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Oxfordshire Strategic Economic Plan

Deep Dive Report: Innovation and Diffusion

Prepared on behalf of Oxfordshire LEP

SQW

OxLEP driving economic growth

Contents

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Preface

In January 2023, Oxfordshire Local Enterprise Partnership (OxLEP) commissioned SQW – working with Oxford Brookes Business School and glass.ai – to prepare a refreshed **Strategic Economic Plan** for Oxfordshire.

To support the development of the Strategic Economic Plan, an **Independent Economic Review** was completed. As well as taking a fresh look at the county's economic data and bringing together a wide range of existing evidence, the Review focused on four key questions, each of which has transformational, long-term implications for Oxfordshire's economy:

- How do we **enable progression** within Oxfordshire and **achieve more inclusive economic growth**?
- How do we **advance Net Zero and sustainability** in shaping future economic growth?
- How do we **secure the future of the 'foundational economy'** within Oxfordshire?
- Recognising Oxfordshire's world class strengths, how do we **accelerate innovation and diffusion** – both within Oxfordshire and across the UK?

This topic paper considers the fourth of these questions, looking in detail at innovation and diffusion, its importance to the county's economic sustainability and its prospects for the future.

1. Our starting point for the Deep Dive

Introduction

1.1 For many, Oxfordshire's economy is synonymous with innovation. Its credentials are impressive. University of Oxford is the highest ranked university in the world according to Times Higher Education's World University Rankings (and it has held this position continuously for eight consecutive years)[1]. It has 22,000 students (over 40% of whom are international) and it is also associated with 11 winners of the Nobel Prize in chemistry, five in physics and 16 in medicine. Oxford Brookes University also performs strongly, for example in terms of IP incomes. In addition, Oxfordshire is the host of world class science at Harwell Campus and Culham Science Centre. The county is home to a stream of science and technology focused start-up businesses, and also to several that have now achieved 'unicorn' status (i.e. valued at more than $1bn) including, over the last decade, Oxford Nanopore Technology (DNA/RNA sequencing technology) and Exscientia (applying artificial intelligence to precision medicine).

1.2 Against this backdrop, Oxfordshire's *Local Industrial Strategy (LIS)* – which was developed locally in response to the *Industrial Strategy White Paper (2017)* and published in 2019 – set out Oxfordshire's ambition to be a top three global innovation ecosystem by 2040. In practice this meant "*building on our world-leading science and technology clusters to be a pioneer for the UK for emerging transformative technologies and sectors*". The LIS and its supporting documents identified six main features of a global innovation ecosystem. It concluded that Oxfordshire was already world class on some elements but that further progress was needed on others. Specifically:

- **Iconic brand**: Oxfordshire needs to strongly set out a distinctive and unique proposition that makes it stand out from its competitors and provides a strong purpose that Oxfordshire's citizens, businesses, leaders and investors can unite around;
- **Liveable place**: Oxfordshire has a unique and attractive lifestyle, but needs to do more to solve the critical issues of housing unaffordability and connectivity that are impacting on its ability to attract and retain talent;
- **Strong financing**: Oxfordshire is home to various funds, but needs to think more creatively about how to attract investors and different types of investment in order to secure the financing it needs;
- **Commercial culture:** Oxfordshire has a strong commercial culture but should look to create better enabling conditions for innovation, commercialisation, and scale-up of businesses;

[1] See Oxford University is the world's top university for a record eighth year | University of Oxford

- **Keystone assets:** Oxfordshire is home to a number of globally-renowned assets, and should look to better use its strengths here and connections with the (then-)Oxford-Milton Keynes-Cambridge Arc to better attract talent, business, and investment;
- **Talent proposition**: Oxfordshire needs to do more to attract and retain talent, and to nurture and develop the skills of its domestic labour pool, for both knowledge-intensive jobs and for the critical jobs that support them.

1.3 Nationally, the Industrial Strategy White Paper was subsequently 'downgraded' and, with a change of prime minister and in the midst of the pandemic, the national focus shifted to *Build Back better: Our Plan for Growth (2021)*. UK government then published an *Innovation Strategy (2021)*; expressed an ambition to make the UK a "*science and tech superpower by 2030*" in its *Integrated Review of Security, Defence, Development and Foreign Policy* (2021)[2]; and set out a systems-based *Science and Technology Framework (2023)* through which its superpower intentions might be achieved. In parallel, various reviews were completed. Sir Paul Nurse led an independent review of the existing ecosystem of research, development and innovation within the UK, to identify improvements to the organisational research landscape required to deliver the Government's ambition to be a science superpower[3]. The Nurse Review concluded that a successful landscape for research, development and innovation has ten key attributes: high research quality; agility and flexibility in approach; permeability between sectors, disciplines and organisations; transparency and navigability for those seeking to engage with R&D; a skilled workforce; inspirational leadership; a good research culture embracing ethical behaviour; strong international collaboration; and financial sustainability.

1.4 For the most part, the attributes identified by Sir Paul Nurse map onto the themes identified at an Oxfordshire level in the earlier LIS and onto the main principles within the *Science and Technology Framework (2023)*. Despite the enormous 'churn' of policy statements, there has therefore been some overall continuity.

1.5 Four years on – and now in the aftermath of the pandemic – all six of the LIS priorities continue to be important; and as we consider in Chapter 2, some important progress has been made. However in the context of the SEP, we have also sought to consider processes of innovation and diffusion across the Oxfordshire economy more broadly. This is challenging in terms of evidence and data, but important in relation to the SEP as a whole.

[2] *HM Government,* Global Britain in a competitive age: The Integrated Review of Security, Defence, Development and Foreign Policy (March 2021)
p 4: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/975077/Global_Britain_in_a_Competitive_Age-_the_Integrated_Review_of_Security__Defence__Development_and_Foreign_Policy.pdf
[3] *Independent Review of the UK's Research, Development and Innovation Organisational Landscape* completed by Sir Paul Nurse, March 2023

2. Understanding innovation and diffusion in Oxfordshire

2.1 The LIS set out an ambition for Oxfordshire to be a top three global innovation ecosystem by 2040. The extent to which Oxfordshire is on track to achieve this ambition is very hard to 'measure' in quantitative terms – although there are many different indices which claim to provide key insights (despite the substantial definitional challenges). One is the *Global Innovation Index 2023*[4]. This considered the world's biggest science and technology clusters, and also the world's science and technology clusters with the highest levels of science and technology intensity. In relation to the former, Oxford was ranked a lowly 79; London was the best performing area in the UK (ranked 20), but the top spots were all in East Asia. On the second metric, Oxford was ranked as the third most intensive science and technology intensive cluster (relative to population density) worldwide. It was behind Cambridge (UK) and San Jose–San Francisco (USA) but ahead of Eindhoven (Netherlands) and Boston–Cambridge, MA (USA). On that measure at least, the 'top three' ambition from the LIS appears to be firmly in view.

