 – 63); R&D, advertising and market research (codes 72 and 73); and other professional scientific and technical activities (74).

TABLE 1: GVA for Oxfordshire, by industrial groupings, by year (all data in £millions)

Knowledge Economy Group	Year								Difference 2020 vs 2013
	2013	2014	2015	2016	2017	2018	2019	2020	
Telecoms and ICT	558	558	591	575	579	608	560	494	-64
R&D, market research	844	1073	1329	904	1048	1088	1363	1999	1155
Other R&D and technnical	109	153	162	220	174	166	163	108	-1
Total GVA p.a.	1511	1784	2082	1699	1801	1862	2086	2601	**1090**
Total cumulative GVA across all years (2013 – 2020)								**15,426**	
Difference in total GVA per annum in comparison to 2013 used as a baseline		273	571	188	290	351	575	1090	
Summed difference in GVA per annum between each year and the 2013 baseline								**3338**	

Source: ONS

5. https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry. Data used are part of the Regional economic activity by gross domestic product dataset published by the ONS on 30 May 2022.

6. https://www.gov.uk/government/publications/standard-industrial-classification-of-economic-activities-sic

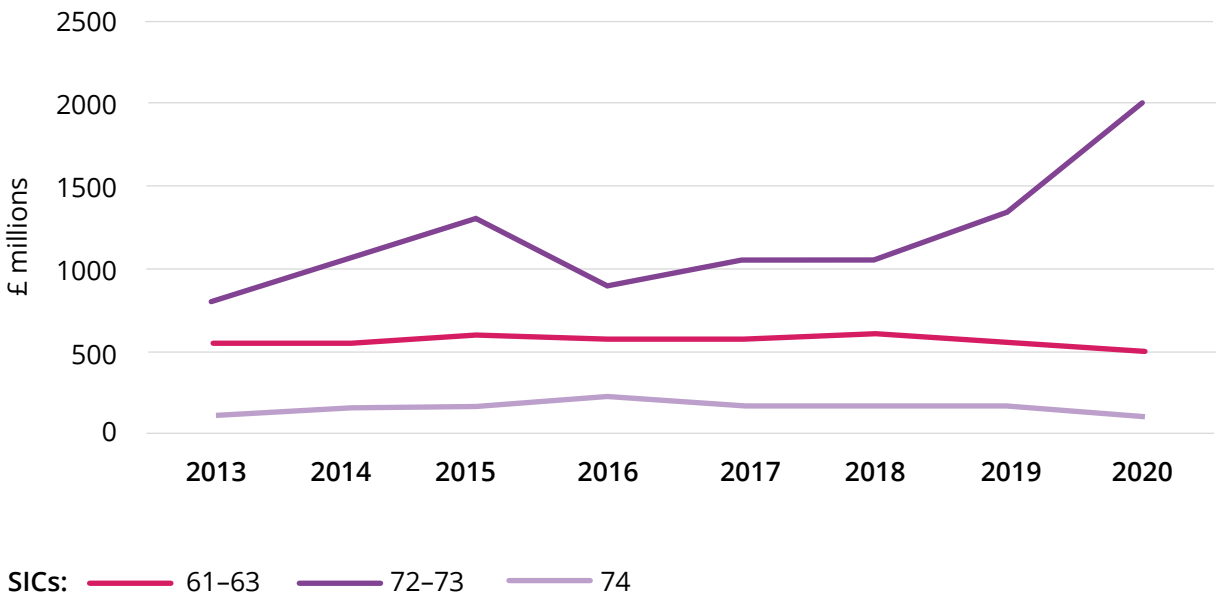
These SIC groups are similar, but slightly different to the Eurostat high tech/knowledge intensive definitions and therefore provide the best approximation of the GVA contribution of the knowledge economy in Oxfordshire that can be derived from national statistics.

GVA levels have remained stable for companies with SIC code 74 and have fallen by around 11.5% for telecoms and ICT related companies, when compared to 2013 GVA levels (the fall is slightly less, 11.3% when compared to the mean across the 8-year period). On the other hand, there has been considerable growth in GVA for the companies with SICs 72 and 73, particularly in 2020. The difference between GVA contributed by this group of companies in 2020, when compared to 2013, is £1,155 million. When the decrease in other groups is added in, the GVA contribution across the knowledge economy has increased in the 8 years from 2013 to just over a billion pounds: £1,090 million. The cumulative contribution over the eight years is over £15 billion. If the 2013 GVA contributions were taken as a baseline, and the additional GVA contributed each year is summed, this provides an additional GVA contribution of over £3 billion (£3,338 million).

> … the ambition to add another £1 billion to the economy from knowledge economy activities has been met.

While caution must be applied to these data, given the 2020 data are provisional, and recognising that there will be a contribution from the advertising, media representation, and PR activities, captured by SIC 73, (estimated to be between 300 and 340 companies across Oxfordshire), it would appear that by any measure, the ambition to add another £1 billion to the economy from knowledge economy activities has been met.

CHART 1:
GVA per annum (2013 – 2020) by industry group, set out in the legend with the relevant SIC codes



Source: ONS

2 Stronger and more productive relationships between Oxfordshire's high-tech businesses, the universities and research institutions

It is interesting to note that this success measure, and associated recommendations from the 2013 report, were focused almost exclusively on the University of Oxford, with some reference to joint appointments with the Harwell campus.

The report identified a need for the University of Oxford to improve visibility, particularly in relation to inter-disciplinary research, and to improve signposting for firms that might be looking for relevant research capability and expertise. By 2016, the update noted that the University was developing a new innovation strategy and that the technology transfer organisation, (ISIS Innovation), was being restructured, becoming Oxford University Innovation in 2016.

The University's website is more intuitive than it was in terms of navigating from the home page to various engagement options and this helps to cut through the complexity that lies beneath. The University's response to Covid 19, in particular the "Oxford Vaccine," has also become a useful shorthand for university research that can solve big problems jointly with industry and has been valuable in communicating an openness to engage with industry.

Nevertheless, many companies still find the University and other regional research institutions too complicated in terms of finding the right solution for a given commercial challenge. While the original OIE report was effectively silent on the research and contribution from Oxford Brookes University, there is still very little cross-institutional knowledge sharing and companies with a strong heritage in the University of Oxford do not know what is available at Oxford Brookes, nor how to find relevant capability or activity, outside of academic literature reviews as a means to search for academic collaborators.

There are few honest brokers or front doors that can direct companies to the relevant departments at either institution, or indeed to other locations such as Culham and Harwell. Feedback from companies in relation to this issue suggested that a landscaping exercise to see what knowledge transfer initiatives already exist within Oxford and Oxfordshire could be a useful first step.

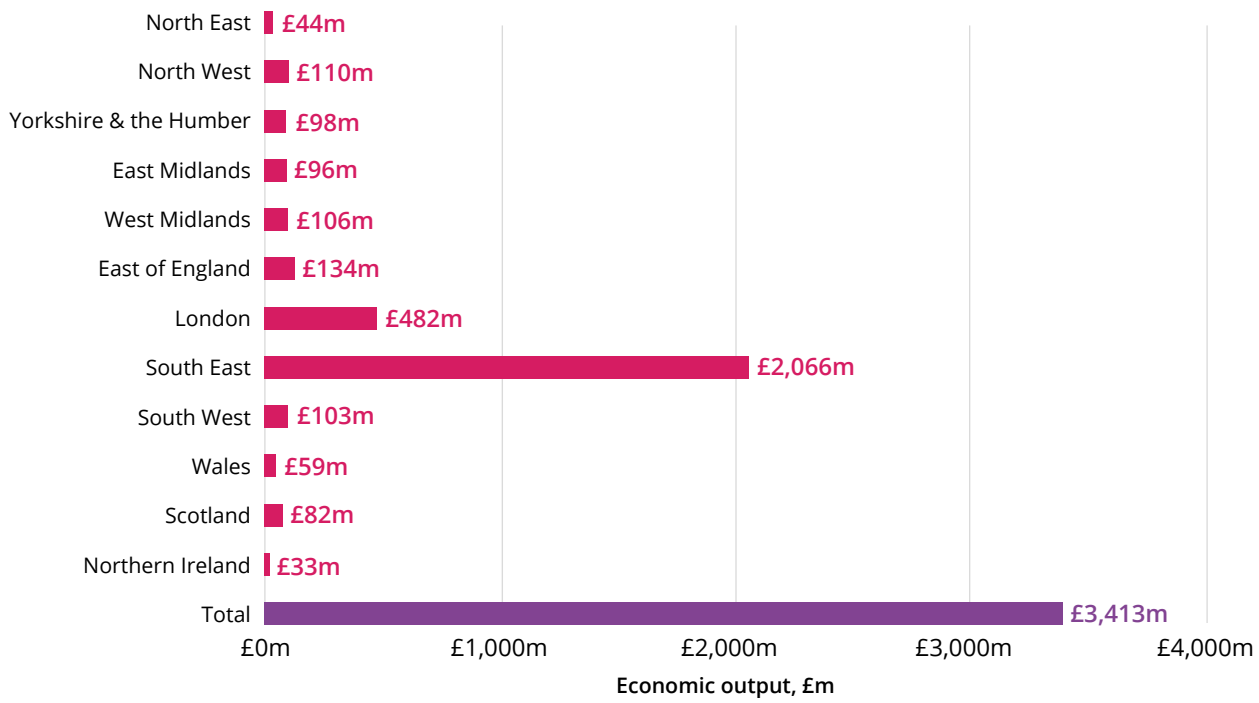
IMAGE COURTESY OF PROJECT ESO

Oxford Brookes University has a newly established Directorate for Research, Innovation and Enterprise (RIE), which aims to strengthen activities in these areas. The work of the Directorate builds on Brookes' achievements in the most recent Research Excellence Framework (REF 2021) which judged 97% of Oxford Brookes research to be internationally recognised, of which 70% was deemed to be world leading or internationally excellent. The Directorate has been created to drive forward Brookes' ambitions in relation to research and innovation.

The Directorate's work on knowledge exchange and impact facilitates collaborative work with industry, through mechanisms such as Innovate UK Knowledge Transfer Partnerships, while the enterprise arm is focused both on supporting students, staff and recent alumni to develop entrepreneurial skills, and on providing space and support for spin-outs and start-ups through the Brookes' Enterprise Centre. RIE now provides a first point of entry for stakeholders to access the community of researchers, innovators, and entrepreneurs across Brookes' four faculties.

The Research England Knowledge Exchange Framework (2021) scored the University of Oxford as having very high levels of engagement for research partnerships; IP and commercialisation; working with business; and public and community engagement, when benchmarked against other very large, very high research-intensive, broad discipline universities. The University of Oxford's approach, is set out in its Knowledge Exchange Strategy[7] which was commended by HEFCE for its "focus on sustainable local growth, supporting the Oxfordshire high-tech cluster, and working closely with public and private sector partners and local communities."

CHART 2:
Total economic output associated with the University of Oxford's knowledge exchange activities for 2018–19 by region



Source: London Economics' analysis, presented in The Economic Impact of the University of Oxford. Estimates rounded to the nearest million.

7. https://researchsupport.admin.ox.ac.uk/files/knowledgeexchangestrategypdf

The University's scale, quality and impact of knowledge exchange has improved significantly in the period since the 2013 OIE report and the knowledge exchange strategy commits the University to further improvement. Two examples of the University of Oxford's approach have been the creation of the BioEscalator and the pilot for The Energy Systems Accelerator (TESA).

The BioEscalator was fully occupied within months of opening its doors in 2018 and has been operating at capacity ever since, prompting development of a plan for a second facility. Over 30 companies have been supported in the BioEscalator to date (February 2023), and collectively they have attracted over £1.6bn of funding and investment and created over 260 jobs.

In June 2022, the University opened a pilot of The Energy Systems Accelerator (TESA). The pilot will experiment with methods for collaborative innovation and help design a full-scale TESA that will underpin development of an innovation district in the heart of Oxford. This project is one of the core projects from the Oxfordshire Local Industrial Strategy, and is funded by regional funds awarded through the Oxfordshire Local Enterprise Partnership (OxLEP) Get Building Fund. TESA now co-locates 100 people from academic research, a networks supplier, social enterprise The Low Carbon Hub, and businesses, with the aim of facilitating the creation of a super energy systems cluster and to accelerate innovation.

Alongside Oxford's two universities, other institutions within the region have also developed ways of opening their doors to collaboration and research partnerships. In 2019, the Science and Technology Facilities Council (STFC) launched a proof-of-concept programme called the Harwell Cross-Cluster Industrial Engagement Proof of Concept Grant, offering grant funding to stimulate collaborative research projects between businesses and the organisations across the Harwell Campus. The call supported projects that linked firms with academia, commercial and research organisations. The programme has now run a number of funding rounds, with the most recent competition closing to applications in

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November 2022. Again, with the aim to stimulate business engagement, business-led projects must involve one or more project partners at Harwell Campus. The programme has now been extended to include Sci-Tech Daresbury and additional funds have been made available for projects undertaken with the National Quantum Computing Centre (NQCC) and with the MTC – Manufacturing Technology Centre, the latter establishing an Oxfordshire hub at the Culham Science Centre in 2023.

Similarly, a competition launched by the Rosalind Franklin Institute in the autumn of 2022 gave UK life science SMEs the opportunity to access the latest technologies and high-level scientific support worth up to £50,000. Although only one winning company will take part in a 12-week residency starting in 2023, the competition provided for shortlisted companies to take part in a workshop to discuss their ideas with Franklin scientists, to help them develop a full project plan.

It is clear that knowledge exchange, with new mechanisms to support stronger and more productive relationships between Oxfordshire's high-tech businesses and the region's universities and research institutions, has been a focus over the last decade. Communication has improved in the last 10 years, but there is still room for improvement. There is great capability, but some companies still experience challenges in finding expertise and collaboration partners, so there is a continuing need to create transparency, to open up information and to further develop a joined up, industry-facing, academic and research environment across the whole of Oxfordshire.

3 Substantially higher levels of public and private investment into Oxfordshire

Although there is no baseline, nor indeed any starting point from which the concept of substantial investment can be judged, it would appear that there has been positive progress with regard to this measure of success.

There has been a strong record of public sector investment into Oxfordshire's science and technology environment, including:

- Continued support from Government for the fusion cluster and campus at Culham. Canadian firm General Fusion has chosen the site as the location for its demonstration plant; Culham Science Centre and UKAEA plan to build a new 8,000 square metre R&D building; Oxfordshire Advanced Skills opened a newly-fitted out building at Culham in 2016.
- National research institute, the Rosalind Franklin Institute, started construction on its 5,300m^2 hub in 2019, with the building on the Harwell Campus opening in 2021.
- University of Oxford's medical science-focused BioEscalator, home to spin-out and start-up companies, opened in 2018; The Oxford Trust's Wood Centre for Innovation, also located in the Headington area of Oxford, opened in 2019 and Oxford Brookes University has recently created a new Enterprise Centre and Bioinnovation Hub, supported with capital funding from Oxfordshire LEP, which launched in 2022.
- Harwell Campus was also selected as the location for the Nucleic Acid Therapy Accelerator (NATA), a £30m investment from the UK Strategic Priorities Fund through the MRC and UKRI. The campus will also house the UKRI National Quantum Computing Centre facility, currently under construction.

Looking at equity investment into the industrial base, there are now an array of business analysis platforms that track investment into companies,

There has been a strong record of public sector investment into Oxfordshire's science and technology environment

with a range of methodologies. This report does not contain detailed data on investment levels, although this is likely to be follow up work to this report, to be undertaken by Advanced Oxford. However, there have been some positive developments within the investment landscape, which would suggest that the levels of private investment into companies have continued to fare well, recognising that investment levels fluctuate year to year. Milton Park has recently published data relating to investment in companies located within the science and technology park. $2.14 bn of equity investment has been raised across 272 companies that have premises on the park since 2013.[8] The investment landscape is explored in more detail later in this report (see the section on the innovation ecosystem and business environment on page 41).

In recent years, 15–20 companies are typically formed as University of Oxford spin-outs through the technology transfer office, Oxford University Innovations (OUI). Oxford Science Enterprises (OSE) was established in 2015 having raised over £600m to invest into University of Oxford science and technology driven spin-outs. In the first three years of OSE operation, from March 2015, OSE invested in 44 companies, of which 73% were investments with other investors. During the same period OUI formed a further 28 companies where OSE was not an initial investor.[9] OSE has gone on to raise a further £250m to support its

8. https://www.miltonpark.com/news/milton-park-companies-secure-over-7-of-uk-s-life-sciences-investment/

9. Source, OUI

IMAGE COURTESY OF THE ROSALIND FRANKLIN INSTITUTE

> Another area of considerable growth within the region has been investment into science and technology infrastructure

activities and has invested in over 85 companies, helping progress 28 from seed to Series A and 22 to Series B and beyond, including 2 IPOs and 7 trade sales. (See the OSE case study in the innovation ecosystem and business environment section of this report).

The University of Oxford is not the only source of new companies across the Oxfordshire region. In the eight years that OSE has been operating, over 1,970 science and technology-focused companies have been started with a registered office in Oxfordshire,[10] with around 2,850 knowledge-focused companies having been started in the last decade (further data is provided in the dynamics of the innovation ecosystem section of this report).

Another area of considerable growth within the region has been investment into science and technology infrastructure, particularly new innovation campuses and sites and the development of existing science parks/ campuses. Innovation real estate is considered further in this report in the section on the innovation ecosystem and business environment. Notable among the development in Oxford is Oxford North, a joint venture between Thomas White Oxford, the development company of St John's College, Oxford, and Stanhope, which is under construction, and development of The Oxford Science Park, owned by Magdalen College Oxford. Madgalen College entered a Strategic Partnership to accelerate the development of The Oxford Science Park with GIC, a global long-term investor, in 2021. Other investments include Evotec's expansion on Milton Park and the opening of The Bee House; the acquisition of Oxford Business Park (now ARC Oxford) by Brookfield and masterplan development for the University of Oxford Begbroke Science Park through the University and Legal and General's joint venture, Oxford University Development. The formation of Oxford University Development, a £4bn partnership, is also advancing the development of affordable staff and student housing co-located with the science and innovation districts in and around Oxford.

A very positive picture therefore emerges in relation to both public and private investment into the region.