2.2 In this chapter, drawing on evidence from the Independent Economic Review which was completed as part of the process of developing the new Strategic Economic Plan (including feedback from bilateral stakeholder consultations; submissions to a 'call for evidence'; and feedback from stakeholder workshops held in Spring 2023), we take the themes identified in the LIS (from 2019) and we consider some of the key changes over the last four years. We then reflect on the implications for wider innovation and diffusion in relation to Oxfordshire as a whole.

The LIS's 'six main features of a global innovation ecosystem' revisited

Iconic brand

2.3 Since the publication of the LIS, the strength of the 'brand' associated with Oxfordshire in relation to its innovation ecosystem has certainly grown. The University of Oxford had – and continues to have – a very high profile, not least because of its performance in world university rankings. Announcing its recent decision to invest £600m in transforming the MINI Plant Oxford to an all-electric production site from 2030, a spokesperson from BMW stated that "*Oxford is and remains the heart of the brand*"[5] – suggesting something of its brand power. But perhaps the most significant development since the LIS has been a consequence of the

[4] *Global Innovation Index 2023: Innovation in the face of uncertainty* 16th Edition – edited by Soumitra Dutta, Bruno Lanvin, Lorena Rivera León and Sacha Wunsch-Vincent, and published by the World Intellectual Property Organisation (WIPO)

[5] See MINI Plant Oxford goes Electric: £600m investment for all-electric MINI production in the UK. (bmwgroup.com)

pandemic response: the 'Oxford–AstraZeneca Covid-19 vaccine' is now known literally around the world, and with it, the currency and profile attached to Oxford and Oxfordshire has seen a further step change.

Box 2-1: Global perspectives on investment into Oxfordshire

Oxfordshire's horizons in relation to science and technology are, rightly, global. But this means that the bar is set very high. Recent comparator data suggest that Oxfordshire's international footprint is compelling relative to European benchmarks but still well behind those from North America. There are many reasons for this (not least spatial scales), but in aspiring to be a top three world class innovation ecosystem (the ambition set out in Oxfordshire's LIS), there is no scope for complacency. As the data below demonstrate, across key knowledge intensive sectors, North American comparators continue to attract more investment (as defined here) than Oxfordshire.

Capital invested* over 2010-2023 in selected sectors, Oxfordshire vs international comparators**

Source: SQW analysis of PitchBook Data, Inc. Data as at March 2023. Note that data have not been reviewed by PitchBook analysts
** Capital invested in: Pre/Accelerator/Incubator, Angel, Seed, Early Stage VC, Later Stage VC, Other VC Stages (including grants), Private Equity Growth/Expansion, PIPE. Excluding failed/cancelled deals.*
***Note that values refer to investment tagged with the above sector keywords – as many deals are tagged with more than one keyword, the sectors (and therefore investment amounts) are not mutually exclusive.*

2.4 This has translated into substantial investor and developer interest (which we consider in more detail later), but in headline comparator terms, it has catapulted Oxfordshire into new narratives. Oxfordshire is much smaller than East Asian clusters (as referenced above) and it is still also significantly smaller than major North American knowledge hubs (e.g. Boston) but it now competes well with European comparators on many different indicators; Box 2-1 provides data and evidence, based on an analysis of the Pitchbook database. Its role during the pandemic certainly helped, but the scale and pace of investment has made this tangible. In parallel, the success of some of its businesses is creating a new level of awareness and profile: alongside the likes of Oxford Instruments, Sophos and Evotec, the growth narratives of newer companies (such as Oxford Nanopore Technology, Oxbotica, Oxford Space Systems, Tokamak and OrganOx) are attracting a good deal of attention and strengthening further the world class brand linked to Oxfordshire.

Strong financing

2.5 The last decade has seen considerable investor interest of different forms across Oxfordshire's innovation ecosystem[6]; this preceded the pandemic but was considerably accelerated by it. The scale of investment has reflected the world class nature of Oxfordshire's core assets and an increasing recognition of their criticality in terms of addressing major societal challenges and, as a result, unlocking substantial economic growth and securing competitive and comparative advantages for the UK as a whole:

- Public sector investment into the science and innovation infrastructure has continued apace – including, for example, through the Rosalind Franklin Institute, Nucleic Acid Therapy Accelerator, the National Quantum Computing Centre and additional investment into the Diamond Light Source synchrotron[7] on Harwell Campus; and through an 8,000 sqm R&D facility at Culham (supported by UKAEA).

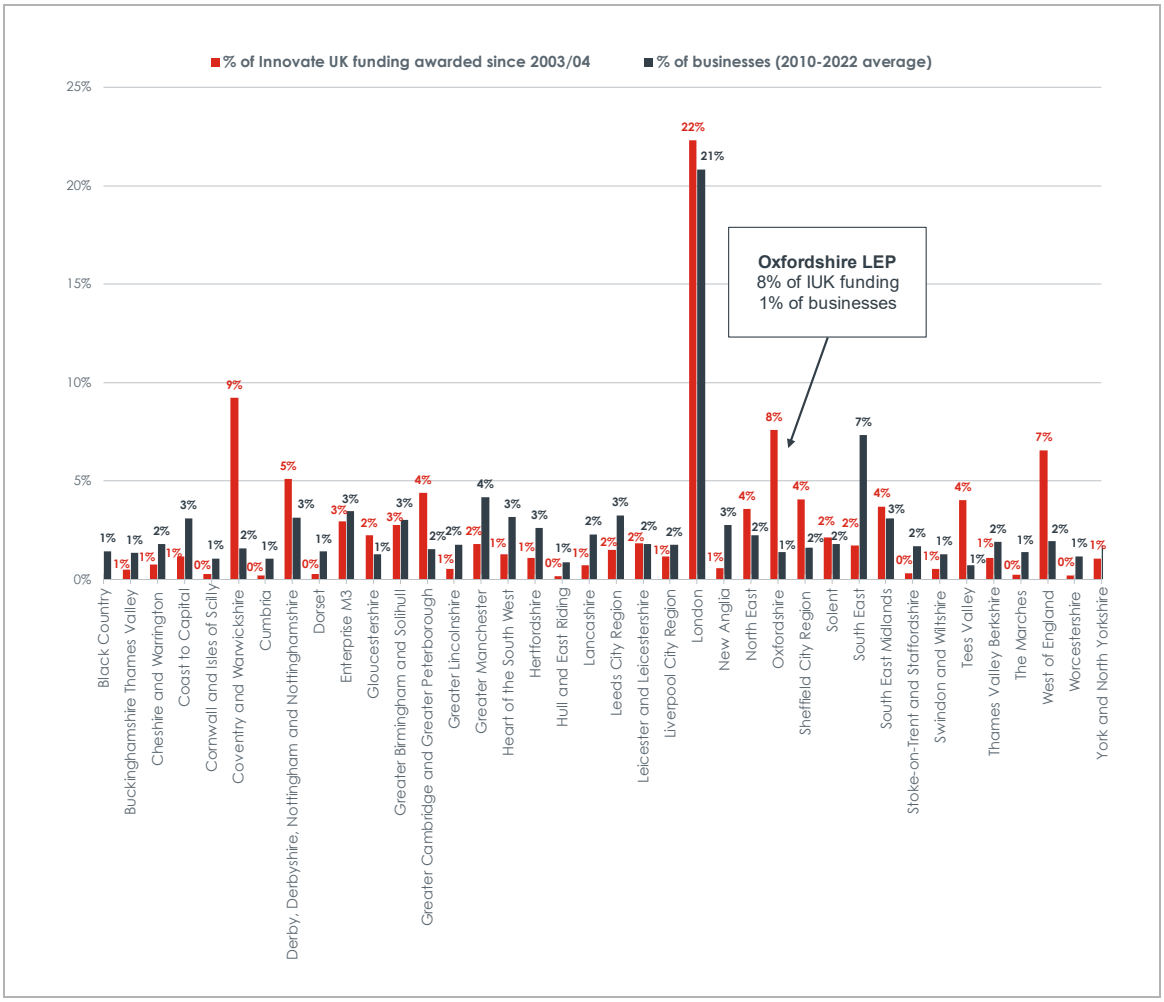
- Oxfordshire has attracted substantial institutional investment. Oxford Science Enterprises (OSE) was set up in 2015 and it has subsequently increased investment in university spinouts *"from an average of £125m per year (2011-15) to £1.4bn in 2021"*.[8] Some of these have subsequently grown at the Bioescalator, and then at locations including Oxford Science Park, Begbroke Science Park and Milton Park.