10. Source, mnAi – companies incorporated between 1st January 2015 and 15th December, 2022, using SIC codes 61, 62 and 72 and a registered office within Oxfordshire.

4 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 local and national benefits, whilst also achieving global impact.

This is perhaps the most difficult measure to assess, as it is based on perception. Nevertheless, it is almost impossible to consider this measure of success without reflecting on the impact that the Covid-19 pandemic has had on Oxfordshire's global reputation in medicine, life sciences, diagnostics, and data. Oxfordshire's response to the pandemic focused on the rapid development of the vaccine, a collaboration between the academic, clinical, and industrial base within the region and beyond, but other critical developments, such as rapid implementation of the RECOVERY drugs trial, were driven from Oxford and Oxfordshire-based expertise.

It is easy to focus on life sciences and the significant impact and activity that is based within the region, from companies like Immunocore, Oxford Nanopore and Vaccitech, but Oxfordshire's high-tech community is characterised by its breadth, as well as its depth of expertise. Two of the leaders in commercial fusion energy research and development are based in the region: First Light Fusion and Tokamak Energy. Innovation in autonomy and automotive technologies outside of the well-recognised world of motorsport are being pioneered by companies like Oxbotica and Saietta. The region is home to a growing group of companies commercialising quantum technologies, while materials science, chemistry and data science are at the heart of other groups of companies. It becomes difficult to pin the region to a small number of technologies or competences.

Nevertheless, as noted in the introduction to this report, there is a continuing need to position and communicate the importance of the region's innovation ecosystem to decision makers, to politicians at the local and national level, to the innovators and entrepreneurs who choose to start, grow, or locate their science enterprises in the county and to potential inward investors. Equally, there is a need to convey the importance of what happens in our region to the citizens of Oxford and Oxfordshire, because their support

> The Oxfordshire ecosystem is using science and technology to address real world problems and global challenges

is needed if the value and prosperity which can be achieved from turning exciting ideas into products and services is to be realised. The Oxfordshire ecosystem is using science and technology to address real world problems and global challenges, not just for the people of Oxfordshire or the UK, but for all.

The Oxfordshire Innovation Engine 2013 noted there were 'ambiguous attitudes towards growth' across the region. Oxfordshire is lacking strong, economically-focused, representatives, advocates, and cheer leaders. The innovation community must continue to engage and bring its voice and influence to decision making, planning and make the case for investment. The benefits that the region's high-tech community can bring in addressing pressing societal, technological, environmental, health and sustainability challenges need to be recognised and celebrated. Oxfordshire is a place that can identify, develop, and provide solutions to the world, but there is a need to be proactive in telling Oxfordshire's innovation story – not everyone knows how rich, varied and successful this ecosystem is.

2013 recommendations

Alongside the measures of success, the *Oxfordshire Innovation Engine* 2013 report set out a number of recommendations under the themes of research infrastructure; soft infrastructure; physical infrastructure; and leadership and messaging. The full set of recommendations from 2013 can be found as an annex to this report. Most issues contained within the recommendations are addressed within this document, particularly in the sections on the business environment and the dynamics of the ecosystem sections. Nevertheless, it is worth making observations regarding some of the recommendations, specifically those that are not addressed elsewhere in this report.

RECOMMENDATION FROM 2013

Lobby Government to improve, and 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.

The view expressed by companies[11] within the region is that, while the system has changed, the situation has deteriorated. Migration and visa requirements have changed dramatically due to Brexit. The visa application process is onerous, and applications can be rejected on a technicality. Companies now have to rely on consultants to support this process – uncertainty, additional cost and additional time have been introduced into the system. These views were also expressed repeatedly during the research undertaken for Advanced Oxford's research on skills and talent, *Attract, Retain, Grow*.[12]

RECOMMENDATION FROM 2013

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.

Workshop discussion in preparation for this report suggested that there could be value in a tool that allowed companies to search for others within the locality, perhaps to help find potential collaboration partners. A view was expressed that it would also be interesting to see the evolution of the ecosystem over time. Company directories could also be used to support labour market analysis and as a resource for careers services. Nevertheless, there was no real enthusiasm for the creation of such a database.

A project to develop a company and resource map for Oxfordshire's innovation activity – the Oxford Cluster map[13] – was backed by OxLEP, OUI, Bidwells, University of Oxford and OSE (at the time Oxford Science Innovations). The resource still exists but has changed and no longer provides functionality to search for companies across the ecosystem. A key challenge, following its publication in 2019, was how to manage, resource, and maintain relevant and timely data relating to companies.

OxLEP has had a similar project under development since 2021, although currently on hold, entitled *Oxford Calling*, which was an attempt to draw together mapping, recruitment and promotion of the region. However, it seems likely that the challenges that faced the Oxford Cluster map have not been resolved and without active and widespread support for such a platform it will be difficult to deliver real value.

11. Data collected through workshops with Advanced Oxford members and through research conducted for Advanced Oxford's report, *Attract, Retain, Grow*

12. https://www.advancedoxford.com/project/skills-and-talent/

13. https://oxfordcluster.com/

RECOMMENDATION FROM 2013

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.

There is a more ambivalent view around this recommendation, particularly with regard to the question of networking. Generally, intra-clusters (science park/campus/sector) networks are considered to be working well, but inter-cluster networks are still not so well developed.

A recent review of Venturefest Oxford[14] identified changes in the knowledge economy landscape, with many other organisations and places playing a role in convening companies, promoting the region, and encouraging collaboration. Oxfordshire's science parks and campuses have developed their own events and networks/clusters. For example, University of Oxford's Begbroke Science Park held a three-day innovation festival for the first time in July 2022. The local/regional government environment has also changed significantly in this time. Oxfordshire Local Enterprise Partnership (OxLEP) has also played a role in bringing together the innovation economy and running conferences and events.

After 23 years of operation, the board of Venturefest Oxford has concluded that the Oxfordshire innovation ecosystem, having grown hugely, is now too big and too complex to bring together all the key players around one annual, all-encompassing event, particularly given there are many other organisations, institutions and places across the region that are convening clusters and delivering high quality events which also offer networking opportunities, thought leadership and discussion.

It is also worth noting that the effects of repeated lockdowns and the associated challenge of organising face-to-face events and conferences in the wake of the Covid pandemic has taken a toll on the success of meetings and networking activities. There now appears to be a much greater reluctance to attend events, which may be more to do with convenience and the challenges associated with travel arrangements, rather than fear of engaging in person.

Nevertheless, there is demand for high-quality, engaging, networking events that bring different members of the ecosystem together. The region will continue to require champions, willing to convene people around specific challenges, issues, or sectors. In some instances, this will be driven by networking organisations, such as Oxford Biosciences Network (known as OBN) or the BioIndustry Association (BIA) – established networks in life sciences – meet-up or interest groups, by the growing number of sizeable professional services firms in the region, or by institutions like Oxford's universities, STFC, the NHS or local/regional government. Opening these meetings and events to the widest participation will be key, and again, this is an activity where honest brokers and signposting is needed to ensure that the calendar of events is widely communicated and contributes to joining up the ecosystem.

Conclusions

If the commissioners and authors of the *Oxfordshire Innovation Engine* 2013 report had been able to travel forward a decade and assess the innovation ecosystem as it is now, it is likely that they would have been pleased with what they found. There has been positive progress across all measures of success, and they may well have concluded that the challenges and opportunities presented within the report had been noted, considered, and acted upon. Despite some unforeseen and significant events in the ten years that followed the publication of the report, the Oxfordshire science and technology-related ecosystem has strengthened and is a significant contributor to the UK and to Government's ambitions for the country to be a scientific superpower. While a number of the recommendations are no longer relevant, the majority continue to speak to issues that concern the region's innovation community. They remind us that the region must continue to work together to ensure that Oxfordshire remains an engine room for innovation, but that there are long-term challenges that must be addressed with ambition, with all actors working in the interests of this region and what it can achieve.

14. https://venturefestoxford.com/ The Future of Venturefest Oxford, 2023

Dynamics of the Oxfordshire Innovation Ecosystem

The Oxfordshire innovation ecosystem has its foundations in the region's institutions: Oxford's two universities, world-leading scientific infrastructure in locations including Harwell and Culham, and, from a life sciences and health perspective, the region benefits from research intensive hospitals and community health services. However, it is the richness, breadth and depth of the industrial base which acts as an engine room for innovation. In this section, the changing characteristics of the knowledge economy – and the businesses that drive this activity – are considered.

The stock of innovation-based companies

Innovation is a broad concept, and from a business perspective, it can be considered in the context of companies that engage in the development of new products and services, and/or from the perspective of companies that are innovating the way that they operate, to drive efficiencies, improvements or productivity gains within a business. This report considers the first category – the companies that are commercialising ideas through science, technology, engineering, maths and data to generate new products and services. Many of these companies will also be 'process' or 'organisational' innovators.

The Oxfordshire Innovation Engine 2013 report used Government's Inter-Departmental Business Register (IDBR) to quantify the stock of Oxfordshire-based businesses across all sectors of the economy, identifying around 33,500 companies. Using Eurostat definitions,[15] the stock of high-tech businesses was estimated at around 2,000, but the authors revised their estimate of the stock of high-tech businesses to around 1,500, based on company databases and directories.

Research for this report has identified around 2,950 high-tech businesses (February, 2023) with an attempt to identify the number of truly innovative businesses which is estimated to be around 1,500.

There are many challenges in compiling and comparing company related data as ONS and Government statistics use different data sets, some of which are based on workplaces within Oxfordshire, while data from Companies House is based on the registered address of a business, which may be very different from the place in which the activity occurs. No single data set has the full picture. The IDBR contains all businesses operating VAT and/or PAYE schemes, with estimates for very small businesses that are unregistered for PAYE or VAT, however, given the kinds of businesses that are likely to fall into the category of 'high-tech' or innovative, the IDBR is likely to pick up a reasonable number of companies with the SICs (standard industrial classification of economic activities) which act as identifiers for science and technology driven companies. These challenges and further details on our methodology is provided in a dedicated section of this report (see Methodology).

15. For details of the Eurostat definitions of technology and knowledge based firms, refer to the Methodology section of this report.

TABLE 2:
Number of high tech/knowledge intensive companies in Oxfordshire, compared to UK

Eurostat definition category	No. companies Oxfordshire (October 2022 data)	Total number of companies UK (October 2022 data)
High tech knowledge intensive	4,743	398.6k
High tech manufacturing	190	11,226
Broader definition knowledge intensive	7,899	617k
High and medium tech manufacturing	678	48.4k

Source: mnAI (2022) – based on companies registered with an Oxfordshire address, using the Eurostat definitions (see Methodology section).

TABLE 3:
The stock of innovation active companies within Oxfordshire

Data point and source	2013 (as reported in OIE)	Current data (based on most recently available data set, typically 2021/22 data)
Eurostat narrow definition high-tech businesses (IDBR)	2,000, revised by authors to approximately 1,500	2,950
Eurostat narrow definition high-tech – registered companies in Oxfordshire (Companies House data)	Not given	5,000
No. companies claiming R&D tax credits in Oxfordshire (2019/2020 data – gov.uk)	Not given	1,335
No. companies with a registered address in Oxfordshire using a SIC 72.1 (R&D in natural sciences and engineering) (Companies House)	Not given	600
No. companies registered for PAYE and/or VAT in Oxfordshire using a SIC 72.1 (R&D in natural sciences and engineering) (IDBR)	Not given	300
No. of Oxfordshire based companies that have received Innovate UK funding since 2004 (Innovate UK)	Not given	190
No. companies publishing in peer reviewed scientific journal with a registered Oxfordshire address since 2013 (Scopus)	Not given	310
No. companies named on patent applications published since 2013 with a registered Oxfordshire address (LexisNexis)	Not given	420
Estimated stock of innovative companies across the region (based on location of activity)	Not given	1,500

Sources provided for each data point. All numbers, excluding the R&D tax credit data rounded to the nearest 10. Companies House data was extracted at the end of 2022. The estimated stock of innovative companies across the region has been compiled by Advanced Oxford and Elsevier, cross referencing a number of different data sources. For further details refer to the Oxfordshire Innovation Dashboard (https://www.advancedoxford.com)

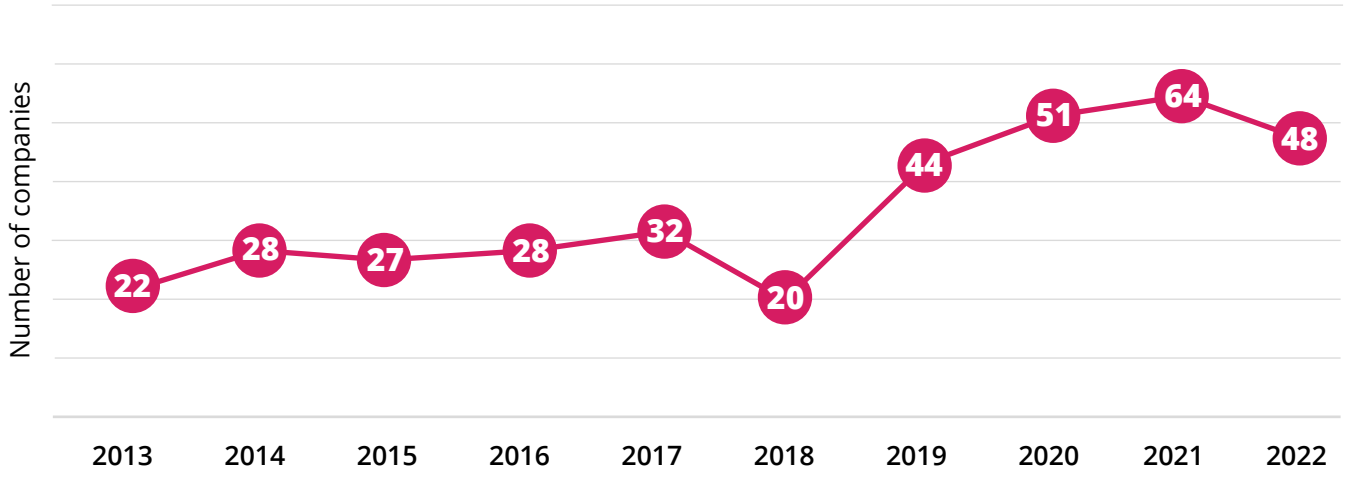
Company birth and death rates

When comparing data from 2013 with current data sets, it appears that the number of innovative (science, technology, engineering, maths, and data driven companies) operating within the region is around 1,500. When comparing numbers of companies defined as 'high-tech' it would appear that the number of companies has grown over the last decade. This also seems likely when the rate of company formation is considered, particularly observing the increasing number of spin-out companies being generated by the University of Oxford. Company birth and death rates over the last ten years contain useful insights into the dynamics of the ecosystem.

Data for three groups of companies has been examined in relation to company formation: scientific and technical R&D related companies, high tech manufacturing and ICT focused companies. 2,850 companies started across these three groups (companies with a registered address in Oxfordshire) in the last ten years (1 January 2013 to 31 December 2022), the majority of which were ICT companies (84% - 2,382 companies). If company starts are approaching 3,000 companies in the last decade, how does this report conclude that the stock of innovation-related companies is half that level? In producing the report, data from numerous sources has been cross-referenced and activities of many companies have also been verified. The conclusion is that a large number of companies apply an ICT related SIC to their business, even if this is not a core activity, for example a clothing retailer that deploys an e-commerce platform. These companies may be process or organisational innovators, but they are not using science or technology to produce new products or services. The ICT companies that are innovating are those that are developing new software or algorithms to underpin data platforms and analysis. These are the ICT companies included in the stock of 1,500, which also contains pre-existing companies (those founded before 2013).

Just over a hundred high-tech manufacturing companies started in the last decade and 364 R&D focused scientific and technical companies were incorporated. In the period 2013 to 2018, the rate of scientific R&D focused company formation was reasonably stable with a mean of 26 companies starting per annum. In the four years to, and including 2022, the rate appears to have increased, with a total of 207 company starts, with a peak of 64 in 2021. It should be noted that all data on company starts relates to companies that have started in the period since 1 January, 2013 and are still active. Any company that has started and closed in the last decade is not included in this data set.