- Angel investment networks have matured. Oxford Angel Network merged with OION in January 2020 to create a unified angel network for Oxfordshire and beyond[9].

- Oxfordshire has attracted significant investment from Innovate UK, as the chart below shows. Overall it has accounted for about 8% of funding (across 38 LEP areas). This sums to over £1bn since 2003/04 – which is the third highest LEP area-level figure in absolute terms and the second highest on a weighted (per job) basis. Latterly (since 2018/19) it has seen the second largest volume of funding in absolute terms (behind only London), and the greatest overall funding on a weighted basis. The inference is that the UK's national innovation agency is investing heavily in businesses and organisations within the county. Major beneficiaries have included companies (such as Oxbotica, Delta Cosworth (Delta Motorsport), Williams Advanced Engineering, Reaction Engines and YASA) and organisations (e.g. Satellite Applications Catapult, Faraday Institution and Vaccines Manufacturing and Innovation Centre[10], all three of which are based on Harwell Campus).

[6] An account of progress over the last decade is provided in *Oxfordshire's Innovation Engine 2023: A scientific super-cluster, looking back, looking forward.* Produced by Advanced Oxford, this updated SQW's initial report on the Oxfordshire Innovation Engine which was published ten years earlier.
[7] Funding for a £500m upgrade was announced in September 2023 (see UK science facility that kickstarted Covid drug development granted £500 million upgrade fund - GOV.UK (www.gov.uk))
[8] See We found, fund and build for tomorrow's challenges, today - Oxford Science Enterprises
[9] See About Us | Oxford Innovation Finance
[10] Note that this was sold to Catalent in March 2022

Figure 2-1: Distribution of Innovate UK funding (since 2003/2004) across LEPs relative to the distribution of businesses



Source: Innovate UK. Data as at May 2023.
Note 1: The data includes awards made to both lead applicants and co-applicants based in a given LEP area.
Note 2: Multi-LEP awards have been excluded for analytical reasons. These account for a very low proportion (c. 0.3%) of IUK funding.

- Oxfordshire in general – and Oxford in particular – has attracted significant interest from overseas investors in office and laboratory space; GIC (Singapore) for example acquired a 40% stake in Oxford Science Park in 2021[11]. It is important also to note the role that Advanced Oxford has played in galvanising a dialogue across developers, particularly those with an interest in lab space and life sciences.

- On a different front, Oxfordshire has attracted inward investment: in March 2023, Moderna announced its intention to establish a substantial Innovation and Technology Centre at Harwell Campus. More recently again, BMW announced plans to invest £600m in the MINI plant at Cowley in Oxford, focused on the manufacturing of electric cars[12].

[11] See tps://www.savills.co.uk/insight-and-opinion/savills-news/326070/oxford-sees-record-breaking-levels-of-investment-as-it-continues-to-gain-ground-as-global-science-hub
[12] See Statement on BMW's plans to invest £600 million in MINI Plant Oxford (oxfordshire.gov.uk)

2.6 Whilst 'strong financing' could always be 'stronger', the progress over the last few years has been phenomenal. However there are remaining gaps and an important one relates to the financing of wider infrastructure; here, the mechanisms continue to be relatively underdeveloped and the progress of comparator areas (not least Greater Cambridge) should be recognised. A world class innovation ecosystem needs world class infrastructure.

Commercial culture

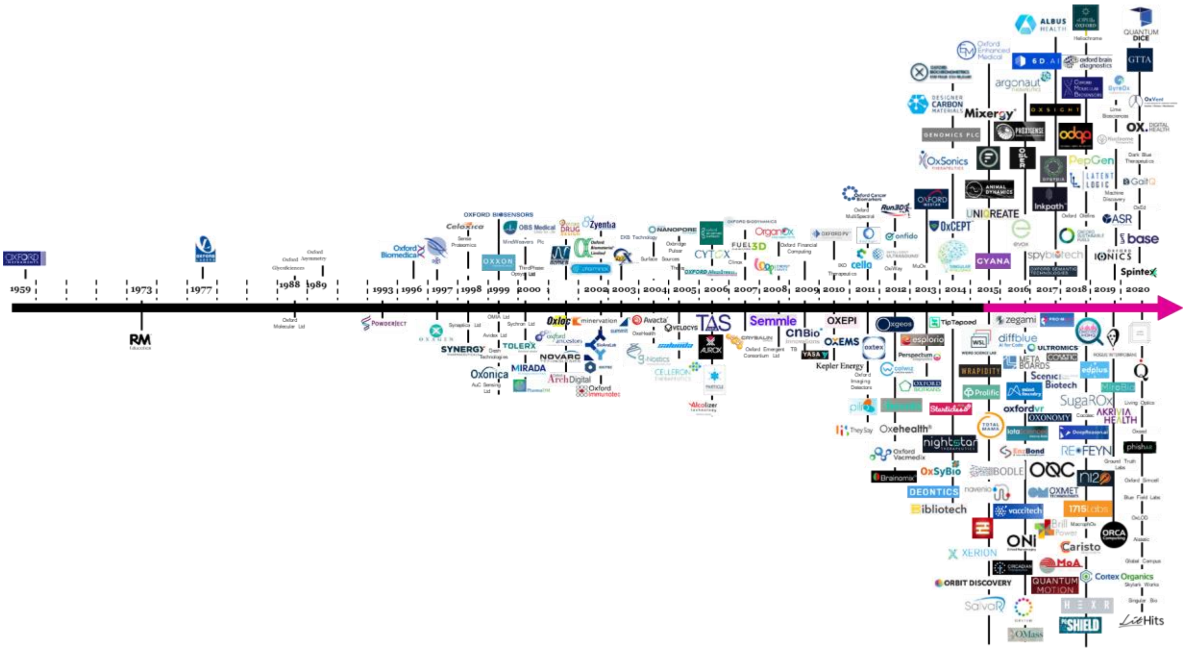
2.7 In the LIS, the point was made that Oxfordshire needed to create better enabling conditions for innovation, commercialisation, and the scale-up of businesses. The evidence points to real progress over recent years – not least in relation to different forms of both finance and commercial property as described above. One of our stakeholder consultees made the following observations:

The commercialisation process has got much better. OSE and OUI[13] have made a massive difference. There are over 100 companies in the portfolio, and they have attracted a lot of capital partners. It is all happening around Oxford. OSE in particular has hugely improved commercialisation from inside the University of Oxford (Stakeholder consultation, March 2023)

2.8 A core element of this process has been a so-called 'big bang' of spinouts from the University of Oxford which has been propelled by OSE, as illustrated in Figure 2-2 below. Evidence from Beauhurst suggests that the University of Oxford accounted for the largest number of spin-out businesses (across UK universities) between 2011 and 2022; University of Cambridge was in second place and two London institutions (Imperial College and UCL) were third and fourth. In addition, three of the top four IPOs of spin-outs by market capitalisation between 2012 and 2021 were linked to the University of Oxford. The largest of these – Oxford Nanopore Technologies – spun out from the University of Oxford in 2005 and secured £856m of equity funding prior to floating on the London Stock Exchange in September 2021[14].

[13] Oxford University Innovation, the University of Oxford's technology transfer office
[14] *Spotlight on spinouts: UK academic spinout trends* Beauhurst, April 2022

Figure 2-2: University of Oxford spinouts



Source: Oxford Science Enterprises

2.9 In parallel, international studies have pointed to the significance of graduates from the University of Oxford in driving forward unicorn businesses, whether or not they are formally spin-outs. A recent European study ranked the University of Oxford as the top academic institution for producing tech unicorn founders. It identified the Otto Beisheim School of Management (WHU) in Germany in second place and Stockholm University of Economics in third[15].

2.10 In terms of a commercial culture, developments at the 'big science' campuses have also been very significant. Harwell Campus, for example, has invested heavily in cluster development which is significant in this context [see Box 2-2].

[15] *Europe's new tech founders, 2023: the changing demographics of a new generation of tech founders* Published by Antler – see Meet the New Generation of European Tech Founders (antler.co)

Box 2-2: Cluster strategies linked to Harwell Campus[16]

Harwell Campus hosts over 6,000 scientists, engineers and innovators across more than 200 public, private and academic organisations; and the value of scientific infrastructure on the Campus is has been variously estimated in the range £2bn-£3bn[17]. The Campus occupies a 700-acre site, with about 1 million sq ft business space[18]. This includes some provision for small businesses – including an Innovation Centre which was established in 2000 and provides offices/flexible workspaces (110-1,400 sq. ft[19]).

In seeking to brigade its asset base – and to 'animate' the diversity of organisations and individuals within it – the managers/owners of Harwell Campus, led by STFC, have been increasingly proactive in the definition, management and promotion of a series of clusters. Facilitated by dedicated cluster managers and with oversight from wider steering groups (with representatives from Campus bodies, wider Oxfordshire stakeholders and national funding bodies/institutions), these have sought to encourage networking and collaboration within and between research organisations and businesses, and to provide a narrative that is compelling and communicable across the UK and internationally.

Currently the focus is on four key clusters[20]:

- **Space** was the first to be formally defined (in 2009). It is now associated with around 100 organisations with more than 1,400 staff. These include RAL Space, ESA's hub for satellite communications (ECSAT) and Business Incubation Centre, the UK Space Agency, the Satellite Applications Catapult, and companies such as Astroscale and Oxford Space Systems.
- As a cluster, **Energy Tech** was launched in 2018, bringing together over 80 organisations on Campus and over 1,400 people working within them. Key organisations and infrastructure include the Faraday Institution and the Extreme Photonics Applications Centre, and companies such as Qdot and Reaction Engines.
- With 74 organisations on site and more than 1,600 associated staff, Harwell's **Health Tech** Cluster includes organisations operating across medtech, biopharma, medical imaging and cell and gene therapy. Key organisations include the Rosalind Franklin Institute, the Diamond Light Source national synchrotron, the Nucleic Acid Therapy Accelerator and Medical Research Council Harwell, alongside companies such as Vaccitech.
- The National Quantum Computing Centre (supported by a £93m investment from UKRI and due to be fully open in 2023) is at the core of the new **Quantum Cluster**. Other key organisations include e6 and RedWave Labs.

Harwell Campus and STFC are working to encourage multidisciplinary research and development between the four clusters. The Campus provides a variety of support to organisations on site, including a start-up incubator initiative and the STFC-led Cross-Cluster Industrial Engagement Proof

[16] Based substantially on an annex to *Towards Pioneer Campus 2040* Prepared by SQW for Harwell Campus, April 2023. See Towards Pioneer Campus 2040 (hubspotusercontent-na1.net)

of Concept Grant (which runs across Harwell and Sci-Tech Daresbury); this offers up to £40k of grant funding from STFC (matched by businesses) to stimulate industrial engagement with organisations across the clusters. The Campus also runs schemes such as Connect Harwell, bi-monthly networking events open to all, and Connect Harwell Next Gen, a programme for early-career professionals and students[21].

2.11 All of this suggests that the commercial culture has developed substantially over recent years and – as an 'innovation *engine*' – Oxfordshire is world class. Previously its 'Achilles heel' was often seen as scale-up (i.e. many businesses were formed, but few grew locally), but there is some evidence to suggest that this is changing. The infrastructure to support scale-up has improved (with, for example, a network of innovation centres as well as financing mechanisms) and Oxfordshire is demonstrably now producing businesses that are growing locally; some are recognised to be unicorns. Interestingly, the feedback from stakeholders during workshops held in March 2023 as part of the Independent Economic Review suggested an ongoing challenge in relation to scale-up [see Box 2-4]. Whilst further improvement is always possible, it may be the case that local perceptions are now lagging the situation 'on the ground'.

Keystone assets

2.12 Oxfordshire's keystone assets are generally well established, and they have seen substantial investment over recent years. These take many forms. They include national assets linked to big science (notably Harwell Campus (including the Rosalind Franklin Institute; European Space Agency; Faraday Institution; Rutherford Appleton Laboratory; Diamond Light Source; National Satellite Test Facility; and National Quantum Computing Centre) and Culham Science Centre in Science Vale), but also the group of science and business parks that are functioning as innovation drivers in their own right (from Oxford Science Park, through Milton Park, Begbroke Science Park, Oxford Bioescalator, etc.) through to major businesses, research organisations and the two universities.