CHART 3:
Scientific and technical R&D focused company formation (2013 – end of 2022)



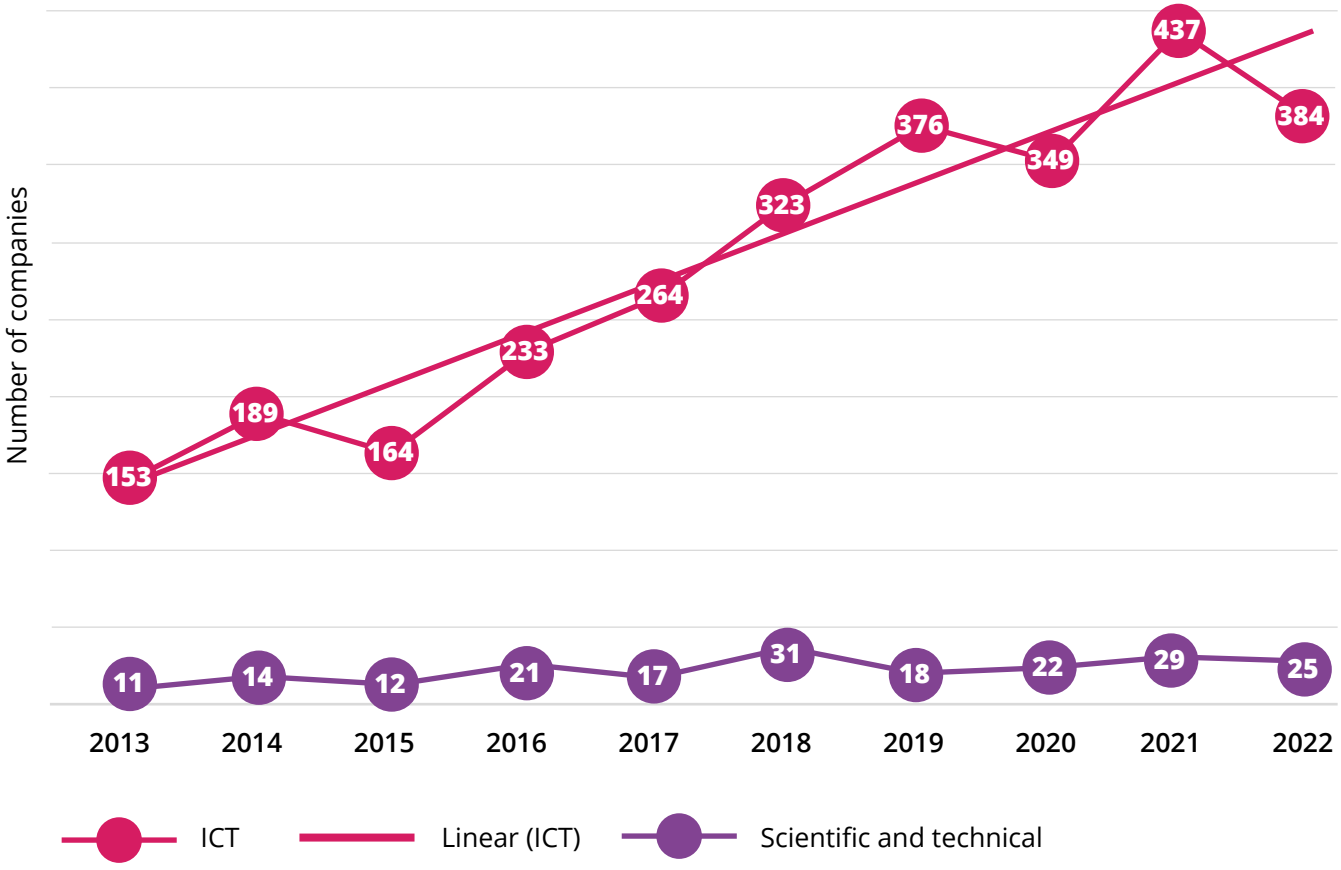
Source: mnAI

Data relating to company closures can also be helpful in understanding the health of an ecosystem, particularly when considered in relation to the total stock of companies, or the birth rate of companies within the same sector/SIC categories. However, the numbers also hide changes and reorganisations, that do not necessarily mean that a company has closed or ceased to trade completely. For example, when looking at high tech manufacturing, Oxford Instruments Plasma Technologies Ltd closed in 2019, after more than 37 years of operation. In fact, the company had been dormant since 2010 and its assets and activities were transferred to Oxford Instruments Nanotechnology Tools Ltd. Similarly, Circassia closed Circassia Pharma Ltd, but the company continues to operate from The Oxford Science Park, and the Oxford Gene Technology company group closed Oxford Gene Technology EBT Ltd.

There has been no attempt to determine why companies closed and whether they were voluntary winding-up or liquidations, for example due to bankruptcy. In all categories, there appear to be a cadre of companies – the oldest companies – that have reached ages of 35+ years and it might be reasonable to assume that these businesses closures relate to decisions by founders/Directors to withdraw from the labour market. At the other end of the spectrum, it is surprising, and in some instances puzzling, to see that across all years, and across different categories, there are companies that dissolve within months of incorporation.

During the ten year period, again looking at 2013 through to the end of 2022, the region saw around 3,150 company closures across ICT, high tech manufacturing and scientific and technical industry groups (based on a company registration address in Oxfordshire) with the majority, 91%, falling in the ICT sector group. It is not entirely clear why there are such high levels of closure within the group of companies that use an ICT related SIC to categorise themselves. As noted in relation to company starts, many companies apply an ICT related SIC to their business, even if this is not a core activity, so further analysis may reveal that these companies are not truly

CHART 4:
Company closures (scientific and technical R&D and ICT companies) 2013 to end of 2022



Source: Company closure data (source mnAI)

ICT related businesses. Based on the data presented in this report, it appears that more ICT category companies (3,150) have closed in the last 10 years than have started (2,382), so the total stock of these companies within the region is reducing. Although the pandemic may have had an impact on company starts and stops, chart 4 on page 22 demonstrates the closure trend in ICT companies within Oxfordshire is up.

The number of company closures remained relatively stable across the decade in the manufacturing and scientific and technical R&D groups, with a mean of 8.4 company closures in the high-tech manufacturing group and a mean of 20 company closures in the scientific and technical group.

Employment

It is extremely difficult to gather accurate employment data relating to the knowledge economy. It is possible to pull headcount data from company accounts, but as accounts are submitted retrospectively, data may not be particularly up to date. Various approaches to solving this issue were considered, but recognising the considerable effort required in collating, validating and analysing data, it was decided to use ONS's Business Register and Employment Survey (BRES). This provides estimates for employment but given the rapid scale up of some knowledge economy companies, it may well under-state the level of employment. The methodology applied by the ONS to BRES was changed in 2015, with PAYE only companies included in the sample used to estimate employment numbers. Given that the numbers cited in the 2013 and 2016 reports were from BRES estimates generated prior to 2015, caution must be applied when comparing data over the last decade. Nevertheless, the substantial increase in employee numbers across the knowledge economy sectors, both narrow and broad definitions (again using Eurostat definitions) suggests that there has been real and significant growth in employment within the region relating to knowledge-economy companies. However, there has been a fall in employment relating to manufacturing and, given the small number of companies in the region (see data in table 2 on page 20) this may not be surprising.

TABLE 4: Oxfordshire employment data

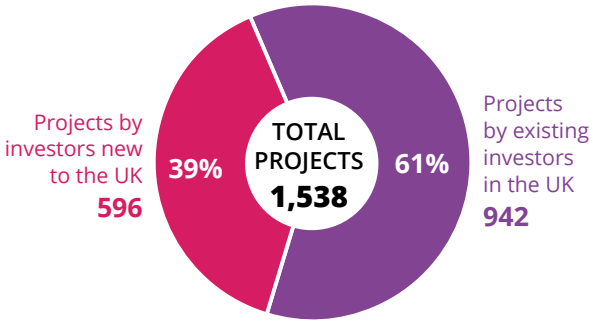
	Employment 2011 (reported in OIE 2103)	Employment 2014 (reported in OIE 2016)	Employment (2021 data)	% difference (+/-) 2021 data in comparison to 2011	% difference (+/-) 2021 data in comparison to 2014
Total employment	371,500	400,600	434,000 (2020 data)	16.8%	8.3%
Total employees	320,600	341,500	369,785	15.3%	8.3%
Science and technology (SIC 72.1)	Not reported	Not reported	12,000	–	–
High tech knowledge intensive	16,000	16,800	28,965	81%	72.4%
High tech manufacturing	4,000	3,800	2,890	-27.8%	-23.9%
Broader definition knowledge intensive	29,900	33,700	52,365	75.1%%	55.4%
High and medium tech manufacturing	13,100	12,400	12,065	-7.9%	-2.7%

Source: BRES, NOMIS
Comparing data reported in 2013 and 2016 with the most recent BRES estimates.
The difference between employment and employees relates to self-employment, partnerships etc.

Foreign Direct Investment into the region

Analysis by FDi Intelligence suggested that the UK had 981 foreign direct investment (FDI) projects in 2021, an 11% increase when compared to 2020,[16] whereas the Department for International Trade (DIT) reported a total of 1,538 FDI projects in 2020/21, a decrease on the previous year and a significant reduction from the peak of 2,265 in 2016/17.[17] FDi Intelligence also reports the UK received a fifth of Europe's capital investment in 2021 ($US43.4bn). UK outbound investment for the same period was $US37.4bn (1417 projects).[18] Regionally, the south-east of England, including London and Oxfordshire, fares well, with 2,732 FDI projects between December 2017 and November, 2022.[19]

CHART 5:
Breakdown of 2020/21
FDI projects into the UK



Source: DIT

FDi Intelligence produced rankings for UK Local Enterprise Partnerships, (LEPs), placed Oxfordshire as the third ranked LEP, rising from 11th place in the 2018/19 study, however the 2023 ranking places Oxfordshire in 10th position, behind London (1st) and Cambridge and Peterborough (3rd), although OxLEP is ranked 1st for FDI strategy.[20]

The 2023 European Cities and Regions of the Future ranks cities for FDI on size, with Oxford sitting within the 'small European cities' category (a small city is considered to have an immediate population of 100 – 350k). Four UK cities are ranked in the top ten, with Oxford ranked 10th – Reading is placed 3rd, Cambridge 7th, and Slough is in 9th position. The 1st place sits with Basel, Switzerland.

Oxford appears in the overall FDI rankings, scores well for human capital and lifestyle, but does not appear in other categories that are ranked. Performance is ranked across five subcategories: economic potential; business friendliness; connectivity; human capital and lifestyle; and cost effectiveness. No UK city appears in the cost effectiveness ranking – all ten are located in Eastern European countries. FDI strategy ranking is a judged category, based on submissions from inward investment related organisations and it may be that Oxford, as a city, did not provide a submission on FDI strategy.

TABLE 5:
Small European Cities rankings, European Cities and Regions of the Future, 2023

	Overall for FDI (top 10)	Human capital & lifestyle	Connectivity	Business friendliness	FDI Strategy
No. UK cities in top 10	4 out of top ten	2 out of top ten	2 out of top ten	5 out of top ten	3 out of top ten
Oxford's ranking	10th	2nd	Not ranked	Not ranked	Not ranked
1st place	Basel	Nicosia	Slough	Reading	Braga (Portugal) and Wolverhampton

Source: FDi Intelligence

16. The FDI report, 2022, FDi Intelligence
17. Department for International Trade inward investment results 2020 to 2021 (HTML version) – GOV.UK (www.gov.uk)
18. The FDI report, 2022, FDi Intelligence
19. The FDI report, 2022, FDi Intelligence
20. European Cities and Regions of the Future, FDi Intelligence

Most analysis of FDI data is not sector specific, so it is difficult to determine to what extent science and technology drives inward investment activity within regions and cities. Nevertheless, innovation-based investments have been a feature of the Oxfordshire region. Secured investments in the last decade include Astroscale, Novo Nordisk, BMW, Mercedes Benz following its acquisition of YASA, General Fusion at Culham and Abbott Diabetes Care at Witney. However, much of the FDI activity within the region has been expansions of existing activities, acquisitions, or significant investment stakes into Oxfordshire-based companies.

While Oxfordshire has been successful in attracting inward investment, it has not landed one big R&D investor, or significant investment from the tech community, although Moderna has recently announced its intention to establish its Moderna Innovation and Technology Centre at Harwell Campus[21] (March, 2023). Rather, Oxfordshire has successfully grown its own community of businesses, bottom up. The rate of company formation and growth is such, that Oxfordshire could successfully pursue a strategy of 'born in Oxford, raised in Oxford(shire)', although this is a long-term game. If the regional goal is inward investment, the ecosystem needs to work collectively to develop the strategy.

A recent (March, 2023) report from the Higher Education Policy Institute (HEPI) highlights the role that universities already play in attracting FDI to the UK and proposes that there is a clear opportunity for this to be expanded and enhanced. The report suggests that this can be achieved through better collaboration between universities, local partners, and government. The report recommends that local economic growth organisations should look to work with universities on longer term strategies to secure strategically significant inward investment[22] and identifies the need for universities to work together on FDI activities.

The question remains, what strategy should Oxfordshire pursue with regard to inward investment? Should the region try to attract a small number of big-ticket investments, or many medium sized investors? Regardless of the strategy, there needs to be an open and compelling offer, the entry point(s) for investors must be clear and there must be absorptive capacity to accommodate larger scale investment. With regard to home grown businesses, the focus should be on retaining companies within the region and being conscious and intentional about how spill-over benefits and functions, such as manufacturing, can locate and bring benefit to other parts of the UK as the ecosystem matures.

> The question remains, what strategy should Oxfordshire pursue with regard to inward investment?

Intellectual Property

The innovation activity of ecosystems is often judged or measured by the level of intellectual property (IP) that is generated. An analysis of patent filing data has been undertaken for this project by Mathys & Squire, using data from Filing Analytics. In table 3 (page 20), the number of companies named on patent applications, published since 2013, with a registered Oxfordshire address, has been used as a data point in analysis of the stock of companies within the region. This data was sourced from LexisNexis. As companies may file multiple patent applications, further examination of data is required, beyond the number of companies active in patent filings. As with other data sets, this analysis does not show the complete picture, as data relates to registered address. Companies that are active in registering IP within the region will not be included if the application is associated with a registered address outside the region, which is the case for example with Siemens, which has no registered address in Oxfordshire. The top-ranking Oxfordshire-registered companies that are active in filing patent applications are shown in table 6.

21. https://www.harwellcampus.com/moderna/

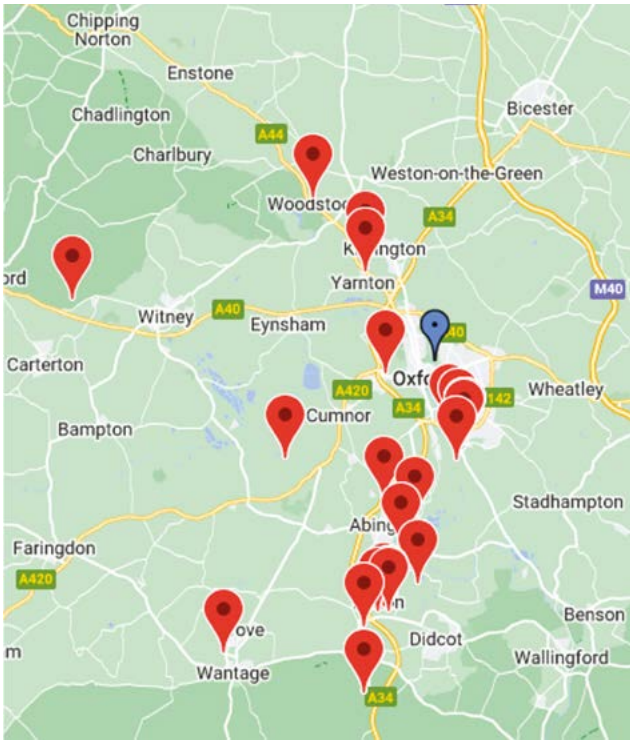
22. The role of universities in driving overseas investment into UK Research and Development, Higher Education Policy Institute, HEPI Report 157, 2023

TABLE 6:
Top ranking companies within the Oxfordshire ecosystem by number of patent applications in the last 5 years, to June, 2022.

Company name	No. of Patent Applications in 5 years to June, 2022
ELEMENT SIX	471
OXFORD NANOPORE TECHNOLOGIES	405
OWEN MUMFORD	349
INFINEUM	340
TOKAMAK ENERGY	283
IMMUNOCORE	214
ADAPTIMMUNE	191
CROWN HOLDINGS	169
EVOX THERAPEUTICS	156
MYOTEC THERAPEUTICS	156
SHARP LIFE SCIENCE	144
SOPHOS	141
WAVE OPTICS	118
ADAPTIX	115
OXIS ENERGY	115
OXFORD INSTRUMENTS	105
KARUS THERAPEUTICS	96
NEXEON	91
BIODYNAMICS	77
INTRABIO	76
MATOKE HOLDINGS LIMITED	76
IPSEN	73
OXFORD GENETICS	54
EMERGEX VACCINES	44
VELOCYS	30
JSP CORPORATION	27
OXFORD BIOTHERAPEUTICS	23

Source: Data sourced by Mathys & Squire, using Filing Analytics

MAP 1:
Locations of the most active IP (as measured by patent application filings) companies and institutions within Oxfordshire



Source: Based on data from Filing Analytics, courtesy of Mathys & Squire. For further mapping information relating to patent applicants, refer to the Oxfordshire Innovation Dashboard (www.advancedoxford.com).

Data was examined for the top 25 companies/ organisations/institutions by applicant name for the previous 5-, 3- and 2-year period. For each time series, the top-ranking entity in Oxfordshire was the University of Oxford. Data for Oxfordshire has been compared to a number of other innovation ecosystems/clusters, centred around Cambridge, Manchester, Newcastle, Southampton and Edinburgh, although in all comparators, the geographical area extends beyond the city into surrounding areas and towns/cities. It is clear from the underlying data, that individual companies, or institutions, can dominate an ecosystem in terms of patent activity. Although not shown in table 7 on page 27, if the Southampton area is extended to include Portsmouth, the total number of patent applications in 5 years increases dramatically to 8,688, over 7,000 of which have been filed by IBM. Similarly, in the Cambridge ecosystem, Arm Holdings is responsible for 2,372 of the patents within the 5-year data set, and is ranked as the top named applicant across all three time series.

TABLE 7:
Patent application for the top 25 applicants in each ecosystem, based on applications from 5 years, 3 years and 2 years prior to June, 2022.

	All applicants			University data			Applicants excluding university data		
Cluster	**Past 5 years**	**Past 3 years**	**Past 2 years**	**Past 5 years**	**Past 3 years**	**Past 2 years**	**Past 5 years**	**Past 3 years**	**Past 2 years**
Oxfordshire	5704	3320	1950	1798	1065	682	3906	2255	1268
Cambridge ecosystem	8473	5262	3494	798	477	272	7675	4785	3222
Greater Manchester and surrounding area	2690	1526	965	376	207	120	2314	1319	845
Newcastle/NE	642	410	257	184	107	61	458	303	196
Southampton cluster	947	656	449	296	183	107	651	473	342
Edinburgh and wider area (including Rosyth and Dunfermline)	2963	1640	1084	420	239	138	2543	1401	946

Source: Data sourced by Mathys & Squire using Filing Analytics

Gender diversity

In 2021, Oxford Brookes University, in collaboration with Advanced Oxford, looked at a sample of 110 innovation and knowledge-based companies within Oxfordshire to investigate women's participation as founders and leaders of these companies.[23] This analysis revealed that only 13.6% of these companies have at least one female founder. Further analysis has now been undertaken by Oxford Brookes University, examining companies identified as being within the Technology/IP-based businesses sector, as defined within data platform Beauhurst.[24] The new analysis compares and contrast gender diversity in the Oxfordshire innovation ecosystem to the national picture.

Beauhurst's company database was used to obtain numbers of Technology/IP-based businesses in Oxfordshire, and nationally, at all stages of evolution. Approximately 490 companies were identified in Oxfordshire and 16,450 companies across the UK. The following characteristics were examined; companies with:

- At least one female founder
- All female founders
- At least 30% female key people (C-Suite)
- No female founders

Data was examined at all stages of evolution (excluding companies classified as dead) as defined by Beauhurst.[25] This includes, seed, venture, growth and established stage companies, as well as companies that are 'zombie' or have exited, for example through an IPO, and are no longer tracked within the platform.