2.13 From the LIS, the key issue was less the scale and significance of these assets individually than the extent to which they operate 'as a system' (noting the parallels with key themes from the national *Science and Innovation Framework* which was published subsequently and is referenced above). This 'system' is one that needs to function both within Oxfordshire and also, importantly, beyond. Innovation, commercialisation and growth are complicated processes in the context of technological disruption and regulation is often a key factor. The

[17] Harwell Science and Innovation Campus (2022) Science and Innovation - Harwell Campus; Bidwells (2022) Harwell Science and Innovation Campus Limited Partnership (bidwells.co.uk)
[18] Harwell Science and Innovation Campus (2022) Science and Innovation - Harwell Campus; Bidwells (2022) Harwell Science and Innovation Campus Limited Partnership (bidwells.co.uk)
[19] Harwell Science and Innovation Campus (2022) Harwell Innovation Centre
[20] Harwell Innovation and Science Clusters - Harwell Campus
[21] Harwell Campus Proof of Concept Programme and Life at Harwell - Harwell Campus

possibilities for enterprise need to be understood in this context. As one of our consultees observed:

We are seeing significant investment in Oxfordshire's energy tech companies. Battery companies are putting demonstrators on site as a way of demonstrating the technology. But the challenges are vast. There is a hesitation to push too quickly because the regulation needs to align with technology. Regulation and (national) strategy are holding it back. Some of the ideas will need buy-in from government. But how does the dialogue happen? Through large organisations? Some have real influence, but it is very difficult indeed for the smaller companies to engage. (Stakeholder consultation, March 2023)

2.14 In this context, there is evidence of collective 'conversations' across, essentially, the 'triple helix' (research organisations/universities, industry and government) both within Oxfordshire and beyond. One example is through the annual 'Oxford Summit'[22], but there are many others too.

2.15 Some major externally focused ventures however have made limited progress since the LIS was published. (What was) the Oxford-Milton Keynes-Cambridge Arc largely stalled although a new Pan-Regional Partnership for the Oxford-Cambridge area (with, in 2023, a new managing director and new non-executive board members) is now creating renewed momentum. It is currently developing an *Investment Atlas* and it is also promoting an *Economic Prospectus* (undated) which sets out the ambition to maximise the area's transformative economic potential. It states that "*we will increase productivity by intensifying our global strengths in science, technology and high-value manufacturing together and contribute to a doubling of GVA by 2050 to over £200bn"*[23]. Its six economic priorities are very similar to those identified previously in Oxfordshire's LIS.

Talent proposition

2.16 The pace of growth opportunities is such that there have been substantial pressures in relation to labour and skills supply. Evidence within Oxfordshire's *Local Skills Report and Plan* (which preceded the *Local Skills Improvement Plan*) indicated that employers are reporting shortages of high-level technical skills, particularly in (what it describes as) the 'innovation sector'. In this context, labour shortages have been amplified by settlement challenges following the UK's departure from the EU.

2.17 Consultations undertaken whilst collecting evidence for the SEP also pointed to the scale of the challenge. One consultee noted:

If we have 300 new spin-outs, it means that 300 of everything is needed – finance directors, HR professionals, and so on. If those businesses scale, there are foundational economy skills issues too. The commercial property industry has responded, but we are not seeing the skills side

[22] See Oxford Summit | University of Oxford
[23] See 63d13481b378db530c13542f_Oxford.to.Cambridge.Partnership.EconomicProspectus.pdf (webflow.com)

responding in anything like the same way. We have got to get to grips with it, and to be far more agile in relation to changing skills issues (Stakeholder consultation, March 2023).

2.18 In parallel, one of the submissions (from a business) through the 'Call for Evidence' highlighted the critical importance of labour supply issues more generally, particularly in relation to technicians and support staff. There was a strong sense that these skill sets are in especially short supply:

If the region wants to retain some of the start-up and scale-up businesses in the region, long term solutions must be found for infrastructure and facilities that enable the 'foundational economy' to thrive – technicians, apprentices and support staff for these industries will not be available. (Submission to the Independent Economic Review / SEP Call for Evidence, Spring 2023)

2.19 At the same time, however, there is also much evidence that the innovation ecosystem is not drawing on the full range of talent in Oxfordshire. Businesses within it are overwhelmingly run by white men (as is the case nationally): research by Oxford Brookes University found that women are under-represented within the innovation ecosystem and, although the evidence is thinner, the strong suspicion is that the same is true in relation to those from black and minority ethnic (BAME) groups[24]. Yet as the authors reflected, "*the development of cutting-edge innovation requires diversity of ideas and perspectives*".

Liveable place

2.20 Alongside issues of skills and labour supply (linked to diversity and inclusion), the pace of investment has created place-based pressures. Rental levels for city centre office space and for accommodation on the major science parks across Oxfordshire doubled between 2016 and 2023[25]. There has been a significant shortfall in the availability of laboratory space[26], particularly within Oxford (where demand is highest), while available office space is often of a poor quality.

2.21 However there are major schemes within the development pipeline – and on one estimate, up to 1.9 million sq ft of office and laboratory space is due to be delivered between 2023 and 2025[27]. Examples of major schemes include Oxford North (almost one million sq ft); 135,000 sq ft of space for commercial/ University research at Begbroke Science Park; 625,000 sq ft of R&D facilities at Oxford Science Park; and an 80,000 sq ft venture at Milton Park. Longer term, there are plans for a science and technology park at Salt Cross in West Oxfordshire. The provision of commercial space should then increase – albeit with concerns surrounding its affordability.

[24] A Snapshot of Gender Diversity in Oxfordshire Innovation/ Knowledge-based Companies, Discussion Paper by Alexis Still and Professor Simonetta Manfredi, Oxford Brookes University (2021)
[25] Oxfordshire's Innovation Engine 2023, Advanced Oxford
[26] This is recognised as a constraint in relation to the UK government's ambitions to become a science superpower. See Howard T, Science superpower dreams thwarted by lack of laboratory space, The Times 14 February 2023
[27] Savills UK | Oxford sees record breaking levels of investment as it continues to gain ground as global science hub

2.22 There are two other dimensions of 'liveability' that have also featured prominently throughout the evidence gathering for the SEP:

- The *affordability of housing* continues to be a major concern. Housing is, in general, expensive in Oxfordshire. There are particular challenges for those in lower paid jobs and/or those whose jobs are temporary (which may well include international workers with short term contracts). In relation to the innovation ecosystem, there are many roles which are not well paid – from lab technicians through to post-doctoral studentships and those working in start-up businesses whose take-home pay may be modest and insecure. The associated challenges are well rehearsed. They are also long term in nature. However data from ONS suggest that the ratio of lower quartile house price to lower quartile gross annual workplace-based earnings was lower in 2022 (the latest year for which data are available) than in 2018 for every district in Oxfordshire. The data are insufficiently robust to conclude there has been a significant 'improvement' and the changing ratios may have been a reflection of short term shifts in house prices post pandemic, but this insight is interesting and needs to be monitored.
- In addition in terms of 'liveability', *congestion in Oxfordshire* is an ongoing issue. In Oxfordshire, the M40 and A34 are both part of the Strategic Road Network, and both saw speeds decrease in the years before the pandemic. The decrease in road speeds was however greater on the county's A roads (in line with the national average); and within this, the greatest deterioration was seen on the A4185 and the A4130. In parallel, the reliability of frequent bus services in Oxfordshire has decreased in recent years, in part because of congestion, whilst movements of freight were affected by – and contributors to – growing congestion[28]. Congestion is then a continuing problem – and an ongoing threat to Oxfordshire's aspirations to be a top three global innovation ecosystem.

Evidence of – and implications for – wider diffusion

2.23 Overall then, the progress of recent years in relation to the innovation ecosystem has generally been strong. But what of wider diffusion? This is more complicated conceptually and the surrounding evidence base is underdeveloped.

Supply chains

2.24 In relation to the know-how from the core innovation ecosystem finding its way into other parts of Oxfordshire's economy, the evidence is limited. In principle, the strongest link is through supply chains, and there is acknowledgement that the major organisations in particular are making some efforts. As one consultee explained:

The big campuses are moving in the right direction – e.g. there is more focus on local supply chains. They talk the right language about integration but work still needs to be done on the pathways. Oxfordshire Inclusive Economic Partnership is doing work on local procurement, but

[28] Local Transport and Connectivity Plan – Baseline Report, Oxfordshire County Council, July 2022

no one is good at building local supply chains and there is a lot to do (Stakeholder consultation, March 2023).

Oxfordshire businesses growing elsewhere

2.25 There is also some evidence of businesses that were formed in Oxfordshire – sometimes as spin-out businesses – growing elsewhere. Views varied on the desirability of this process. For some, it was an opportunity 'lost' (and evidence that provision for scale-up has some way to go). For others, it was a sign that Oxfordshire is making an appropriate contribution to growth across the UK, including outside of the Greater South East, and therefore to general processes of 'levelling up' [Box 2-3].

Box 2-3: Oxfordshire's contribution to innovation and wellbeing elsewhere in the UK

Oxfordshire is a home for world class research and innovation – and many of the organisations that are part of this ecosystem need to be in Oxfordshire. Some cluster around the specialist scientific infrastructure and most of these businesses also draw on Oxfordshire's specialist labour market.

However there are many examples of commercialisation processes occurring elsewhere in the UK – even if the science continues to be concentrated in Oxfordshire.

One example is YASA Motors. YASA is a spin-out from University of Oxford which was founded in 2009. In 2018, YASA officially opened a 100,000 unit per annum e-motor serial production facility in Kidlington near Oxford. This was followed by specialist Controller development team, based in Welshpool, Wales. In 2021, it was acquired by Mercedes-Benz.

Role of creative industries in diffusion

2.26 Oxfordshire is home to 5,000 creative industries businesses and it was defined as a high growth cluster in the Creative Industries Sector Deal (2018). More recent analyses have pointed to 11 microclusters[29] and three rural clusters[30]. There is substantial overlap between the creative industries and what might be defined core sectors in relation to the innovation ecosystem – notably in relation to software/computing services, gaming, and publishing. However the creative industries are certainly broader, and Oxfordshire has specialisms linked, for example, to music and performing arts. These can often be a route to social and economic inclusion (and also to place shaping). It is probable therefore that the creative industries in the round – and the process of creativity more broadly – is important in relation to the diffusion of ideas, insights and know-how across different parts of Oxfordshire and beyond.

[29] *Creative Industries Radar: Mapping the UK's creative clusters and microclusters* Josh Siepel, Roberto Camerani, Monica Masucci, Jorge Velez Ospina, Patrizia Casadei, Martha Bloom (2020). Creative Industries Policy and Evidence Centre / Nesta

[30] *Rural Enterprise: Mapping and examining the determinants of England's rural creative microclusters* (May 22) Creative Industries Policy Evidence and Centre and National Innovation Centre

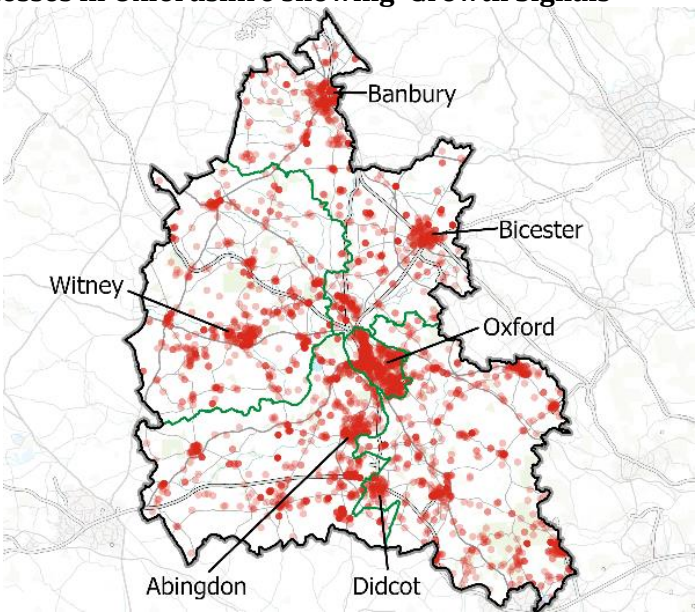
Working from home

2.27 With the rise – and persistence – of home-based working in some sectors[31] since the start of the pandemic, stakeholders within Oxfordshire are seeing what they describe as '*diffusion by stealth*' – as the spatial reach of labour markets grow and the opportunity to participate in Oxfordshire's innovation economy extends across a broader geography. The consequences are, as yet, unknown: larger labour markets *might* ease recruitment and retention challenges, and working from home *might* ease congestion (at least on some days), but what are the consequences in terms of the processes of innovation, and in terms of carbon consumption (as homes become workplaces which need to be heated all day during the winter months)?

Wider patterns of, and limits to, business growth

2.28 Finally, it is important to note that growth businesses are seen county-wide. The map below was generated by glass.ai. It shows spatial concentrations of growth businesses that essentially map onto the main urban areas and the major employment sites. Whether this is a sign of 'diffusion' is impossible to know, but it suggests that the conditions for business growth are reasonable county-wide.

Figure 2-1: Businesses in Oxfordshire showing 'Growth Signals'



Source: Source: Produced by SQW 2023 based on data provided by glass.ai. Licence 100030994
Data: Esri, Ordnance Survey © Crown copyright and database right 2023
Note: 'Growth Signals' have been identified through a web-crawl of Oxfordshire businesses, with a business tagged when its company website refers to one of: new offices, funding, collaborations, product launches and hiring. 6,129 out of 18,240 Oxfordshire-based businesses with a web presence were identified as having a 'growth signal'.