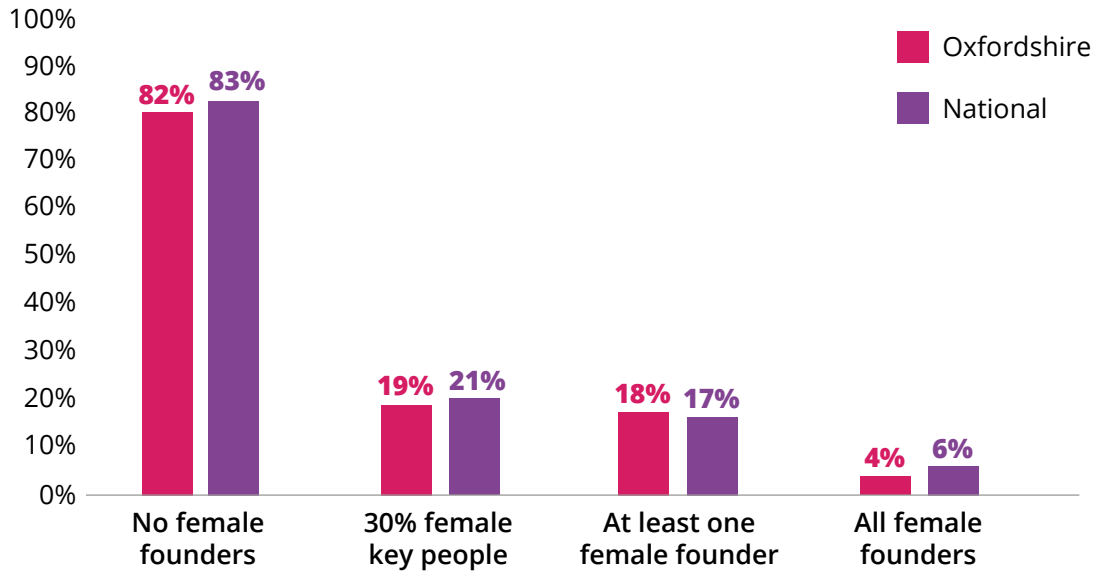
The overall picture for all gender characteristics at all included stages of company evolution is similar between Oxfordshire and the national average, with differences of less than 4% between the regional proportions and the national picture, as demonstrated in chart 6 overleaf.

23. Discussion paper: A snapshot of Gender Diversity in Oxfordshire https://www.brookes.ac.uk/research/units/obbs/projects/women-and-spinouts/reports/

24. https://www.beauhurst.com/

25. Definitions of each stage of company evolution can be found on Beauhurst website

CHART 6:
Proportion of companies at all stages of evolution (excludes dead companies) comparing Oxfordshire companies with UK companies in terms of female participation.



Overall, the Oxfordshire innovation ecosystem gender diversity metrics closely match the national average, although there are more notable differences when data from different stages of company evolution are considered. There is a marginal increase of 4% in the number of companies in Oxfordshire with at least one female founder in recently founded companies (seed and venture stage) when compared to the national picture.[26] There is also a significant gap in female representation in key positions in mature companies in Oxfordshire compared to the national average: 8% fewer companies in growth stage, and 7% fewer companies in established stage have females in key positions, when compared to national data.[27] These results are disappointing especially considering that national averages of companies in the Technology/IP-based sector with women's participation either as founders or as key people are already low. This data suggests that in spite of the resources and capabilities existing within the Oxfordshire ecosystem, women remain largely excluded in founding and leadership teams.

> It is clear that there is still much to do to ensure the Oxfordshire innovation ecosystem becomes more gender inclusive

However, on a more positive note, when companies in Oxfordshire do have at least 30% of women in key positions the data indicate that they result in 15% fewer zombie stage companies compared to national average, and 9% more successful exits, suggesting that when women are present in the C-Suite this may be associated with better results for companies.

There is scope to continue monitoring progress and for more in-depth analysis to better understand women's experiences as company founders and as leaders, but it is clear that there is still much to do to ensure the Oxfordshire innovation ecosystem becomes more gender inclusive.

26. 26% of seed stage companies have at least one female founder whereas 22% of national companies have at least one female founder. At venture stage, 24% of companies have at least one female founder, compared to 20% of national companies.

27. A companion paper with further breakdown of the data relating to gender diversity at different stages of company evolution is being published alongside this report. Refer to https://www.advancedoxford.com.

Conclusions

Despite the challenges in data collection and availability, Oxfordshire appears to have a thriving and diverse innovation ecosystem. The knowledge economy, as defined by the Eurostat definitions, has grown considerably in the last decade both in terms of the stock of companies and in terms of employment. Both high and medium tech manufacturing has declined in the same period however, although this may reflect a maturing of the ecosystem, where manufacturing activities move out of the region as companies scale. Equally, a maturing ecosystem results in company growth that has a more international outlook, rather than significant growth within the region.

The region is a location for inward investment, but the strategy needs to be better defined moving forward and whatever the approach, there is an opportunity for organisations and institutions to work together even more. The region has a good record on starting and retaining science and technology focused businesses, but they still tend to be male dominated, in both their formation and leadership. If there is still a long way to go on gender equality, it seems likely that other diversity characteristics also need attention and action.

IMAGE COURTESY OF ROYAL ACADEMY OF ENGINEERING VIA UNSPLASH

Where are they now?

Case studies and review of companies featured in 2013 and 2016 *Oxfordshire Innovation Engine* reports

The Innovation Engine reports of 2013 and 2016 gave an insight into some of Oxford and Oxfordshire's leading high-tech businesses. In the three years between each report, much had changed. Progress was applauded but challenges were also highlighted.

There can be few more turbulent years that businesses have had to endure than the period that followed the 2016 update. Companies have had to contend with a pandemic which brought successive lockdowns and caused huge supply chain disruption, followed by worrying energy inflation and the cost-of-living crisis.

Throughout this period, though, the companies featured in the 2013 and 2016 reports have shown tremendous resilience. Concerns they might decline or move out of the area have proven unfounded as they recover from the pandemic years, with companies reporting growth and an ever-increasing demand to tap into the region's rich supply of skilled talent and its science and innovation networks.

In this section of the report, each company is revisited, reflecting progress as charted in the previous reports, and the position in 2023, with case studies on Immunocore, Sophos and Oxford Nanopore Technologies. A new case study on Perspectum is also included. The years in brackets accompanying company names reflect the OIE report, or reports, that featured the company.

Oxford Assymetry/Evotec (2013) **– Evotec** (2016)

2013 Oxford Assymetry was set up by Professor Steve Davies from the University of Oxford's chemistry department. After floating in 1998, the company decided it need to focus on drug discovery and was bought in 2000 by Evotec, from Germany. The 2013 Innovation Engine report notes the two businesses were culturally very different and yet after the business doubled down on drug discovery through partnerships with established pharmaceutical companies, it became profitable.

The 2013 report noted that 200 people were maintained at Evotec's Milton Park base, working in partnership with colleagues in Germany and the US with limited links to Oxfordshire networks and institutions.

2016 The Innovation Engine update reported that Evotec had grown through acquisition, including Bionamics in Germany and Euprotect, a contract research business in Manchester. The biggest change was a partnership with Sanofi to work on five oncology medicines, among other projects. The deal involved 200 scientists at Sanofi's Toulouse labs becoming Evotec employees. The report referred to this as a 'major undertaking' and suggested the company was expecting growth, which may otherwise have come from Oxfordshire, to now come from France.

2023 Growth has been rapid with 2016's global headcount of 950 (240 at Milton Park) hitting 5,000 (600 at Milton Park in 2020). Company revenue is up from 55m Euros in 2010 to 700m Euros in 2022.

The company operates as a shared, end-to-end R&D platform and has a large range of partnerships in co-owned discovery, co-owned preclinical and co-owned clinical assets with several pharmaceutical companies. Concerns over Milton Park's role in Evotec's future have proven to be unfounded. To the contrary, Evotec has expanded its Milton Park footprint to just over 197,000 sq ft, making it one of the largest occupiers of the park. At the time, Christophe Muller, then head of Evotec's Milton Park site, summed up the move.

> "Milton Park is an integral part of Evotec's history and more than ever its future. The current expansion has been driven by an increased demand for our high-end drug discovery services, specifically in the areas of biological and protein sciences. The additional footprint, in bespoke facilities on Milton Park, as well as the recruitment of scientific experts, are also part of our plans to develop a fully integrated platform and centre of excellence for structure-based drug discovery in the UK."

Oxford PV (2016)

2016 The 2016 report hailed Oxford PV as leading the global race to develop and commercialise perovskite technology in solar panels. While normal PV panels absorb energy from the red and green part of the light spectrum, Oxford PV uses the mineral perovskite to absorb the blue part of the spectrum also. It is hoped this will increase the efficiency of a PV panel from around 20% to 30%.

The firm is a spin out from Oxford University, originally based at Begbroke Science Park. In 2016, it employed 30 advanced materials scientists. Between 2015 to 2016, the report mentioned it had raised £12.6m to commercialise the technology.[28] *The Powering Up for the Green Recovery*, a report by Advanced Oxford (2020), revealed the company was expected to launch commercial products in the near future, but these would almost certainly be made in Germany, rather than the UK.

2023 In early 2023, the company revealed its CEO, Frank Averdung, was retiring to be replaced by long-term board member, David Ward. At the same time, the company announced it would be launching its perovskite-on-silicon 'tandem' cells during 2023. It anticipates these will take a traditional cell's efficiency up from 20% to 27%. In fact, in 2022, it set a world record for reaching an efficiency rate of 29.52%.

The Advanced Oxford prediction that these cells will be made in Germany was proven right, after the company announced its was investing in manufacturing facilities in Brandenburg an der Havel, near Berlin. Work on the facility was finished at the end of 2021. While manufacturing will take place in Germany, Oxford remains the company's R&D centre, as was made clear when it announced a move to larger premises, on the Oxford Industrial Park, in 2018. The business now employs 140 people across its Oxford R&D and Berlin manufacturing operations.

28. https://www.advancedoxford.com/green-recovery/

Williams Advanced Engineering (2016)

2016 The Innovation Engine report picked up on Williams Advanced Engineering (WAE) two years after the business, formed in 2010, moved into its own building on the F1 team's Grove campus (where it remains). In 2015, WAE accounted for 150 of the 700 people employed in the wider Williams group. Its focus was, and remains, to use cutting edge technology to develop more energy-efficient solutions for a range of clients and industries – automotive and motor sport accounted for the majority of business, with additional clients in defence, renewables and sports science. Its key areas of expertise are hybrid and electric power and lightweight, aerodynamic engineering.

The company was noted for its work with the Oxfordshire LEP and the close networking links it was forming with companies on Harwell Campus, Culham Science Centre, and Oxford University.

2023 The huge change since 2016 is WAE was sold to Australian mining business, Fortescue Metals Group, for £163m in 2022. Fortescue has set itself a target to be (scope 1 and scope 2 emissions) carbon neutral by 2030. As such the purchase of WAE coincided with a commitment to build an electric mining train, called the 'Infinity Train', that it claims will use gravity to recharge its batteries for an entire return trip to and from an iron mine.

WAE is keeping to its motorsport roots though, announcing that after developing the batteries for all cars in the Formula E series between 2014 to 2018, it will be developing and manufacturing the Gen 3 Formula E battery from 2023 onwards. It is also helping to power the Triumph TE-1 electric motor bike.

The business employs 400 people in Grove and its continued commitment to the area has been underlined with an announcement of a 400 MWh battery factory in nearby Kidlington. It was due to open in April 2023 and create a further 300 jobs.

Oxford instruments (2013) and (2016)

2013 Oxford Instruments' place in history was echoed by the 2013 report, citing its launch in 1959 as "the beginning" for high-tech Oxfordshire. The success the business has enjoyed was noted as highly significant in supporting new start-ups in the area. Additionally, the report drew attention to the personal backing for local innovative business from the company's founders, Sir Martin and Lady Audrey Wood.

2016 The report covered a growth strategy for the imaging, x-ray and laser spectrometry business which saw purchases of companies from Northern Ireland, the US, Germany and UK. Adverse trading conditions had led to some people leaving and the business bringing in a range of cost savings. However, the relocation of previously Sussex-based RMG to its Tubney Woods offices helped to reverse this. The report picked out Oxford Instruments for its strong local ties, very good apprenticeship programme and its commitment to local partnerships, such as investing in Tokamak Energy.

2023 British company, Spectris, dropped plans to buy Oxford Instruments for $2.4bn in March 2022, citing global economic uncertainly due to the war in Ukraine.

The company reaffirmed its position as one of the area's biggest providers of apprenticeships, announcing in February 2023, it was to offer a record 25 roles.

The latest preliminary results for the six months preceding September 2022 were positive. They show the company's revenues have increased by just over 10% compared to the corresponding period the previous year. Operating profit was also up by just over 4.6%. An accompanying note predicted further growth from its "record order book".

Tokamak Energy (2013) and (2106)

2013 Tokamak Energy was picked out as an exciting central player in Oxfordshire's fusion cluster at the Culham Innovation Centre, home to the UKAEA. It intended to use superconductive electromagnets to suspend plasma in a fusion chamber and so received early investment from magnet technology pioneer, Oxford Instruments.

2016 The update report of 2016 noted that while governments are concentrating on funding large collaborative projects to achieve fusion, Tokamak Solutions remains convinced its small devices will deliver the dream of fusion far quicker. Staffing levels had increased between the two reports to 20 science engineers and 10 contractors, plus a range of part-time consultants. Its collaborations within the Culham cluster, Oxford Instruments and the Rutherford Laboratory were also picked out by the report.

As ever with fusion, the challenge to growth was clear – proving the science is commercially viable.

2023 The challenge to reach a temperature hot enough to create fusion energy was demonstrated in 2022 by Tokamak Energy. It recorded 100m degrees Celsius, a record for a compact, spherical tokamak. The company, which now employs 200 people, hailed the landmark of achieving a temperature six times hotter than the sun as evidence it is on track to deliver 'grid-ready' power by the early 2030s.

At the end of the year, the UKAEA agreed to work with the business on exploring spherical tokamaks as a means to achieve fusion. The commitment was formalised in 2023 with news that the company's ST80-HTS spherical tokamak will be built at the UKAEA's Culham Campus. The new facility is expected to be opened in 2026.

IMAGE COURTESY OF TOKAMAK ENERGY

CASE STUDY

Sophos commits to Abingdon after PE sale

Sophos is one of the best-known cybersecurity companies in the world. International expansion had led to it opening offices throughout Asia, Europe, the Middle East, and Africa as well as North and Latin America. Its HQ remains in Abingdon, reflecting both the company's roots and where it believes it is still best placed to tap into the brightest talent.

Its two founders, Jan Hruska and Peter Lammer, met while studying at the University of Oxford in the 1980s. The pair launched an anti-virus business in a semi-detached house in Kidlington before launching what is now its global headquarters in Abingdon. It houses SophosLabs, one of a network of threat analysis centres which monitors online activity to understand new and emerging cybersecurity threats.

Since the 2016 Innovation Engine report, the biggest news for Sophos is its 2020 purchase by private equity firm Thoma Bravo for $3.8bn. A year later, the business also opened an additional office, primarily for sales, in Manchester.

Abingdon was originally chosen at the company's headquarters not just because the founders met at nearby Oxford University. They felt the town's proximity to Oxford as well as London, Birmingham and Cambridge meant the business would be close to customers operating in some of England's biggest markets. Following the buyout, the company confirms it is still committed to the area as its natural home as it continues to offer access to those key markets. Most importantly, the company credits the universities of Oxford as providing a steady stream of top talent, whilst also hiring the best talent globally thanks to its hybrid and remote working models.

Pioneering cybersecurity as a service

While the origins of the company lay in anti-virus, it is now fully-focussed on further developing advanced cybersecurity solutions which do not just detect existing forms of attack but can also respond to new threats. These include its Managed Detection and Response and incident response services and a broad portfolio of endpoint, network, email, and cloud security technologies that help organisations defeat cyberattacks.

Last year Sophos launched upgrades to its Managed Detection and Response (MDR) service – a fully-managed, threat hunting, detection and response service that provides a dedicated 24/7 security team to rapidly identify and neutralise complex threats. It fuses machine learning and human analysis to spot threats and counteract them. The company claims that since August 2020, and the upgrades to MDR, the service has grown by 500% and is now used by 15,000 customers.

Since the 2016 report, the business has also launched an improved Sophos Firewall which it claims works far faster than previous releases, offering users great flexibility. The move has been designed, in particular, to support its channel partners as they help clients migrate their services to the cloud.

While firewalls monitor traffic entering networks, Sophos Intercept X uses AI to offer multiple layers of security at the 'end point', on the devices people use to access services. This is particularly aimed at adding an extra 'smart' layer of protection to spot and block the growing menace of ransomware demands. These typically occur when criminals trick an employee into clicking on a link or passing over their network credentials through a fake log-in page. When rogue actors have control of data or a corporate function, they then issue a ransom demand to return it.

The use of AI sums up how Sophos now seeks to actively protect computer systems, end point devices and their users from cyberattack. This work will lead to further updates to its detection and prevention services. The services it offers are bound to change in the coming years but the commitment to Abingdon appears to be constant, thanks to the history of the company, the town's proximity to major markets and the region's track record in supplying, or attracting, the necessary talent to grow the business.

Sophos was featured in both 2013 and 2016 reports.

CASE STUDY

Immunocore – a journey to public, commercial biotech

IMMUNOCORE

Immunocore develops novel therapies that harness our immune system by using T Cell Receptor (TCRs) biology to fight cancer, infectious diseases and autoimmune conditions, using science that originated from research conducted at Oxford University.

Researchers at the company develop, what they call, ImmTAX™ (Immune Mobilizing Monoclonal TCRs Against X disease) molecules. The idea of the 'X' is that the technology can be used to target cancers and other diseases, using the same approach.

These molecules are designed to get around the challenge that the body's natural immune system is not always able to do what it is meant to do, because cancers and infectious diseases are adept at hiding from it or, in the case of autoimmune diseases, the immune system attacks the body. They work by helping the body detect cancer or disease and encourage the immune system to kickstart a patient's natural defences, for cancer and infectious diseases, or control them, for autoimmune conditions.

When the Innovation Engine update report of 2016 last covered Immunocore, it had scientific partnership arrangements with Genentech (a Roche company), GSK, Medimmune (owned by AstraZeneca) and Eli Lilly. Trials were reported as providing positive early results.

Since then, partnerships may have changed, but the positive results have continued. In 2022, Immunocore received FDA and EMA approval for its treatment for Uveal

→

Melanoma (a cancer that affects the eye). It is the company's first commercialised treatment, the first TCR therapy approved, as well as the first approved treatment for the condition. The drug is now approved for use in around thirty countries. Discussions with NICE are ongoing to establish if the treatment can be made available in the UK on the NHS.

Immunocore is conducting multiple additional trials. The therapy approved for uveal melanoma is being investigated for treating advanced melanoma in a phase 2/3 trial, while a second investigational therapy is currently in a phase 1 trial enrolling patients with endometrial, ovarian, lung and melanoma, as well as a range of other solid tumours.

Potential candidates for colorectal, gastric and pancreatic cancers are in the pre-clinical stage, aiming to start Phase 1 trials in the next 18 months.

The business is also conducting Phase 1 trials in infectious disease in hepatitis B (HBV) and HIV, the latter is in partnership with the Bill and Melinda Gates Foundation.

At the moment, its treatments are designed to be administered intravenously on a weekly schedule. Tests are ongoing to establish if the 'half-life' of its treatments could be extended so injections might last longer and require patients to receive treatments less frequently.

Financially, there have been several huge developments since the 2016 Innovation Engine update report. The business floated in New York in February 2021. This followed two rounds of financing. In 2020, a Series B round raised $130m and then a Series C round raised $75m in 2021. Then, following its floatation, the business raised a further $140m in 2022 from existing shareholders.

Throughout this growth in financing and regulatory approval for its first treatment, Immunocore has remained in the Milton Park headquarters and laboratories it opened in 2000. Of its 450 staff, 300 are based at Milton Park and the remainder are split across offices near Philadelphia, opened in 2014, and near Washington, opened in 2019. According to the company's CTO and Head of Pipeline and Platform Research, Annelise Vuidepot, the commitment to its roots is not just historic, it is also forward-looking. "The technology was developed in Milton Park and this site remains our Research and CMC base. We are now growing teams across many other functions, including commercial, at all three sites, and the leadership team is split between the three locations" she says. "As of today, Milton Park remains our largest site because of the availability of research talent in the area due to the proximity to Oxford but also because the city is an integral part of the Oxford, London, and Cambridge golden triangle."

"Milton Park remains our largest site because of the availability of research talent in the area due to the proximity to Oxford but also because the city is an integral part of the Oxford, London, and Cambridge golden triangle."

Immunocore, now a commercial-stage biotech listed on NASDAQ, retains strong ties to the University of Oxford and continues to rely on academic collaborations. While the company's footprint is increasing in the US, the research pipeline for new discoveries is set to remain just outside Oxford, where the company began and where it feels it can continue to tap into the brightest talent and the excellent academic scientific network going forward.

Immunocore was featured in 2013 and as a joint review with 'sister' company Adaptimmune in 2016.

CASE STUDY

Oxford Nanopore Technologies – a story of global growth

Oxford Nanopore Technologies (Oxford Nanopore) is now firmly established as one of Oxford's major innovation growth and impact stories. The Oxford Innovation Engine Update listed the business as one of the five, billion pound, or 'unicorn', tech businesses to be spun out of Oxford University. This was underlined in October 2021 when the business floated on the London Stock Exchange, valued at £3.3bn.

The company's DNA sequencing technology is now being used by researchers in more than 120 countries, supported by a worldwide team of more than 1000 staff. In the UK, Oxford remains its global HQ with offices and a state-of-the-art manufacturing facility at the nearby Harwell Campus. Internationally, the business operates out of 13 offices spread around the globe.

Sequencing disruption

Its technology represents a massive disruption to the scientific equipment market. Rather than charge hundreds of thousands of pounds for conventional optically-based devices, Oxford Nanopore customers buy consumables called 'flow cells' that are inserted into a sequencing device, the smallest of which costs as little as a few thousand pounds, and is often provided free of charge as part of a starter pack.

It is the only approach that sequences the original DNA/RNA of a sample as it passes through a tiny 'nanopore'. Its sequencing equipment was first made available in 2014. The company now offers sequencing options which vary in size from the desktop GridION and ultra-high-output PromethION systems to the lightweight, portable MinION, designed to be used in the field.

The equipment is much cheaper and faster than systems offered by rivals, empowering scientists to get results back in real-time, and to access sequencing at much lower cost than alternative systems. This speed of operation was proven at the start of 2022 when a team from Stanford University announced it had been awarded a Guinness World Record for sequencing a human genome in just five and a half hours with Oxford Nanopore's equipment. By way of comparison, the original Human Genome Project took 13 years from its inception, in 1990, to achieve the same feat.

A global company, from Oxford roots

The system was developed by Oxford Nanopore's substantial R&D teams, who while they were creating the nanopore sensing platform also worked with collaborators at the Universities of Harvard and California at Santa Cruz, as well as building on early work by Professor Hagan Bayley at the University of Oxford's Chemistry Department. Since forming in 2005, the company has proven the principle is sound, scaled the technology and manufacturing, and amassed more than 2,500 patents as it developed the technology available today.

While the company is proud of its Oxford roots and operates its global headquarters in the city, it has operated as a global company for a decade.

"We started in Oxford and our HQ offers access to a highly skilled talent pool that includes scientific, manufacturing and operations teams – essential to drive growth" says Gordon Sanghera, CEO.

"We established our first large scale, high-tech production facility in the nearby Harwell Campus. However, both our supply chain and our customer base are global. We support many of our users online and also have commercial, support and logistics teams, and offices around the world who support our global user base. We're truly international."

For those who are not familiar with genetic sequencing, the advances made by Oxford Nanopore's technology can be likened to helping scientific researchers piece together a puzzle more effectively, and to see more detail in the pieces of that jigsaw.

Sequencing is a little like doing a jigsaw, but traditional technologies have only been able to supply jigsaw pieces akin to the "size of a grain of sand". Oxford Nanopore's technology can sequence longer fragments of native DNA or RNA, so it's a little like replacing those grains of sand with pieces the size of a 10 pence coin in the jigsaw puzzle. This is easier to put together, but where genetic variations are larger than the "grain of sand" size fragments – those can be seen with Oxford Nanopore's technology.

Even so, Gordon still describes the world as being "in the foothills" of what DNA and RNA sequencing can achieve, both inside and outside the laboratory, particularly in clinical settings where people are seeking rapid, information-rich insights that are near to the patient.

Hence, the company has recently announced a collaboration with a Dutch start-up, Cyclomics, to test a new method of detecting molecules associate with cancer in the blood stream. Additional collaborations have also been announced ranging from rapid BRCA 1 and 2 testing with 4bases, automation with Tecan and joint work with PathoQuest to develop a quality control test for the biopharma industry to check the safety of biologic therapeutics.

The company has also announced that it is working with Genomics England on a range of programmes including comprehensive genetic analysis of cancer tumours using their unique capability of sequencing any-length fragments of DNA.

Oxford Nanopore Technologies was featured in the 2013 report.

Not featured in previous reports, a case study on Perspectum charts the journey of the company from University of Oxford spin-out to international success story.

CASE STUDY

Perspectum – pioneering diagnostics in the UK and beyond

Perspectum span out of Oxford University in 2012, based on a pioneering discovery by Dr Rajarshi Banerjee. He was convinced the MRI research he was conducting at the city's John Radcliffe hospital for diagnosing heart conditions would be best applied to the liver.

Traditional ultrasound results only give doctors a rudimentary image, which he refers to as similar to the silhouette a photographer gets when they take a picture of someone in front of a bright window. He suspected MRI scans could give greater clarity but the problem with the liver is it is full of iron and so is difficult to image accurately with a magnetic system. Dr Banerjee's solution was to take MRI images on two different axes and use a sophisticated AI programme to determine iron levels and counteract them, so they do not influence the final scan. The result was a breakthrough he and the University hoped would save many lives in diagnosing

the early stages of liver disease non-invasively.

In particular, the scans are well suited to assessing patients for Non-Alcoholic Fatty Liver Disease (NAFLD), which the British Liver Trust estimates affects one in five people in the UK. Catching the disease at this stage is helpful because, if left untreated, it can lead to Non-Alcoholic Steatohepatitis (NASH), which in turn can lead to cirrhosis, liver cancer and liver failure.

The company then expanded beyond liver scans, using its in-depth knowledge of what healthy organs should looks like to enable it to spot the early signs of disease in multiple organs. This led it to be tasked, during the pandemic and shortly afterwards, to carry out multi-organ scanning to check for organ damage caused by long Covid. This 'CoverScan' project checked lungs, kidneys, pancreas, heart, liver and spleen. It ended in 2022 and found that 29% of people with long Covid could have damage to multiple organs and 59% could have damage to one organ. The project led to Perspectum launching CoverScan as a multiorgan scanning service, alongside its LiverMultiScan and MRCP+ (biliary and pancreatic scan) products. These have been recognised by both Medicare and commercial payers in the US and are also available in the UK, privately. In the UK, Perspectum's services are also being used to reduce scanning waiting times for the local NHS at its Community Diagnostics Centre at its ARC Oxford Business Park offices.

International expansion

Dr Banerjee believes his breakthrough idea for better liver imaging, and then scanning multiple organs, is just the start of medicine moving to consider the whole patient, as reflected by its research work with pharmaceutical giants on the impact of different drugs on each patient. "Developing multi-organ imaging is a good way of looking at the whole patient," he says. "Normally we wait until part of you gets sick and then send a specialist for that part. We've forgotten how to do holistic medicine. This work on precision medicines

> "Oxfordshire has got a massive talent pool and a great culture of innovation. It's a pretty easy place to do business from, there's very little reason to move. So, it's easier to retain UK headquarters with satellite offices."

and getting the necessary recognition and reimbursement codes for its scanning technology to be used in the United States, and in other regions, has meant the past couple of years has seen "a lot of activity". The business announced a series C fund raising of $55m in the first quarter of 2023. The investment will be used to build up its business in the US as well as further develop its scanning technology for use in detecting inflammatory diseases and cancer. In total, the business has raised $140m since forming in 2012. It now employs circa 280 people across offices in Boston, San Francisco and Dallas, which handle interpreting scans from American patients, while Singapore handles those in its local region. Portugal covers the EU and scans in the UK are processed in Oxford.

Oxford HQ

The city is likely to remain its HQ, as well as its centre for research and development, for quite some time, Dr Banerjee reveals. While part of this reason is down to the area scoring highly on living indexes as a great place to work, socialise and relax, there are also more practical reasons for remaining in the city. "Oxfordshire has got a massive talent pool and a great culture of innovation," he says. "It's a pretty easy place to do business from, there's very little reason to move. A place would have to be really exceptional for us to move, and I don't think a place that special really exists. So, it's easier to retain UK headquarters with satellite offices."

Conclusions

Although the 2013 and 2016 reports focused on companies that were candidates for success, it is nevertheless positive to see these companies have all survived, and despite the challenges of the last decade, all are thriving. Companies may have undergone changes, including in ownership, whether that be acquisition or moving onto the public markets, but they remain and are growing in Oxfordshire.

What is notable is the global outlook of all of the companies featured in this report. Companies that started in Oxfordshire are trading and expanding internationally – they are inward investors into new territories, reflecting the global markets in which they operate. This is a true measure of success – born in Oxfordshire, translating science and technology ideas into new products and services, resulting in commercial companies that operate in the region and the rest of the World. Collectively they provide a blueprint for the rest of the ecosystem.

IMAGE COURTESY OF OXFORD NANOPORE TECHNOLOGY

The innovation ecosystem and business environment

The Oxfordshire Innovation Engine (OIE) report considered Oxfordshire's infrastructure and business environment in 2013. A decade on, many of the issues remain, although there have been a number of positive developments and some new priorities. There are many good reasons why people choose to live and work in Oxfordshire, but for all these positives, the worse aspects of life are dominated by issues around the cost of housing, poor transport links, congestion and the cost of living in Oxford/Oxfordshire. This section considers these issues, alongside other key areas of infrastructure, including the provision of laboratory and innovation space. Access to finance is also examined.

Innovation real estate

In 2013, the OIE reported that Oxfordshire was well endowed with specialist property for new and small high-tech firms, but less so for larger firms. Innovation spaces across the county provided around 10,000 sqm of space. In the intervening period there have been some important developments with regard to space for smaller high-tech companies, including University of Oxford's BioEscalator and the Wood Centre for Innovation in Headington, Grassroots in central Oxford and Oxfordshire's largest co-working space, The Bee House, on Milton Park.

The 2013 report also noted that six science parks had around 500,000 sqm of floorspace, with a total of 385,000 sqm available for development on existing schemes, with the majority of this developable space in the south of the county. The picture has changed significantly, with regard to both the stock, but also schemes in planning or under development. Note that while OIE used square metres data (sq m) most of the data provided below is in square feet (sq ft).

These developments are much needed, and there are others in discussion, including ambitions for the development of the cluster around the hospitals and innovation campuses in Headington, and development of the campus at Abingdon's science park. It is also positive to see that many of the developments are focused not only on the provision of appropriate workspaces, but also of high-quality amenities, collaboration and meeting spaces such as conferencing facilities, and housing. Mixed developments are likely to help to attract and retain talent, with many companies highlighting the need for a broader amenity and cultural offering as a means of attracting employees to come to the Oxfordshire labour market.

However, despite this pipeline, data shows an existing mismatch between demand for and supply of science and technology space across the region, and this picture is replicated across the whole of the Oxford – Cambridge Arc. Indeed, it could be argued that Oxfordshire's failure so far to land a significant R&D heavy-weight inward investment project has been, in part, due to the lack of a suitable location for such a development.

Highlights from the 2023 development pipeline:

Harwell Campus intends to create 140,000 sq m (1.5m sq ft) of new cutting-edge labs, offices, R&D and advanced manufacturing space alongside a new hotel, conference centre, homes and amenities.

Oxford North will be a thriving and vibrant new district with innovation and sustainability at its heart, established across 64 acres, it will provide 936,500 sq ft of workspace and 480 new homes.

Two new buildings are being developed at **Begbroke Science Park**, providing c.135,000 sq ft of space for commercial research companies to grow, as well as further facilities for University of Oxford research. The project is targeted for completion in early 2024.

Oxford University Development is also consulting on emerging ideas for this 190 hectare site, five miles north of Oxford town centre, focused on creating Begbroke Innovation District. The aim is to deliver a range of research and development facilities, new homes and associated social and physical infrastructure, including schools, community centres, space for leisure and recreation, and excellent sustainable transport links to Oxford.

A £200 million redevelopment of **Oxford's Clarendon Shopping Centre** will include 30,000 sq ft of labs and offices under plans for a wholesale development of the city centre site which will also offer space for student accommodation, offices, retail outlets and restaurants in a scheme totalling 250,000 sq ft.

The **Oxford Science Park** is focused on its development to support the ambitious growth of new and existing science and technology occupiers from the UK and abroad. 625,000 sq ft of new state-of-the-art R&D facilities are anticipated by 2025 within the Park's development plan.

Plans have been approved for a new state-of-the-art 'tech box' scheme at **Milton Park**, designed with space, technology, life science and engineering companies in mind, focused on the growth of start-ups and cross-industry collaboration. The development will comprise a total gross internal area of just under 80,000 sq ft, featuring seven new research and development workspaces.

There are also plans for a new science hub on Oxford city centre's **Botley Road**, while a joint venture company, owned by Nuffield College and Oxford City Council, owners of the majority of land that lies between the city's **Oxpens Road** and the railway line, is working on a mixed-use riverside neighbourhood, transforming this part disused brownfield site, to bring homes, jobs, connectivity, and public spaces into this part of the city.

An analysis of innovation real estate in Oxfordshire – supply and demand data (2022 and 2023)

Combined laboratory and office/workspace take-up data is collected by a number of real estate companies. Data has been provided for this report by Bidwells and by Carter Jonas. As each company collects data at different time points and for different geographies within the Oxfordshire ecosystem, there are some differences in individual data points, but these are identified and qualified below.

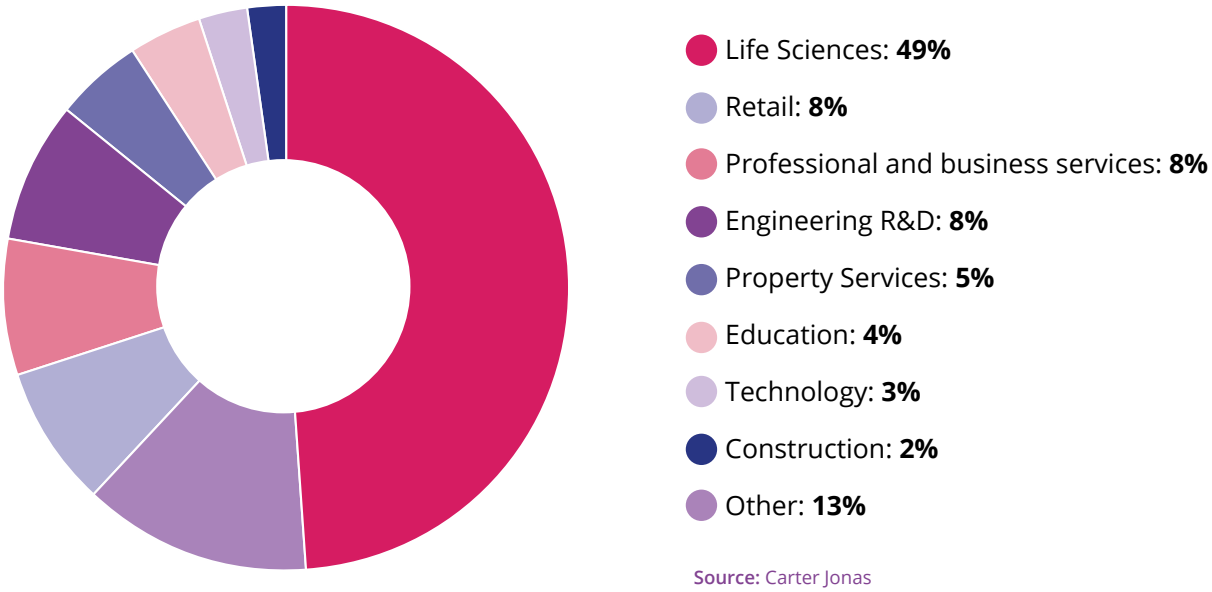
Bidwells data identifies the total take up of office and laboratory space in 2022 at just over 505,000 sq ft,[29] of which 261,300 sq ft was laboratory space and 243,900 sq ft was office space. 76% of this take up was by innovation (or knowledge intensive) companies. These figures do not include industrial lettings (e.g. warehousing).