[31] In practice, the shift to home-based and/or hybrid working is complicated. Patterns vary hugely by sector – and for many involved in manufacturing activities, retail and many public services – it is simply not an option. Even where it is possible, employers – and their staff – are still working through different formulations. However a recent report by McKinsey Global Institute (July 2023) suggested that office attendance has stabilised at 30% below pre-pandemic norms in major cities. It noted that cities and buildings need to adapt to hybrid approaches – with more mixed use neighbourhoods, more adaptable buildings and more multiuse office and retail space. (see The impact of the pandemic on real estate | McKinsey)

2.29 However alongside the functioning of the innovation ecosystem, there is also some suggestion that many SMEs in Oxfordshire continue to struggle in relation to basic business functions – just as they do in every local economy. This in turn was considered to limit the extent of both innovation and diffusion. As one of our consultees noted:

During the pandemic, we did a lot to support local SMEs. I was struck by how little use is made of even basic accounting software. We asked about scaling, etc., but often the basic understanding of how to run a business was not there. Everyone is 'busy being busy' – so the capacity to innovate seems very limited. (Stakeholder consultation, March 2023)

2.30 Alongside the achievements of the innovation ecosystem, this observation sits uneasily. It is however important for the new Strategic Economic Plan.

Feedback from stakeholder workshops

2.31 The issues of innovation and diffusion – and links to a world class innovation ecosystem – were discussed and debated and at two stakeholder workshops which were held in March 2023. Key points that were made are summarised below. These highlight the complexity and fluidity of the situation – and the changes that have been seen in the recent past. They also hint at some of the trade-offs that will need to be navigated. On reflection, however, four points arguably stand out:

- the extent to which innovation and diffusion (of whatever form) is essentially about people (and the role that young people can play was particularly noted);
- the need for innovation, particularly in respect of public services (linking to the foundational economy); and
- the actual and potential role of anchor institutions (of many different forms) as a catalyst for further change
- the importance of place (and particularly infrastructure) in enabling innovation and diffusion.

2.32 All of these messages are important for the new SEP.

Box 2-4: Innovation and Diffusion – key observations made during stakeholder workshops, March 2023

The first set of workshops undertaken as part of the Independent Economic Review process focused on gathering evidence and insight across four 'deep-dive' areas.

Stakeholder feedback in relation to innovation and diffusion included:

- **Innovation potential in Oxfordshire is extremely high**: the county has significant assets and capacity, and this constitutes a key resource.
- **There is a huge amount of commercialisation in Oxfordshire, but the county is criticised because it doesn't produce large businesses**. Businesses grow to a certain size then are sold. However, is this starting to change?
- **Part of the problem is a very stretched infrastructure that can't support large businesses and organisations.**
- **Accelerating innovation may have consequences for land use planning and infrastructure:** The inference is that an holistic and systemic response is needed, recognising that innovation is cross-cutting (and it is not just concerned with science). If people know where, for example, bus routes are planned, then they can organise economic activity accordingly, and there will be a process of diffusion.
- Oxfordshire creates great innovations but **doesn't use them within the county** (for example in healthcare). In part, this is because **anchor institutions are not buying from SMEs**. Large bodies find it difficult to buy from SMEs. Is there a real opportunity here?
- **Innovation in the foundational economy is critical for the future of Oxfordshire:** There is a real need for innovation across healthcare, transport, childcare, etc.
- **Permeability of the knowledge economy is becoming increasingly important.** The 'old model 'of the closed-off business park is not working; instead there is a need to engage with the community so they know what happens and benefits.
- **Young people are generally early adopters and keen to try different things – but there is a need for diffusion to older age groups, so that Oxfordshire as a whole might move forward.** Business leaders, inward investors, universities, all connect with young people through education, and social media has an important role to play, but diffusion needs to be in both directions.
- **Stewardship is very important, and it is notable that the most successful investment in Oxfordshire is by long-term investors.** They have a 'natural bent' towards sustainable development because of their long-term engagement.

- **The shift to working from home is likely to be important in relation to innovation and diffusion**:
    - 'Diffusion by stealth' is the consequence, and this could result in larger recruitment pools.
    - Are there actually 'hidden business parks' with clusters of homeworking potentially spearheading both innovation and diffusion?
    - There is a need for better digital infrastructure, including rural phone signal and broadband connection.
    - Homes need to have provision for office space – so this should influence how homes are designed.
    - Working from home is having an impact on the sustainability of public transport in the county.
    - It is too soon to say how working patterns will evolve: working from home won't suit all sectors.
    - Is a diffused workforce actually less innovative? Is this a risk for the county?
- The role of Oxfordshire and manufacturing:
    - Scaling up businesses would mean manufacturing at scale. Is this plausible within Oxfordshire (given its costs and constraints)?
    - If Oxfordshire doesn't have the space, can it link up with areas that are better suited for manufacturing? Example: products for the space industry are designed in Oxfordshire but not made here.
    - If manufacturing goes elsewhere, where does that leave the foundational economy?

3. Looking to the future

3.1 In relation to Oxfordshire's aspiration to be a top three global innovation ecosystem, six key themes were identified in the LIS in 2019. Across these, the evidence appears to suggest substantial headway in relation to three and these now are – or are well on their way to becoming – genuinely world class. These are: **iconic brand; strong financing;** and **commercial culture**. One consequence has been a rapid growth in the stock of high tech businesses[32] and associated employment[33] over recent years. While there is no room for complacency, Oxfordshire's innovation ecosystem appears to be in a strong position, including in relation to international benchmarks. As defined, evidence of progress in relation to the other three themes (**liveable place; keystone assets;** and **talent proposition**) is less conclusive – albeit we are four years into a 21 year journey (from 2019-2040). Some progress has certainly been made but challenges remain, and there is more to do.

3.2 However, when the perspective is broadened away from the innovation ecosystem (in a narrow sense) to innovation and diffusion across Oxfordshire more generally – consistent with higher productivity and a more efficient economy (including in relation to all three of the other Deep Dives[34] which have shaped the Independent Economic Review and informed the SEP), this second group of themes becomes critical. **In a sense, liveable place, keystone assets and talent proposition (or more simply, place, assets and people) are the 'transmission mechanisms' between Oxfordshire as a hub for world class science and technology, and the economy of Oxfordshire more broadly.** In other words, they are, arguably, the 'connecting tissue'. Looking ahead, there are clearly issues that need to be resolved – hence the new Strategic Economic Plan – and at least some of the solutions must be defined around these 'transmission mechanisms'. There are both opportunities and threats for Oxfordshire in this context.

System-wide responses for a 'liveable place'?

3.3 Looking ahead, the challenges around 'liveable place' are substantial and yet, the innovation ecosystem itself ought to present some solutions. An illustration of how this might work was provided by one business stakeholder:

Oxfordshire is home to Oxbotica, a world leader in autonomous vehicle technology, and the first road tests in the UK have been carried out on the streets of Oxford. That provides an opportunity to target early roll out of technology, bringing first mover advantages as well as jobs and

[32] On a narrow definition developed by Eurostat – it is estimated that numbers doubled between 2013 and 2021, to almost 3,000

[33] Knowledge intensive employment across Oxfordshire grew from about 16,000 jobs in 2011 to almost 29,000 in 2021, an increase of over 80% (based on data from BRES)

[34] i.e. inclusion and progression; sustainability and the transition to net zero carbon; and the foundational economy

investment in connection with associated infrastructure. (Submission to the Independent Economic Review / SEP Call for Evidence, Spring 2023)

3.4 Similar illustrations were made in relation to other technologies and other infrastructures – most notably sustainable energy. There were also examples of Oxfordshire-based companies leading the way elsewhere[35]. The extent to which Oxfordshire has the appetite to be a 'living lab' or 'test bed' – using its innovation ecosystem to solve its own challenges – needs to be established.