Carter Jonas monitors the take-up of office and lab space of 5,000 sq ft and above. In 2022, this totalled just under 320,000 sq ft, 18% below the 10-year average, although only 4% below the average over the previous four years. However, according to Carter Jonas, leasing in 2022 was constrained due to a lack of available space rather than weaker demand. They have also noted that Oxfordshire's office and lab take-up dropped in the fourth quarter of 2022, with only a handful of deals completed in that period. Carter Jonas data also excludes industrial deals such as storage, warehousing and distribution.

According to Bidwells, 85% of space leased by innovation/knowledge intensive companies in 2022 went to new entrants to the Oxford market. They identified a total of 26 lettings/long leasehold sales to innovation companies in 2022 – 22 companies originated from the UK, two from the US and two from mainland Europe. Nine of the 26 innovation businesses were university spin-outs.

Carter Jonas data indicates that Oxfordshire's office and lab take-up has been supported predominantly by occupiers from the life sciences sector. Around 50% of total take-up in 2022 was from life sciences companies, from early-stage start-ups to large and mature firms.

CHART 7:
Take up of office and laboratory space across Oxfordshire by sector/industry group, 2022



Source: Carter Jonas

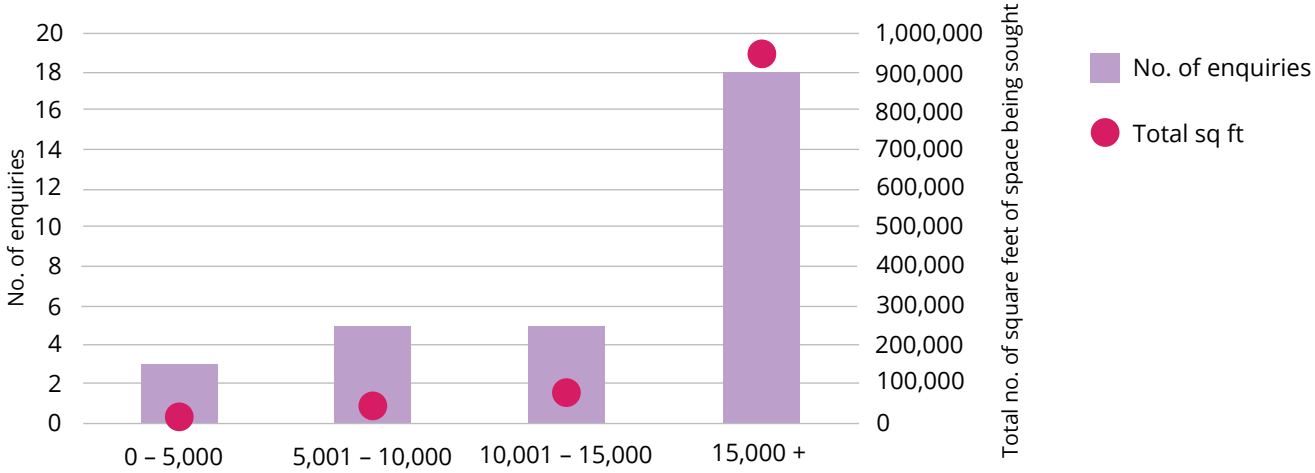
29. Bidwells definition of take up is floorspace leased or acquired for occupation during the period in question. Take up may be represented by pre let space where the floorspace is contracted for occupation at some future date as construction has not yet been completed. Take up has to be represented by a new lease being drawn up and/or a lease being assigned to another tenant.

Total demand for lab and office space in Oxford/Oxfordshire

Total demand for office and laboratory floorspace exceeds 1 million sq ft, with Bidwells suggesting that the split is around 845k demand for laboratories and 367k for offices (data from December, 2022).

A snapshot of demand from March, 2023, from Carter Jonas, based on active enquiries from potential tenants looking for space, shows that the majority of the demand is for space above 15,000 sq ft, with most of this demand being for research and lab space. The majority of these enquiries come from life sciences and the interest in larger spaces appears to be driven by successful fund raising by companies. In addition to innovation space, there is strong demand for storage and distribution space from growing life sciences companies.

CHART 8:
Oxfordshire office/lab demand



Source: Carter Jonas
A snapshot of demand for office and laboratory space from March, 2023, based on enquiries, showing the number of enquiries for different space requirements from enquiries for space of < 5000 sq ft, to enquiries for space of 15k sq ft or more, also showing the total demand for space in each category.

Supply side data should be reviewed with caution, as some of the space is not actually available as it is being converted, often from office to laboratory space. Availability can be subjective in the eyes of potential tenants, as location and grade of space[30] can influence whether a site is considered to be suitable or not. Data may suggest that there is available space, but much of what is available is not innovation-ready space and is not suitable for companies looking for laboratories and innovation appropriate space.

There is currently (March, 2023) around 900k sq ft of available space across Oxfordshire. However, as reflected in table 8, this is mainly offices with the majority being secondary (lower grade) space. Carter Jonas has identified that about a quarter of a million sq ft of available space is suitable for conversion to lab/innovation space and this figure includes projects that are already under-construction/ refurbishment.

TABLE 8: Supply versus demand for office and laboratory space

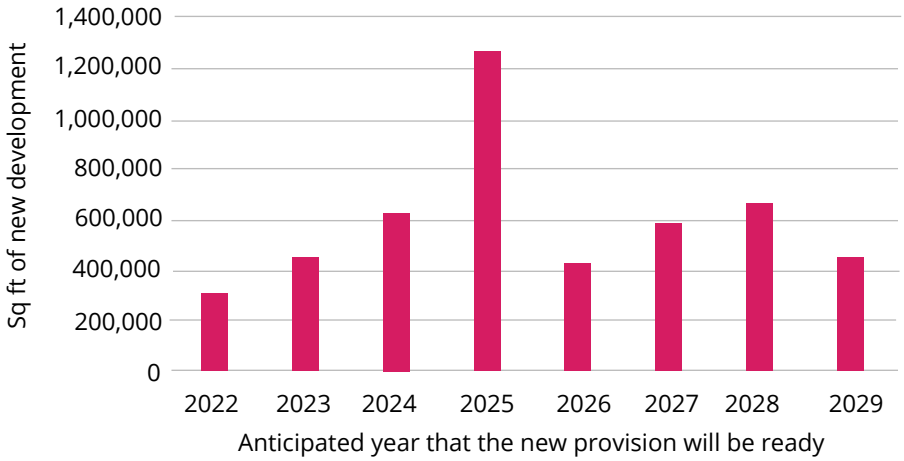
OFFICE SPACE			
Size of floor footprint (sq ft)	**Supply** (000 sq ft)	**Demand** (000 sq ft)	**Under/ Over Supply** (000 sq ft)
<5k	199.9	32.5	167.4
5-10k	173.6	60.0	113.6
10-20k	178.2	82.0	96.2
20-30k	48.6	77.0	-28.4
30-50k	31.7	115.0	-83.3
>50k	87.3	0.0	87.3
Total	**719.3**	**366.5**	**352.8**
LABORATORY SPACE			
All	25.1k	844.5k	-819.4k

Source: Bidwells, December 2022

30. Grade A Floorspace is top specification floorspace either new or recently refurbished typically with raised floors, suspended ceilings and air conditioning. Other facilities usually present are lifts, reception and kitchen.

The mismatch between supply and demand demonstrates the need for more innovation-suitable space, both laboratory and office space, to be provided within the system, however the pipeline of new provision is tight. Availability in the Oxford market has been limited to a small number of schemes, with grade A office and lab space nearly entirely absent. Although there are several schemes going through the planning process, they are not expected to be available before 2024, which is likely to put more pressure on occupiers looking for space in Oxford/ Oxfordshire now.

CHART 9:
Oxfordshire development pipeline (sq ft)



Source: Carter Jonas
The pipeline of new development of innovation related space coming into the Oxfordshire property market with expected year of availability, based on available data from March, 2023.

The mismatch of supply and demand is driving inflation in rents

Oxford has seen unprecedented rental increases over the past 2-3 years, with some caution noted that much of this is driven by the science market rather than the pure office market.

There are different levels of rent for innovation space depending on the nature of the site.

Carter Jonas data indicates that out-of-town laboratory-ready building shell and core rents are currently around £55 per sq ft, due to robust demand amid limited availability, but the amount can vary significantly around these figures, depending upon the build product. This is above the current prime city centre office rent of £49.50 per sq ft. Bidwells data indicates that fitted laboratory space can command around £75 per sq ft (2022 prices).

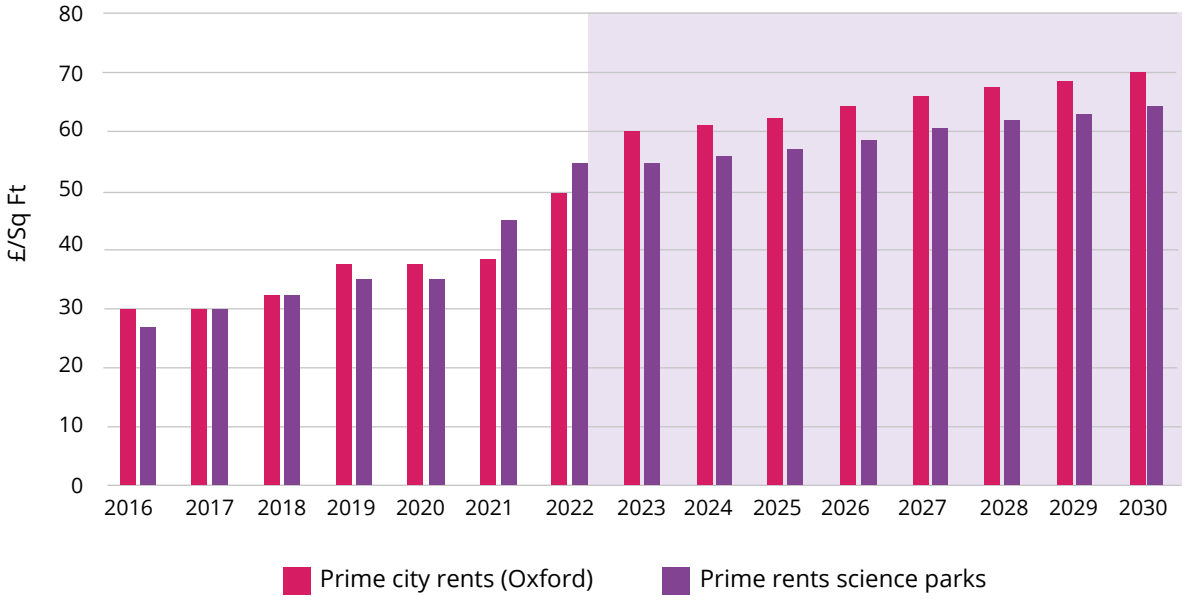
Looking ahead rents for out-of-town laboratory-ready buildings are expected to continue to grow at a moderate pace, with an average of 2% per annum over the next 5 years.

TABLE 9: The change in rents (per sq ft) comparing office with science parks and fitted laboratories

Year	City Centre Office rents	Science Park rents	Fitted Labs rents
2016	£30.00	£27.00	–
2017	£30.00	£30.00	–
2018	£32.00	£32.00	–
2019	£37.50	£35.00	–
2020	£37.50	£35.00	£55.00
2021	£38.50	£45.00	£60.00
2022	£49.50	£55.00	£75.00
2023(f)	£60.00	£55.00	£76.50
2024(f)	£61.08	£55.99	£77.50
2025(f)	£62.48	£57.28	£78.50
2026(f)	£64.17	£58.82	£79.00
2027(f)	£65.97	£60.47	£79.50

Source: City centre and science park rents – Carter Jonas; fitted lab rents – Bidwells. Data for fitted laboratories only started to be provided in 2020. Data from 2023 onwards is forecast.

CHART 10:
Rents for Oxford city locations and prime science parks



Source: Carter Jonas
Based on lab ready building shell and core) with forecasts shown in the shaded area.

Housing

Concerns relating to housing numbers, and constraints on new housing, were identified in 2013, with knock-on effects for accommodation costs and the relative cost of housing when compared to salaries. The housing market continues to be a challenge with consequences for talent attraction, acquisition, and retention.

Data from Advanced Oxford's Quality of Life survey, published in 2019, found that 75% of respondents, all employees in Advanced Oxford member companies and organisations, thought there was a poor range of quality housing to buy and 48% revealed that was also the case for rental properties. While access to cities and transport links were considered positives, 66% thought this was also one of the worst parts of working in Oxfordshire. 89% agreed that Oxfordshire is an expensive place to live. 23% of respondents live outside Oxfordshire and over half of these people said that the cost of housing was one of the factors stopping them from living within the county. 46% of respondents wished that they could live closer to their workplace.[31]

Data from the Department for Levelling Up, Housing and Communities (DLUHC) on new dwellings demonstrates that there has been an increase in house building, as defined here by number of new dwellings in the last decade, with a total of 38,705 new dwellings added to the stock of housing in Oxfordshire between 2012/13 and 2021/22 (inclusive)[32] and an increasing trend in the net number of new dwellings added each year. However, affordability has become even more challenging when viewed over the last decade. The median house price in Oxfordshire was £250,000 in 2013; the latest ONS data sets this at £380,000 (September, 2021). The median salary across the county has risen from just over £29,000 in 2013, to £34,300, again using 2021 data. The ratio affordability has therefore shifted from 8.61 in 2013, to 11.08 in 2021.[33]

31. Advanced Oxford, Quality of Life – Employee Survey, 2018

32. Source - Gov.uk DHLUC - Housing supply, net additional dwellings, https://www.gov.uk/government/statistical-data-sets/live-tables-on-net-supply-of-housing, table 122

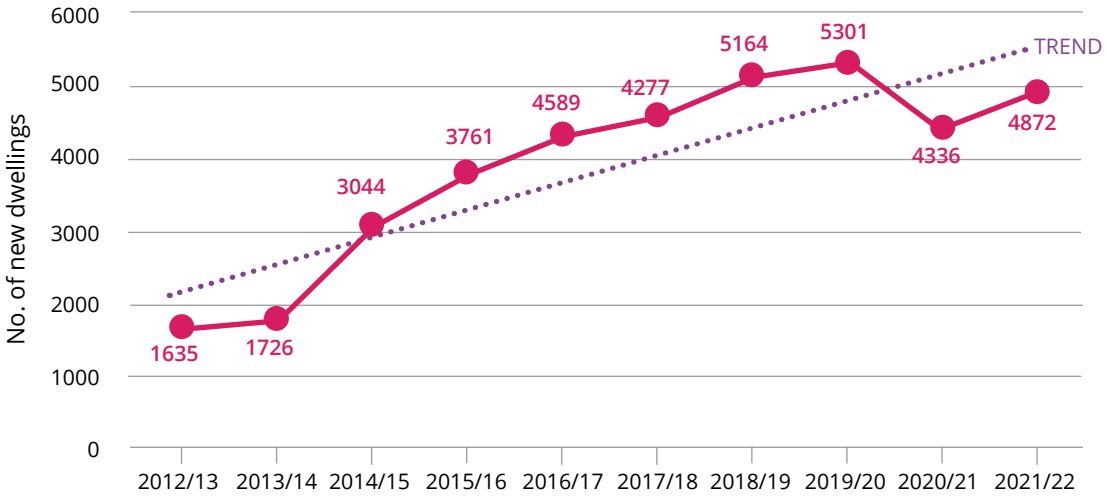
33. https://www.ons.gov.uk/peoplepopulationandcommunity/housing/datasets/ratioofhousepricetoworkplacebasedearningslowerquartileandmedian

TABLE 10: Net additional dwellings added to Oxfordshire stock

Year	Oxfordshire (total)	Cherwell	Oxford	South Oxfordshire	Vale of White Horse	West Oxfordshire
2012/13	1635	342	213	476	326	278
2021/22	4872	1175	540	968	1187	1002
Ten-year totals	38705	10627	2907	8355	10879	5937

Source: DLUHC
Comparing 2012/13 and 2021/22, with total number of new dwellings added in the ten-year period, broken down by local authority.

CHART 11:
New dwelling numbers per annum in Oxfordshire



Source: DLUHC

While the trajectory looks positive, there is a real need for more housing, in the right place and with the right mix of market, affordable and rental property. Planning and green belt rules limit what can be accommodated within the city of Oxford. Recent data from Carter Jonas indicates that there are around 39k houses in the Oxfordshire development pipeline, but around 31k of these are in the planning stage and therefore not assured. Households are predicted to move out of Oxford and into Oxfordshire, due to the cost of housing within the city.

At the same time, the stock of properties available for rent within the city is misleading, due to the student rental market. There is only one pure build to rent scheme in the planning pipeline at the moment – around 150 units in Botley, despite plans needing to provide much more rental property. The pipeline for housing units within Oxford is approximately 3.8k, and that for areas adjacent to or located in key science and technology districts is around 6.8k according to Carter Jonas, so there is a mismatch between where properties are being planned and where they are needed. Without associated transport linkages between planned housing and workplaces, further pressure will be placed upon the region's road network and transport schemes like the Cowley branch line become even more imperative.

Transport

Transport is one of the more contentious issues within the ecosystem and in consultation for this report, it is one of the most frequently cited challenges for companies and organisations. There is a clear view that the lack of investment in transport connectivity and speed of delivery will impact negatively on inward investment and on talent attraction and retention. Public transport is not easy to navigate in Oxfordshire, with multiple bus routes, services, and train systems. There is a view that the system does not work synergistically for the end user. It is unlikely that car usage will be diminished if there is no alternative for users, while cycling/active transport is not a solution for all sites or all people.

Within the region's science campuses and parks, different developers and operators are taking different approaches. Milton Park had a bus service but decided to switch to subsidising the public bus network. Oxford North is looking at use of section 106 funding for improved and increased bus services, locally and further afield.

When considering the need for Oxfordshire's innovation hubs to be joined up, there are two distinct issues that need to be considered, (i) is the need for better bus/rail routes that join all the science parks/campuses together, or (ii) is the key issue about getting to work? Easy, regular, and affordable transport unlocks accessibility to working places and connectivity is key for successful working environments and inclusive labour markets. There may be a reduction in transport usage if houses are built near workplaces, but the distributed labour market means that there will always be a need for transport within the ecosystem.

> "There nees to be a future-looking transport system which is Oxfordshire-wide and not just focused on the City of Oxford.

Investment into fast bus-routes and rail is essential, including East-West rail; the Banbury to Birmingham line, connecting Begbroke-Oxford-Culham-Didcot; and the Cowley branch line.

Speed of delivery is critical for infrastructure development and the Cowley branch line should be a priority.

A clear message emerged from the discussions with the science and technology community in the lead up to this report. There needs to be a future-looking transport system which is Oxfordshire-wide and not just focused on the City of Oxford.

Congestion

The 2013 report recognised that Oxfordshire has a superb strategic location – 40 miles from Heathrow and 50 miles from London, with excellent road connectivity. However, congestion was identified as a major issue and particular concerns were expressed with regard to the A34 and congestion in and around Oxford.

England's Economic Heartland is one of seven sub national transport bodies, jointly funded by the Department for Transport and local authority partners, responsible for planning and promoting the transport infrastructure and policy framework required to realise the region's economic potential while reducing the transport system's impact on the environment. Oxfordshire sits within the Heartland's regional footprint. Fourteen towns and cities in the Heartland area, have been ranked in transport analysts Inrix's top 100 most congested places in the UK,[34] but Oxford is not one of these and does not appear in the top 100 list. The most congested place in the region was Cambridge, ranked as 15th in the UK and 82nd globally, where traffic jams were said to have cost drivers an average of 65 hours during 2022 (compared to if they had been driving in free-flow conditions). London was named the most congested city in the world with 156 hours lost.

Nevertheless, data reported by Oxfordshire County Council showed that 12.3% of

34. https://inrix.com/scorecard/

Oxfordshire's 744 miles of class A road network, equalling 91.2 miles of roads, experienced delays in 2019, which is the most recent data available. A delay is defined as 1 minute or more difference in average journey time per mile when comparing peak morning travel (7.30 – 9.30am) and free-flow conditions. This does not include Highways England roads – the A34, M40 and A43.

Research by National Highways (known until August, 2021 as Highways England) found that drivers using the A34 for professional purposes expressed negative views towards the road, particularly in the Oxfordshire area. The experience on the A34 was described as *"stressful"* and *"frustrating"*. Drivers who had control over their driving routes said they look to use local roads where possible to avoid the traffic.[35] Overall, improvements to safety and congestion on the A34 were considered to be a top priority. In separate research, National Highways reported that 79% of people living in and around Oxford say they want to see the A34 improved, with just under half of those stating the road should be improved as a top priority.[36]

> "Overall, improvements to safety and congestion on the A34 were considered to be a top priority."

Other infrastructure – data and power

Data

The rollout of enhanced digital infrastructure is vital for rural and urban Oxfordshire. This issue was considered by Advanced Oxford members when considering the, now abandoned, Oxfordshire Plan 2050. The expressed view was that there is a need for ambition with regard to digital connectivity. As a region, Oxfordshire is very far from where it needs to be. Rural areas still suffer from extremely poor digital connectivity, including mobile reception, the standard of which is still a significant drag on productivity. There is a need to see rapid progression to 5G and high speed ubiquitous broadband connectivity across the county. Benchmarking against globally significant innovation centres, undertaken by PwC to support development of the 2019 Local Industrial Strategy,[37] showed that the region is poor in this area and there is a need for significant investment and improvement.

Power

The supply of power within the region could become a limiting factor for Oxfordshire's industrial and innovation base. There is a mismatch in supply of electrical power versus demand and this could be exacerbated as the pipeline of innovation campuses and science park development grows. Demand increases with all the additional needs: powering phones, cars, and the shift from gas but there are also concerns about managing demand within science and technology-based activities. For example, life sciences businesses need 100% reliability of power supply for laboratory operation and equipment. However, there may also be behavioural and cultural issues affecting demand, and workspaces can be subject to over-specification. Nevertheless, demand is increasing throughout the year, and this is not a peak demand issue for the region.

National grid upgrading is needed and regional provider, SSEN, should upgrade the system in 2026. The relationship with SSEN should be strengthened and the region could benefit from a collective voice matched to an account management system on the provider side. Currently, there is no transparency on how much power has been booked up for the next 10 years, versus what is actually being used, and different scenarios are needed for demand in the next 5 to 10 year.

35. Nationalhighways.co.uk (2021)

36. Nationalhighways.co.uk (2021)

37. https://www.oxfordshirelep.com/publications

There is also a need to determine what is the right choice for renewable energy as a sensible and feasible choice for sites in the medium to long term. Making the right choice at the moment may be difficult and confusing, with different potential technologies, from hydrogen cells to battery storage and potentially fusion. Battery storage is an option, but takes a lot of space, and hydrogen will depend upon government policy in the next 5 to 10 years. Perhaps demonstration of these technologies, within the region, could form part of the solution, building on other local, large scale demonstration projects such as Project LEO[38] and Energy Superhub Oxford,[39] both of which were recipients of the Industrial Strategy Challenge Fund Prospering from the Energy Revolution programme?

> The supply of power within the region could become a limiting factor for Oxfordshire's industrial and innovation base. There is a mismatch in supply of electrical power versus demand and this could be exacerbated as the pipeline of innovation campuses and science park development grows.

Access to finance

In 2013, the focus was on the role of entrepreneurs-cum-investors who had fuelled early growth in Oxfordshire's high tech business community, but there was also a call to strengthen investment with a call for more angel activity and more patient capital.

There have been some significant developments within the ecosystem, and within the UK, since the 2013 report called for government to develop measures to encourage institutional investors with long term perspective, such as pension funds, to invest in high tech firms. Oxford Science Enterprises (OSE) launched in 2015 to build world-changing businesses based on academic discoveries in life sciences, deep tech and health tech from the University of Oxford, Harwell and Culham. The Patient Capital Review of 2016/17 led to the creation of British Patient Capital by the British Business Bank in 2018, although it is probably too early to be able to tell if this will lead to more, longer term investment. However, Woodford Investment Management closed in 2019 and there is a continuing problem that UK institutional investors – insurance companies and pension funds – are not investing into the science and technology sector.

The demand for innovation space – both office and laboratory – set out above, is being fuelled by significant investment into the region's science and technology companies, particularly into life sciences. However, data compiled by the BIA[40] shows that the investment environment for the biotech industry in 2022 had its challenges. £1.8 billion was raised by UK biotech in 2022, in contrast to the record £4.5 billion raised in 2021, with £1.2 billion venture capital raised by companies in 2021. On a positive note, the report also identified new venture capital funds, created in 2022, with a mandate to invest in UK biotech, will add another £3.7 billion of capital that could be attracted to the UK sector. The big downturn was in public markets, which contributed only £575 million to the UK sector's annual fundraising total, reflecting global trends across all sectors.

Views expressed at an investment conference organised by MedCity and the NHSA[41] in March, 2023, where the discussion focused again on life

38. https://project-leo.co.uk/

39. https://energysuperhuboxford.org/

40. https://www.bioindustry.org/policy/finance-tax-and-investment.html

41. UK Life Science Investment Symposium, https://www.medcityhq.com/ and https://www.thenhsa.co.uk/

sciences, while looking at wider trends in science and technology investment, suggest that 2023 will see a reset period, with investors tending to focus on their own portfolios. The reduction in IPO activity will have trickle down effects across the whole investment environment at all stages. Generally, the view is that 2023 will be a difficult year.

It is also worth noting that acquisition of UK innovation by US companies increased in 2022, with Gilead's acquisition of MiroBio for an estimated £350 million, and AbbVie's acquisition of DJS Antibodies for £229 million, notable deals from the Oxfordshire ecosystem. International players attracted into the ecosystem bring much needed investment into later stage companies, but this brings risks too. While MiroBio – now branded as Gilead - and DJS Antibodies currently have retained operations in Oxfordshire, another company, PepGen, is now entirely US-based.

> The demand for innovation space – both office and laboratory – set out above, is being fuelled by significant investment into the region's science and technology companies, particularly into life sciences.

IMAGE COURTESY OF MILTON PARK

There has been good progress on development of the finance environment in the region in the time since the 2013 report, including considerable work within government to support funding for innovation, including the Patient Capital Review in 2016/17.[42] Access to finance – particularly risk capital – continues to be a critical issue in ensuring the success of Oxfordshire's innovation ecosystem. Early-stage funding is likely to need particular attention during this period of resetting, and many young companies are on a continuous treadmill of fund raising. Most government intervention has been to support venture capital, but series B and later stage fundraising is still challenging in the UK – the £40+ million raises – and if companies are to be retained in the region, and indeed the UK, there is still a need to create the conditions and encourage UK institutional investors to back science and technology-based companies. The creation of Oxford Science Enterprises has been a positive development for the region, but it cannot invest in all companies within Oxfordshire – it is not constituted to do so, and there are downsides to having one, significant player in town. There is now a need to see a growth in and diversification of finance options within the region, including attracting new players and funders into the ecosystem. There is still a need to see recycling of money made from exits and to encourage new, active angel investors to work in the region. Inward investment activities should also focus on encouraging investors to 'put boots on the ground' with long-term commitment to the ecosystem.

OIE 2013 contained two recommendations about angel investment in the region, and one relating to institutional investment. There have been significant changes to the angel network within Oxfordshire in the last decade, so a case study is provided, highlighting developments. Similarly, a significant development in the investment environment in the last ten years has been the creation of Oxford Science Enterprises (OSE). A case study relating to OSE is also presented. These case studies can be found after the conclusion to this chapter.

Conclusions

There have been many positive developments within the local business environment in the last decade since OIE 2013 was published. There is a growing stock of innovation space with many new developments in the pipeline which will add much needed capacity into the system in the next 5 years. Housing and transport continue to be key challenges which need to be addressed. Other infrastructure needs investment too, particularly data connectivity and supply of power.

A healthy innovation ecosystem is dependent upon the supply of risk capital to support our most innovative businesses. There has been development in this area in the last decade, both at a local level, but also in government policy. As the ecosystem matures, the financing environment needs to change too and there is an opportunity to diversify and swell the number of investors operating in the region.

42. https://www.gov.uk/government/publications/patient-capital-review

CASE STUDY

The Oxford Investment Opportunity Network (OION) is the business angel platform of Oxford Innovation Finance and is Oxfordshire's principal angel network. It has been in operation since 1994 when it was one of the UK's first business angel networks. Executive Chair, Jens Tholstrup, joined the organisation, which is part of the Oxford Innovation group, in 2018, and today OION is one of the largest angel networks in the UK, focusing on technology companies from Oxford, Oxfordshire and across the country.

Originally a recipient of ERDF (European Regional Development Fund) funding, the group is now supported by a small group of sponsors, but Jens notes that the economics of managing a professional angel network are challenging. Jens saw the need to bring in as many investors as possible; people who can support companies, not just with investment, but also with expertise. He notes that there is a need to continually regenerate the pool of angels within the network, which numbers around 650 members, and to ensure there is a balanced profile. All angel network needs heavy-hitters – angels who can make and lead substantial early-stage investment into companies and help support their development – and OION would like to expand the number of these individuals and to encourage recycling of funding within the ecosystem by bringing entrepreneurs who have successfully exited into the pool of investors. According to Jens, "The number one mission is to increase our investment capacity".

OION merged with Oxford Angel Network (OAN), part of Oxford University's commercialisation arm Oxford University Innovation in January, 2020. Jens thinks this has had a positive impact on early-stage investment and has helped to create a more coherent early-stage funding platform for the Oxford ecosystem. A recent development has been the establishment of investment funds, which have been transformative. Currently raising their third fund – Oxford Innovation EIS Growth Fund 3 is open for investment – these annual funds are selective in terms of investment but can be flexible on ticket size and the fund is able to co-invest alongside OION angels as well as other investors, like OSE and Longwall. Not all investments have been into Oxfordshire companies though. Jens notes, "We look for a great team, innovative, evidenced technology with a clear USP, and commercial potential, but we will invest anywhere in the UK".

> "We look for a great team, innovative, evidenced technology with a clear USP, and commercial potential, but we will invest anywhere in the UK".

CASE STUDY

Oxford Science Enterprises (OSE) launched in 2015 to build world-changing businesses based on academic discoveries in life sciences, deep tech and health tech made at the University of Oxford. It was originally called OSI (where the 'I' stood for 'Innovation') but changed its name in 2021 to more strongly reflect its role as an independent investment company that helps to found, fund and build new enterprises.

OSE was founded by executives of the investment business, IP Group, which was originally set up in Oxford in 2000 before moving to London and floating on the London Stock Exchange. The aim of OSE was to tackle what the founders, and fellow investors, considered to be an imbalance between the funding and support available to spin-outs from the top universities in the United States compared to Oxford.

OSE's Chief Financial Officer, Jim Wilkinson, believes the problem the company was set up to address speaks for itself when you compare the fact that Oxford can point to only four, billion-pound companies (or 'unicorns') founded on its science, compared to the 200 from Silicon Valley's Stanford and 50 from MIT in Boston. He claims that Oxford, as a world leader in research, clearly had untapped potential, which OSE was set up to release.

"Our impact was almost immediate. After our launch in 2015, you suddenly get up to 20 companies a year coming out of Oxford and that starts building the critical mass needed to create an ecosystem," he says.

"While around about £125 million a year in total was invested in all Oxford spin outs each year in the five years up to 2015, we're now running at well over a £1 billion a year. We're investing over £150 million ourselves across all stages from spin-outs through scale-up, with the remainder coming from other investors outside Oxford, including international VCs and corporate investors

"After our launch in 2015, you suddenly get up to 20 companies a year coming out of Oxford and that starts building the critical mass needed to create an ecosystem"

who really recognise the quality of the science and get what we're trying to do. We're covering everything that the university does from a science and technology perspective. We're doing quantum computing and AI, fusion power, food and climate tech, biologics and small molecule therapeutics, digital health and diagnostics – areas that can make a real impact to people and society."

Long-term view

OSE evaluates the commercial potential offered by the science and technology developed at, or in partnership with, the University of Oxford. As such, it has a close working relationship with the university's knowledge exchange and technology transfer division, Oxford University Innovation (OUI). The arrangement is underpinned by a fifteen-year contract with the University, which can be renewed in 2030 if both sides agree.

On its launch in 2015, OSE raised £600 million from its founders and other

investors and, in 2022, it added a further £250 million of investment. The ultimate aim is to become self-funding through receiving sizeable returns when a business it has helped to build either floats or is sold. It is not quite there yet because, as CFO Jim Wilkinson explains, OSE takes a long-term view on its investments, in contrast to the average VC firm, which operates under the constraints of a limited lifetime fund.

"We find an idea and then create a company to get it out into the world," he says. "We tend to find the management, other investors and help with 'hands-on' operational support and on finding space for the company. We're very patient investors, we expect our average holdings to be about 10-12 years. We hold these companies with the intention of building world-changing businesses, which takes time. Our fellow investors will typically include international firms like Google Ventures, Tencent, and other companies, who can help our companies become global leaders."

So far, the business has benefited from two flotations, Vaccitech (which helped to develop the Oxford vaccine against Covid, developed and distributed by AstraZeneca) and Pepgen, which is transforming treatments for neuromuscular conditions. It has also benefited from seven company sales, including electric motor manufacturer YASA to Mercedes in 2021 as well as DJS Antibodies to AbbVie and MiroBio to Gilead Sciences, both in 2022.

City centre wet labs

Another crucial facility it brings to its portfolio is office and lab space, starting off with the Grass Roots incubator, which occupies the basement level of its Oxford headquarters. For companies needing more room, it also has two properties on the Oxford Science Park that offer 50,000 square feet of office space and 58,000 square feet of wet lab facilities.

"We find an idea and then create a company to get it out into the world,"

The new development for 2023, and beyond, is the conversion of part of the Clarendon shopping centre in the heart of Oxford's city centre, to offer 5,000 square feet of wet lab space for start-ups. Pete Wilder, Head of Property at OSE, explains it has taken on the lease for part of the redeveloped centre to fix the twin problems of a lack of wet lab space in the city centre and, more specifically, inflexible landlords.

"Landlords often don't understand what our companies need," he explains. "They are unwilling to offer the flexibility of term, for example, if you consider that funding rounds might take place every two years, it's just impossible to sign up to a ten-year lease. So, we've leased space ourselves and then lease it back to our companies by using our covenants to underwrite the value of the building, which is great for landlords."

The new city centre wet lab facilities are expected to be ready for OSE's companies during 2025 and with start-up space in great demand in and around Oxford, OSE has its sights set on providing further capacity in the coming years with the goal of providing its companies with the best start in life possible.

2023 Recommendations

Leadership

The Oxfordshire Innovation Engine 2013 noted there were 'ambiguous attitudes towards growth' across the region. A frequently expressed concern in 2013 was that Oxfordshire lacked strong leadership and consistent messaging, with a reluctance to embrace growth positively and manage it for the benefit of future generations. A decade on, these perceptions persist. The Government's levelling up agenda, the low level of funding into the region associated with the Shared Prosperity Fund (the Government's replacement for European regional development funding) the fragmentation of this funding to the local authority level, the uncertainty about the future of LEPs and reduced funding to OxLEP, alongside the collapse in 2022 of the Oxfordshire 2050 Plan have all contributed to this perception. With central government's devolution agenda seemingly favouring mayoral regions and combined authorities, Oxfordshire is lacking strong, economically focused representatives, advocates, and cheer leaders. In the absence of structural change at the local and regional level, there is a need for the innovation community to continue to engage and bring its voice and influence to decision making, planning and to continue to make the case for investment. To quote from OIE 2013, '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.' All players should support activities which contribute to the region's prosperity, economic resilience, contribute GVA to the UK and address pressing societal, technological, environmental, health and sustainability challenges. Oxfordshire is a place that can identify, develop and provide solutions to the World – or, to follow the phraseology used within the University of Oxford, together we tackle the most important, difficult and impactful problems that are faced globally.