3.5 The limits to the 'system' – in sharp contrast to the strengths of the 'components' – is not, in some respects, a new finding. Indeed, the need for 'collaboration' is writ large in the objectives accompanying the Vision for Sustainable Development crafted by the Future Oxfordshire Partnership. But in the context of Deep Dive 4, the associated challenges were captured by a business stakeholder (through the Call for Evidence) in the following terms:

To achieve large scale Net Zero and sustainability projects, the vision and strategy need to help identify the integration of a complex systems of systems (e.g. one company's waste is another's fuel), not just isolated technology demonstrators. Having worked with many of the campuses in the region, it is clear that collaboration is limited, with a focus on gaining any funding for a breadth of independent technology demonstrators. Indeed, every organisation has its own plan. (Submission to the Independent Economic Review / SEP Call for Evidence, Spring 2023)

3.6 A 'system of systems' could be genuinely transformative and – given the scale of the challenges linked particularly to 'liveable place' – it represents a key opportunity. Integration is difficult. Greater collaboration ought, however, to be possible. In its consideration of Oxfordshire's Innovation Engine 2023, Advanced Oxford came to a similar conclusion. One of its recommendations was to '*develop activities which join up nodes of innovation across the region and help others navigate the landscape through better defined pathways and connectors*'[36].

Enhancing the 'talent proposition'

3.7 The opportunities and challenges in relation to 'people' have many dimensions – skills, labour supply, recruitment, progression, inclusion. Looking forward, the links between people 'within' the innovation ecosystem and those that 'surround' it will be absolutely critical. These links are, arguably, the most effective and important route to diffusion and more pervasive innovation across Oxfordshire.

3.8 An overarching requirement – and opportunity – is for greater 'porosity'. There is evidence to suggest that major organisations and businesses from within the innovation ecosystem are paying far more consistent attention to issues linked to inclusion; through the Call for

[35] See for example The University of Birmingham partners with Siemens to create the smartest university campus in the world - University of Birmingham

[36] *Oxfordshire's Innovation Engine 2023: A scientific super-cluster, looking back, looking forward.* Advanced Oxford. Page 58

Evidence, one respondent for example made reference to an internship programme within their own organisation which was starting in 2023 and targeting people from under-represented groups. The major campuses are also taking steps to increase levels of diversity. Harwell Campus, for example, is hosting '*The RISE TOGETHER Solutions Summit: Accelerating Inclusion in Space and Aerospace*' as a direct response to skills shortages and inclusion issues in the sector[37]. There are many other initiatives of this nature.

3.9 The 'priorities for change' identified in the newly published *Local Skills Improvement Plan* (which focus on inclusion, partnership, aspiration and careers) should all be helpful. The fact that the new Employer Board has a chair from Moderna and includes representatives from priority sectors, SMEs, and the locality is to be welcomed[38].

3.10 However there is a lot to do in relation to the 'talent proposition'. The challenges are tied up with issues linked to 'liveable place' and some creativity will be needed in developing appropriate solutions. These in turn must respect and respond to the constraints linked to the combination of a medieval city, market towns and Oxfordshire countryside, much of which is (rightly) protected through environmental designations. Transport infrastructure and other forms of connectivity will be critical, but there are key social dimensions too, and these will demand innovative and creative responses.

[37] See Rise Together: SOLUTIONS SUMMIT - Harwell Campus
[38] See https://www.oxfordshirelsip.co.uk/wp-content/uploads/2023/08/OxfordshireAugustFinal.pdf

4. Innovation and diffusion: Summary SWOT

4.1 Drawing together the main lines of evidence and argument from previous chapters, the table below provides a summary SWOT statement. This provides an important input into the new Strategic Economic Plan.

Strengths	• Oxfordshire's innovation ecosystem has seen substantial investment over recent years from a range of sources, and this is driving change. • Commercialisation is now occurring at pace following major developments in the surrounding organisations/infrastructures – including in areas of science and technology that are likely to be transformational on a global stage and in which market potential is substantial. • Oxfordshire's global profile has grown – and Oxfordshire is recognised around the world for its strengths in science, technology and innovation. • There is increasing recognition from major science- and knowledge-based organisations of their local responsibilities and relationships (i.e. many are recognising that they are 'of Oxfordshire', not just 'in Oxfordshire') • There is evidence that more Oxfordshire businesses are successfully scaling-up – through IPO and then on (in some cases) to 'unicorn' status
Weaknesses	• Issues surrounding liveability in Oxfordshire are increasingly a weakness in relation to Oxfordshire's 'top three global innovation ecosystem' ambition. • In relative terms, limited progress has been made in relation to workforce skills linked to the innovation ecosystem; arguably insufficient attention has been paid to the issues from within the innovation ecosystem itself (although this may now be changing). • The innovation ecosystem continues to be dominated by white men (as company founders and business leaders): there is a need for far greater diversity and inclusion, not least to address labour and skills shortages. • Evidence linked to wider diffusion is very limited. However there are, in particular, imperatives surrounding public service innovation that ought to be prioritised through a system-wide response. • Alongside world-leading SMEs with growth potential, many SMEs in Oxfordshire are still very traditional in their approaches and the scope (for example) for the greater adoption of digital technologies is significant. • There is inconsistency among Oxfordshire stakeholders as to whether they want to see local scale-up – or whether it should be encouraged to happen elsewhere. There is a danger of mixed messages, and the implications need to be considered.
Opportunities	• Recent investment has been substantial, and this ought to provide a strong basis for furthering the innovation ecosystem and its global impact. • System-level responses need to be developed, founded on system-wide collaboration, including in relation to some of Oxfordshire's principal challenges (linked to liveability, etc.).

	• The potential of supply chains (linking the research base with local SMEs) is recognised but work needs to be done to unlock the potential. • Working from home and 'diffusion by stealth' might create new opportunities in labour market terms. • Oxfordshire's creative industries are thriving and this may facilitate innovation and diffusion, including through greater inclusivity. • There are opportunities for greater diversity within the innovation ecosystem and this itself could do much for innovation and diffusion, as different insights and perspectives are brought to bear.
Threats	• The relationship between 'liveability' (particularly affordable housing and workspace, and congestion) and the wider innovation ecosystem is, increasingly, critical – and it needs to be seen as a threat. • Labour market and skills issues are acute and creative solutions are needed, particularly as international labour markets have become more complicated and uncertain. • Linking to 'liveability', solutions will be needed to the provision of affordable workspace, which continues to be important in relation to the functioning of Oxfordshire as a whole.

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