RECOMMENDATION:

Strengthen leadership across the region in relation to innovation.

Transport

Public transport is not easy to navigate in Oxfordshire, with multiple bus routes, services, and train systems, meaning it does not work synergistically for the end user. Car usage will not be diminished if there is no alternative and cycling/active transport is not a solution for all people or all places within the region. A continued lack of investment in transport connectivity and speed of delivery will impact negatively on inward investment and on talent attraction and retention. This issue does not impact solely upon our science and technology community – the system needs to work for everyone across the region.

Easy, regular, and affordable transport unlocks accessibility to working places and connectivity is key for successful working environments and inclusive labour markets.

Demand for public transport is strongly linked to housing issues – Oxfordshire's science and technology businesses need a mobile, local labour market, so people can move between employers without having to move home. There may be a reduction in transport usage if houses are built near workplaces, but the distributed labour market means that there will always be a need for transport within the ecosystem. Investment into fast bus-routes and rail is essential.

RECOMMENDATION:

There needs to be a future looking transport system which is Oxfordshire-wide, not just focused on the City of Oxford.

The finance environment

There has been good progress on development of the finance environment in the region in the time since the 2013 report, including considerable work within government to support funding for innovation, including the Patient Capital Review in 2016/17.[43] There is now a need to see a growth in, and diversification of, finance options within the region, including attracting new players and funders into the ecosystem. There is still a need to see recycling of money made from exits and to encourage new, active angel investors to work in the region. Inward investment activities should also focus on encouraging investors to 'put boots on the ground' with long-term commitment to the ecosystem.

RECOMMENDATION:

Grow and diversify the number of risk capital investors operating within the region.

43. https://www.gov.uk/government/publications/patient-capital-review

Inward investment

Oxfordshire has been successful in attracting inward investment but has not landed one big R&D investor, or significant investment from the tech community. Rather, Oxfordshire has successfully grown its own community of businesses, bottom up.

The rate of company formation and growth is such, that Oxfordshire could successfully pursue a strategy of 'born in Oxford, raised in Oxford(shire)', although this is a long-term game. If the regional goal is inward investment, the ecosystem needs to work collectively to develop the strategy.

Do we want a small number of big-ticket investments, or many medium sized investors? Regardless of the strategy, there needs to be an open and compelling offer, the entry point(s) for investors must be clear and there must be absorptive capacity to accommodate larger scale investment. With regard to home grown businesses, the focus should be on retaining companies within the region and being conscious about how spill-over benefits and functions such as manufacturing, can locate and bring benefit to other parts of the UK as the ecosystem matures.

RECOMMENDATION:

There is a need for strategic positioning with regards to inward investment. Different players within the ecosystem need to work together to ensure that Oxfordshire is open, coherent and can respond to potential investors.

Evolution of the ecosystem from distributed nodes, to joined up landscape

While the city of Oxford, and the universities are well known for their innovation activities and their enterprise potential, the Oxford ecosystem is actually a county-wide endeavour. The people and places where innovation activity takes place are spread across the region. Many of these places have grown significantly in the last decade and have become better known outside the region and internationally. Many have thriving groups of firms and some have invested in the soft infrastructure that is needed to create vibrant communities and clusters. There is now a need to join up this distributed ecosystem and to encourage more networking, collaboration and interplay between the nodes. If our science parks, campuses and innovation centres are the jewels, there is now a need to create the links that hold the piece together and to display the whole to those less familiar with the region's assets.

RECOMMENDATION:

Develop activities which join up nodes of innovation across the region and help others to navigate the landscape through better defined pathways and connectors.

Telling the story, banging the drum for Oxfordshire

It has long been recognised that there needs to be a compelling narrative around the innovation ecosystem within Oxfordshire, so the benefits, opportunities and need for investment and development are understood and supported. The distributed nature of the innovation landscape across Oxfordshire can lead to confusion, meaning stakeholders, from potential inward investors to entrepreneurs, are unfamiliar with the diversity and the value of activity across the region. The variety, sectoral diversity, and breadth of clusters across the region should be seen as a strength.

There is a need to be proactive in telling Oxfordshire's innovation story – not everyone knows how rich, varied and excellent this ecosystem is. This story needs to be adapted to different audiences and channels to reach different groups.

The term 'growth' can be associated with a negative narrative by a number of independent groups, but if there were a cohesive and positive message around "resilience" and "prosperity", negative perceptions may be shifted. Communicating the message that change is good for the city and the region can also explicitly draw together other activities, such as equality, diversity, inclusivity, and the relationship to and co-dependence with the foundational economy, generating social value.

There is a need to speak with "one voice," with clear messaging and shared assets which can be 'franchised' and used by anyone in the ecosystem. This will allow for consistent messaging, which reinforces a positive narrative, regardless of the spokesperson or audience.

RECOMMENDATION:

Develop communications assets (messaging, core statistics, case studies, marketing materials etc) which reflect the needs of different audiences, including citizens and local, regional, and national decision makers.

What next?

The funders of the 2013 Oxfordshire Innovation Engine, whilst not committed to providing on-going financial support for implementation of the original recommendations, nevertheless manifested their collective commitment through the 2016 update report which, again, underlined the importance of the work. However, as organisations change and people move on, there is always the risk that less emphasis is given to implementation and to monitoring progress in delivering an ambition. There is great passion and commitment within the region's innovation ecosystem for using science and technology to drive commercial success and to solve global challenges using ideas born and developed within the region.

Advanced Oxford intends that this report acts as a further stimulus to Oxfordshire's innovation community, to come together, to drive the next decade of prosperity, to build a forward-looking and resilient economy. New mechanisms and structures may be needed – Advanced Oxford will play its part – but a collective endeavour, which draws the stakeholders together, is needed if we want to see Oxfordshire's innovation engine flourish, strengthen and play a pivotal role in making the UK a beacon for science, technology, and innovation.

Methodology

The data conundrum

The Oxfordshire Innovation Engine report 2013 estimated the stock of high-tech firms, many of which had a strong focus on R&D, at around 1,500 businesses, employing around 43,000 people. These numbers were a best effort calculation, recognising the challenge of compiling robust data sets. Ten years on, the challenge of quantifying and characterising the nature of Oxfordshire's innovation ecosystem is no less difficult.

Any analysis starts with Companies House and ONS data. The 2013 and 2016 reports drew on the ONS Business Register and Employment Survey (BRES), the Interdepartmental Business Register (IDBR), which draws on VAT and/or PAYE paying businesses and used the Eurostat definitions for high tech and high/medium tech companies that are knowledge intensive and high tech and high/medium tech manufacturing companies (see below for definitions). These analyses in turn draw on SIC codes (Standard Industrial Classification of economic activities) which are used by companies as they incorporate. Anyone undertaking industrial or economic analysis will be aware that there are significant downsides to relying on SIC codes to identify groups of companies. The SIC codes can be broad and do not identify much about what a company actually does – for example, code 72110 is defined as research and experimental development on biotechnology. The life sciences sector, which covers everything from chemistry driven pharmaceuticals to data driven drug discovery, gene therapy to diagnostics, could use one of a number of different SIC codes:

Company name	SIC code(s)	What they do
Adaptimmune Therapeutics	72110	**SIC code:** Research and experimental development on biotechnology **Company description:** T cell receptor, T cell therapy, immunotherapy focused on cancer
Adaptix (one of 5 related companies, all registered in Oxfordshire)	72190	**SIC code:** Other research and experimental development on natural sciences and engineering **Company description:** Low dose, low cost 3D imaging as an alternative to 2D Xray clinical radiology
Arctoris	72110	**SIC code:** Research and experimental development on biotechnology **Company description:** Tech-enabled drug discovery combining automation, with advanced computational approaches – programmess in oncology and neurology

Company name	SIC code(s)	What they do
Arcturis Data Ltd (one of 3 companies, all registered in Oxfordshire)	74909	**SIC code:** Other professional, scientific and technical activities **Company description:** Generating insight from real-world data to support the discovery and development of new medicines
Brainomix	62090	**SIC code:** Other IT activities **Company description:** AI-powered imaging biomarkers to enable precision medicine for better treatment decisions
DJS Antibodies	72110	**SIC code:** Research and experimental development on biotechnology **Company description:** Developing a new generation of highly specific and effective biologics for the treatment of chronic inflammatory diseases
Exscientia PLC	64209, 72190	**SIC code:** Other research and experimental development on natural sciences and engineering NB 64209 is activities of a holding company **Company description:** Combining AI techniques with experimental innovation to engineer a new set of processes for drug discovery
GaitQ	72190	**SIC code:** Other research and experimental development on natural sciences and engineering **Company description:** Developing a smart cueing wearable device with accurate data collection and gait analysis through proprietary software for Parkinson's Disease
Immunocore	72190	**SIC code:** Other research and experimental development on natural sciences and engineering **Company description:** T cell receptor biotechnology company working to develop and commercialize a new generation of transformative medicines to address unmet needs in cancer, infection and autoimmune disease
Ipsen BioInnovation Centre	72110	**SIC code:** Research and experimental development on biotechnology **Company description:** Experimental science and R&D to develop medicines for oncology, rare diseases and neuroscience
Nucleome Therapeutics	72110	**SIC code:** Research and experimental development on biotechnology **Company description:** Unlocking non-coding DNA within the genome to discover which variants regulate which genes in which cell types for drug discovery and development

ONS data also draws on registered addresses for companies. Unlike SIC codes, companies often update their registered address, but this may reflect a change in accountant, a new HQ or holding company, rather than a change of location. It is difficult to find reliable data on trading address, so registered address is the basis for any attempt to identify a company as being located within a particular geography, in the case of this report, the county of Oxfordshire. The examples overleaf demonstrate data that is missed from ONS data that relies on registered address. It should be expected also that while companies with a trading address in Oxfordshire, but a registered address outside the region will be missed, equally, there will be companies with an Oxfordshire registered address where the trading address is elsewhere. Whether this balances out is difficult to determine.

Company name	Trading address	Registered address	SIC code(s)	What they do
Habitat Energy	Oxford Centre for Innovation, Oxford	London since December 2021	35140, 62012	Optimisation of energy trading, battery storage and renewable energy assets, combining the latest techniques in machine learning and artificial intelligence with deep knowledge of the market.
Infleqtion (previously known as ColdQuanta UK)	Oxford Centre for Innovation, Oxford	Warwick	82990	Quantum technologies to create quantum computers, sensors and networks
Vertex Pharmaceuticals UK Ltd	Multiple, but R&D site on Milton Park, Oxfordshire, employing ~ 235 FTEs	London	72190	Drug discovery – using scientific innovation to create transformative medicines

The approach in 2023

The 2013 and 2016 reports relied on ONS, BRES and IDBR data, supplemented by surveys and the author's (SQW) and commissioners' (University of Oxford and The Oxford Trust) knowledge of the ecosystem. Case studies were also used.

Advanced Oxford and Elsevier have equally had to draw on similar sources, including Companies House and ONS data via NOMIS (census and labour market statistics). Companies with registered addresses in Oxfordshire were identified in Companies House data based on the county and postcode information in their addresses. In some instances, the Eurostat definitions for high tech knowledge intensive firms have been used, in part to provide a comparison to data presented in the 2013 and 2016 reports. In addition, data has also been sourced from Innovate UK, the UK Innovation Survey and data/analytics platform mnAI. Counts of technology/IP-based businesses were sourced from Beauhurst by Oxford Brookes University for the gender diversity analysis, contained in the Dynamics of Innovation Ecosystem section of this report. Other company data providers were also considered for company count data e.g. (Crunchbase, Dealroom), but mnAI was selected for its apparent full coverage of active companies present in Companies House data and Beauhurst for the ability to analyse some diversity characteristics.

There was also an attempt to access granular data relating to R&D tax credit claimants from HMRC, which was unsuccessful. HMRC publishes data by region (Oxfordshire) and a national breakdown by industry sector grouping. In preparation for this report, Advanced Oxford made a request for an analysis of the number and cost of R&D tax credit claims for the county of Oxfordshire, as per HMRC's supplementary table RDS1, with the claims further broken down by industry sector SIC code groupings 21, 26, 30, 58, 59, 60, 61, 62, 63, 71, 72 where the data was non disclosive (i.e. the individual company could not be determined from the data). All requests were unsuccessful, so the data used in this report, and the dashboard created to accompany it, uses the combined number of claims for Oxfordshire for all R&D tax credit schemes and all sectors.

Patent filing data and publication data can provide useful insight into companies that are generating new intellectual property

or pioneering research. Analysis of data associated with these activities has been used in this report and in the dashboard, courtesy of Elsevier. Businesses publishing peer-reviewed publications and applying for patents in Oxfordshire were identified in Elsevier's Scopus database, by filtering on geographic keywords, postcodes, and Companies House company names. Further analysis of patent data was derived from IP business intelligence platform, Filing Analytics, courtesy of Mathys & Squire.

Data on innovation-focused companies operating within Oxfordshire was also compiled from tenancy lists for key science parks/campuses/sites, Scale-up Institute's Visible Scale Up list for Oxfordshire and information from OSE's portfolio of companies was also used.

The multiple datasets described above were combined, where possible, by using fuzzy matching approaches to find matches amongst the business names in the different datasets.

In producing this report, the authors have not referred back to every issue considered or identified in 2013 or 2016 respectively, although progress against the key recommendations and the 2013 success measures has been determined. The assessment was undertaken through workshop activities with the membership of Advanced Oxford, as well as engagement with other companies and individuals outside Advanced Oxford's membership.

Eurostat definitions

Innovation is a broad concept, and from a business perspective, it can be considered in the context of companies that engage in the development of new products and services, and/or from the perspective of companies that are innovating the way that they operate, to drive efficiencies, improvements or productivity gains within a business. This report considers the first category – the companies that are commercialising ideas through science, technology, engineering, maths and data to generate new products and services. Many of these companies will also be 'process' or 'organisational' innovators.

In some instances, Eurostat[44] definitions have been used to characterise and identify companies within the region's knowledge economy. The groupings and associated SIC codes used are as follows:

Grouping	Associated SIC codes
Narrow definition:	
High-tech knowledge intensive companies	59-63 and 72
High-tech manufacturing	21, 26, 30.3
Broader definition:	
High and medium-tech knowledge intensive companies	58-63, 71-72, 74.1, 74.9
High and medium-tech manufacturing	20-21, 25.4, 26-29, 30 excluding 30.1, 32.5

44. https://ec.europa.eu/eurostat/statistics-explained/

2013 Recommendations

RECOMMENDATION
RESEARCH INFRASTRUCTURE
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.
SOFT INFRASTRUCTURE
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.
PHYSICAL INFRASTRUCTURE
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.
Support the implementation of superfast broadband across the whole of Oxfordshire by 2015 through the Oxfordshire Local Enterprise Partnership.
STRATEGIC DIRECTION AND LEADERSHIP
Provide strong public and private sector leadership and consistent messaging to realise the growth potential of Oxfordshire's 'innovation engine'.

Reproduced from *The Oxford Innovation Engine – Realising the Growth Potential* (2013)

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Prof. Simonetta Manfredi wrote the section on gender diversity within the Dynamics of the Ecosystem section of the report, using data from Beauhurst.

Advanced Oxford used data from mnAI in this report – thanks to Devon Struthers and team for their assistance.

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Qualitative data, particularly relating to the success measures and the review of recommendations from the 2013 report, was collected through discussions and workshops with a range of companies and organisations, including members of Advanced Oxford. The authors are grateful for the contributions and input received.

The images are attributed as they are used throughout the report. We thank the companies and organisations who shared these images for use by Advanced Oxford.

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If you are reading a hard copy of this report, it has been printed using renewable energy, with no chemicals or water and is 100% recyclable, although hopefully you will read and keep it. It is printed on sustainably sourced material and has been printed by the highest-ranking B Corp printer in the world: Seacourt Ltd, Oxford.

Sarah Haywood
Managing Director, Advanced Oxford

June, 2023

About Advanced Oxford

Advanced Oxford is a not-for-profit membership organisation with members drawn from R&D based/innovative companies working across Oxfordshire. Our membership includes companies, Oxford's two universities, the NHS through Oxford Academic Health Science Network and providers of innovation infrastructure and support.

Advanced Oxford is research-led, providing analysis and a united voice for our members on the key issues affecting the development of the innovation ecosystem in the Oxford region. We generate our own research and work to support and inform key stakeholders involved in the development of the business environment, infrastructure, and policy. Advanced Oxford is working to support the long-term development and success of the Oxford region as a place to live and work. We do this by drawing on our collective experience of setting up, running, or working in knowledge-based, innovation-focused businesses and organisations. We use our connections to other businesses to generate evidence and undertake research.

Advanced Oxford was set up in response to the Oxford Innovation Engine Update report. Published in 2016, the report identified the need for stronger engagement from the innovative businesses in Oxfordshire in the work to develop the region as a centre of excellence and an engine room for innovation. Work to scope and set up Advanced Oxford started in 2017.

For further information about Advanced Oxford, our work and members:

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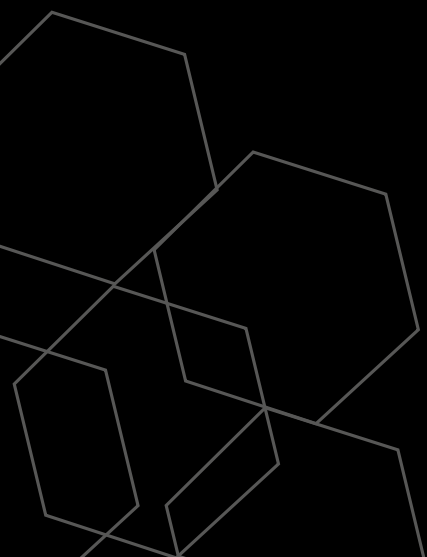

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